
In-Vehicle Information Systems

Behavioral Model and Design Support:

IVIS Demand Prototype Software

User's Manual

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FOREWORD

This report was produced as part of a contract to develop an in-vehicle information systems behavioral model and design support system. The software program resulting from this effort will aid designers to develop in-vehicle information system user interfaces that demand less of the driver's attention. The Design Evaluation and Model of Attention Demand (DEMA_{ND}) software provides designers with a tool for predicting the attention demand of prototype displays for in-vehicle systems.

This report is the User's Manual that describes the purpose of the model and how to use it to predict attention demand. It provides a step-by-step presentation of the software functions and how they are utilized to generate successful models. The User's Manual uses extensive diagrams and screen captures to clearly guide the user when learning to use this software. In addition to the user's guide, the appendix in this report includes a brief summary of all the research supporting the various systems and functions in the model. This report is an essential companion to the software.

Copies of this report can be obtained through the Research and Technology Report Center, 9701 Philadelphia Court, Unit Q, Lanham, Maryland 20706, telephone: (301) 577-0818, fax: (301) 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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16. Abstract The purpose of this research was to develop a behavioral model and prototype computer program for evaluation of modern in-vehicle information systems. These systems differ from earlier in-vehicle instruments and displays in that they may require higher visual and cognitive loads and may also take greater advantage of voice commands and auditory presentation of information. The model developed for evaluation was composed of five driver attention demand components: visual, auditory, supplemental information processing, manual, and speech. The fundamental idea was to develop a new computer program that would assess the resources required of the driver when performing in-vehicle tasks using these complex systems. This document is a short user manual describing the primary functions of the IVIS Demand prototype software.			
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What is IVIS DEMAnD?

The In-Vehicle Information System (IVIS) Design Evaluation and Model of Attentional Demand (DEMANd) was developed to run under Windows 98 or Windows NT™. IVIS DEMAnD is an analysis tool to help vehicle manufacturers and designers of in-vehicle information systems produce systems that do not unduly overburden drivers or distract them from their primary task of driving. The tool is based on a model of driver behavior developed from numerous human factors studies. This model treats the driver as a collection of visual, auditory, supplemental information processing (SIP), manual, and speech resources. The task of driving the vehicle requires most or all of these resources to varying degrees throughout a trip. The load placed on these resources depends on numerous factors, including

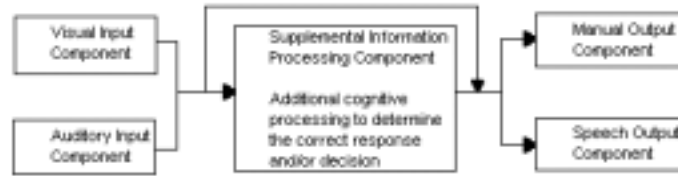
- driver-related factors such as age and the reliance drivers have on signs, symbols, or characters to complete a task;
- driving environment factors such as the level of congestion and the complexity of the road the driver needs to navigate; and
- visual factors such as the size of characters or symbols, their luminance in displays, and the display density, all of which affecting how quickly a driver can find and comprehend certain text or symbols.

When tasks are added to retrieve information or perform a task other than driving the vehicle, the driver's resources are burdened further. When these resources become overburdened, the driver is no longer operating in an acceptably safe manner.

The research to date does not measure driving performance directly. This model uses measures such as estimated single glance time to a display and the number of glances required to comprehend a message, or the amount of time the driver's hand is off the wheel, to derive a figure of demand associated with discrete tasks. The model incorporates the following independent measures of demand:

Resource	Calculated Demand Measure
All Resources	Estimated Total Task Completion Time (seconds) Estimated Percentage of Drivers Unable to Complete the Task
Visual	Estimated Single Glance Time (seconds) Estimated Number of Glances Estimated Eye Transition Time (seconds)
Auditory	Estimated Number of Message Presentations Estimated Message Duration (seconds) Estimated Word Length Subjective Message Complexity Rating
SIP	Subjective SIP Mental Demand Rating Subjective SIP Frustration Level Rating Subjective SIP Time-sharing Demand Rating
Manual	Hand at Task Time (seconds) Hand Travel Time to Task (seconds) Hand Travel Time from Task (seconds)
Speech	Estimated Command Input Time per Attempt (seconds) Estimated Number of Command Attempts Subjective Speech Ease of Use Rating Subjective Speech Comfort Rating Subjective Speech Distraction Rating

This model of driver demand treats the visual and auditory resources as inputs to the driver. In many cases there is negligible additional mental processing needed for a driver to comprehend or respond to a visual or auditory input. This model considers additional cognitive processing [supplemental information processing (SIP)], such as considering alternatives to make a decision or selection, separately from the visual/auditory components used to input the information. When a driver must give some response or take some action, it requires a manual operation or a spoken command or both. These are considered the outputs for this model.



Several research studies have been used to develop a library of templates that describe for a particular task what resources are required to complete that task, how to calculate each independent demand measure for “average” or “default” conditions, and how these calculated measures should be adjusted when conditions deviate from the “average” or “default.” The demand measures for average or default conditions are referred to as “nominal” demand measures. Adjustment factors are used to modify the nominal values when actual or expected conditions deviate from the average or default. The actual estimated demand for a particular task is therefore the nominal measure multiplied by a series of applicable adjustment factors.

IVIS DEMAnD provides the framework for you to describe various in-vehicle information systems in terms of the tasks a driver might routinely perform and to compare the effects on driver attention demand of different tasks and different systems.

Getting Help As You Work

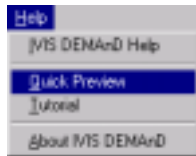
Help is available in a number of ways, including on-line and context-sensitive help, a brief preview of capabilities, and a more extensive tutorial.

On-line Help



Help is available any time through the main Help menu. You can search the on-line help for the information you need through its table of contents, index, find function. Once in the help system, you can select other available menu items. See the Windows User’s Guide for details on using the Windows help system.

IVIS Preview




To see a quick preview of the features of IVIS DEMAnD, select **Help | Quick View** from the main menu. A short sequence of help screens will explain the objectives of the application and its basic capabilities.

IVIS Tutorial



To navigate a tutorial on how to use IVIS DEMAnD, select **Help | Tutorial** from the main menu. A series of screens will take you through the process of creating systems, tasks, and subtasks; analyzing the demand for different values of driver or driving environment modifiers; changing the anthropometry of a subtask; and generating summary reports on task and subtask demand.

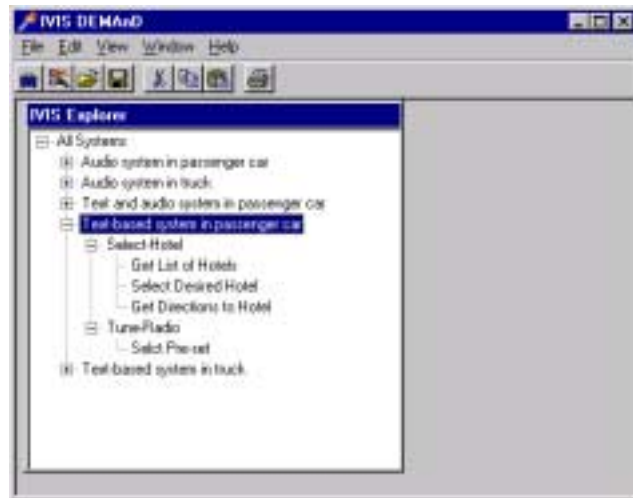
Context-Sensitive Help

Context-sensitive help will take you directly to the information you need. You can get context-sensitive help when you click the **What's This** button, , in a dialog box and then click on the item for which you need information. If the dialog or window does not have a **What's This** button, click on the item for which you need information and press F1. For more extensive information on a particular dialog or window, look in the on-line help.

Managing Systems, Tasks, and Subtasks

Overview

The IVIS DEMAnD model maintains a three-level hierarchy to describe the characteristics of a particular in-vehicle information system. These levels are the system, task, and subtask. At the system level, IVIS DEMAnD maintains information about the vehicle in which the system is installed. At the task level are the driver demand estimates associated with a particular driving task. At the subtask level, the highest level of detail describes the estimated demand the individual steps of a particular task will place on a driver.

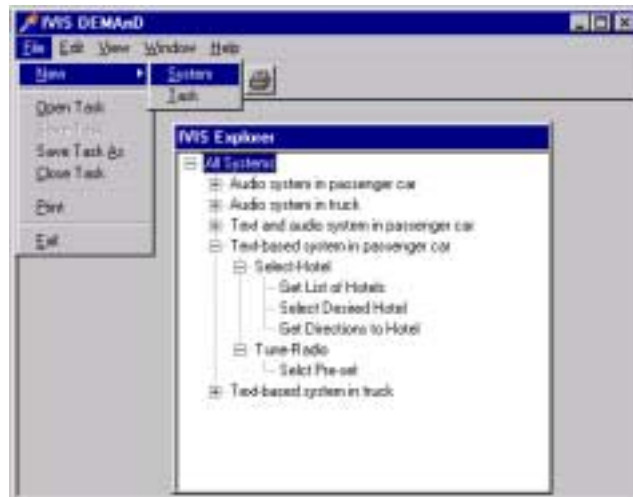


The IVIS Explorer provides a hierarchical view of the systems, tasks, and subtasks you have created. IVIS Explorer allows you to copy or move, delete or rename existing systems, tasks, or subtasks. You can also open tasks for further analysis or change a system's vehicle characteristics. New systems and tasks are created from the main menu or toolbar while subtasks are created through open tasks.

Creating Systems and Tasks

IVIS Systems are always at the highest level of the hierarchy, while tasks are always at the middle level of the hierarchy.

To create a new system select "All Systems" in IVIS Explorer, then select **File | New | System** from the main menu or click the **New System** toolbar button. A new system with the name "new name" is added to IVIS Explorer. You can rename the system using the popup menu from IVIS Explorer. Click the right mouse button on the system name to show the popup menu of available options.



To create a new task, select the system to which the task is to be added in IVIS Explorer. Select **File | New | Task** from the main menu or click the **New Task** toolbar button. A new task

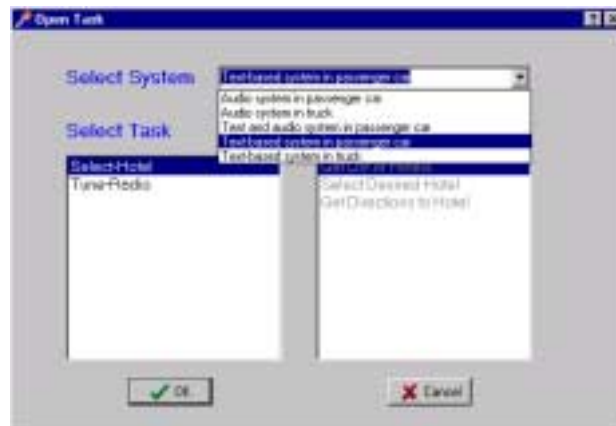
with the name “new name” is added in IVIS Explorer to the selected system. You can rename the task using the popup menu from IVIS Explorer.

Opening Tasks

To open a task, click the right mouse button on the name of the task and select **Open** from the popup menu. In the Task Window the opened task is highlighted and the overall task demand measures are displayed.

You can open all the tasks for a system by clicking the right mouse button on a system name, then selecting **Open** from the popup menu. A task window will be opened for all tasks associated with the system. Selecting **Open** from the popup menu for a subtask will open the Task Window for its parent task. In the Task Window the opened subtask is highlighted and its demand measures are displayed.

If you prefer to use the main menu or toolbar button, you can select **File | Open Task** from the main menu or click the **Open Task** toolbar button. The Open Task dialog is displayed. Select the system, then select the task to open and click OK.



Renaming Systems, Tasks, and Subtasks

To rename a system, task, or subtask, click the right mouse button on the name in IVIS Explorer and select **Rename** from the popup menu. The name in the tree view will be placed in an edit box, allowing you to edit the name. Enter a unique name and press ENTER. All system names must be unique. All task names for a particular system must be unique, but they can be repeated for other systems. For example, you may have the task “Select Hotel” for a “Passenger Car” system and a “Truck” system, but you may not have two different tasks named “Select Hotel” for the “Passenger Car” system. Similarly, subtask names must be unique for a particular task, but may be repeated in other tasks.





Copying and Moving Systems, Tasks, and Subtasks

Systems, tasks, and subtasks may be pasted only at specific levels of the hierarchy. A system must be pasted into “All Systems,” a task must be pasted into a system, and a subtask can only be pasted into a task. Nothing may be pasted into a subtask. The paste operation is not available unless you are at the proper level in IVIS Explorer. In addition, copy, cut, and paste operations may only be performed on objects that are not open. A task is open if there is an open Task Window for it. A system is open if one or more of its tasks are opened. A subtask is open if its parent task is open in a Task Window.

To copy a system, click the right mouse button on the system name in IVIS Explorer and select **Copy** from the popup menu. Click the right mouse button on “All Systems” in IVIS Explorer and select **Paste**.



If you prefer to use the main menu or toolbar, select the system name in IVIS Explorer, then select **Edit | Copy** from the main menu or click the **Copy** toolbar


button, . Select “All Systems” in IVIS Explorer, then select **Edit | Paste** or click

the **Paste** toolbar button, .




To copy a task, click the right mouse button on the task name in IVIS Explorer and select **Copy** from the popup menu. To move a task, select **Cut** from the popup menu. Click the right mouse button on the system name to which you want to add the task and select **Paste**.

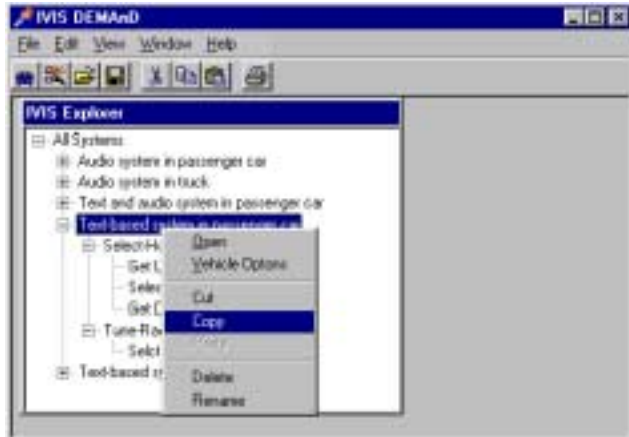
If you prefer to use the main menu or toolbar, select the task name in IVIS Explorer, then select **Edit | Copy** or **Edit | Cut** from the main menu or click the

Copy, , or **Cut**, , toolbar button.

Select the system name to which you want to add the task, then select **Edit | Paste** or click the **Paste** toolbar button, .

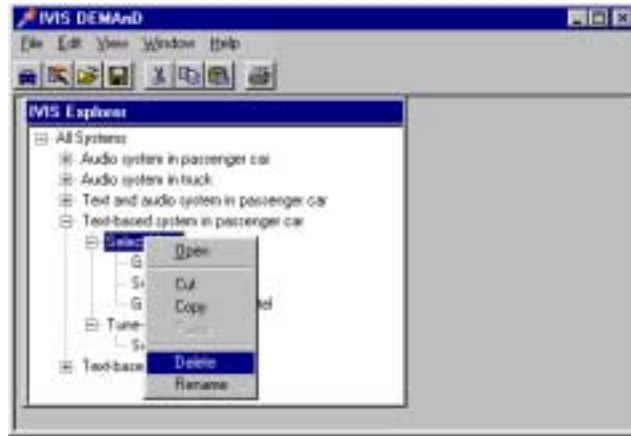
To copy a subtask, click the right mouse button on the subtask name in IVIS Explorer and select **Copy** from the popup menu. To move a subtask, select **Cut** from the popup menu. Click the right mouse button on the task name to which you want to add the subtask and select **Paste**.

If you prefer to use the main menu or toolbar, select the subtask name in IVIS Explorer. Then select **Edit | Copy** from the main menu or click the **Copy**, , or **Cut**, , toolbar button. Select the task name to which you want to add the subtask, then select **Edit | Paste** or click the **Paste** toolbar button, .



Deleting Systems, Tasks, and Subtasks

A system, task, or subtask may be deleted only if it is not open. To delete a system, task, or subtask, click the right mouse button on the name in IVIS Explorer and select **Delete** from the popup menu.



Changing System Vehicle Options

The vehicle options for a system describe the volume of space within which the in-vehicle information system exists. To edit the vehicle options for a particular system, click the right mouse button on the system name in IVIS Explorer and select **Vehicle Options**.

IVIS DEMAnD supports two basic vehicle classes: car and truck. All dimensions are in millimeters. You may change any of the dimensions by typing them in the appropriate edit fields or using the spin buttons to scroll quickly to the new dimension.



To restore the default dimensions for the selected vehicle class, click **Default**. All dimensions will be updated to reflect the current vehicle class defaults. You may re-define the defaults for the selected vehicle class by setting all the dimensions and then clicking **Save Default**. The dimensions you entered will be used any time a new system is created or whenever the **Default** button is clicked for any system.

To save the new vehicle options for the system, click **Save**. To discard changes, click **Cancel**.



Creating and Saving Subtasks


Overview

Subtasks are created in open tasks using the IVIS Subtask wizard. The wizard guides you through the process of describing the driver resources necessary to perform a particular step in a task, setting up the underlying relationships to estimate various demand measures, and establishing the nominal measures of demand.

A subtask may be created using a template from the IVIS Subtask Library or by copying an existing subtask. Each template in the IVIS Subtask Library is based on the results of one or more human factors studies and describes which driver resources are applicable, how the nominal measures of demand are calculated, and what effect different values of task and subtask modifiers have on the nominal measures. For more information on the templates in the IVIS Subtask Library and a list of references, refer to the appendix. The templates are organized in the appendix according to the applicable driver resources required to execute the task. This information is also available in the IVIS Task Library chapter of on-line help.

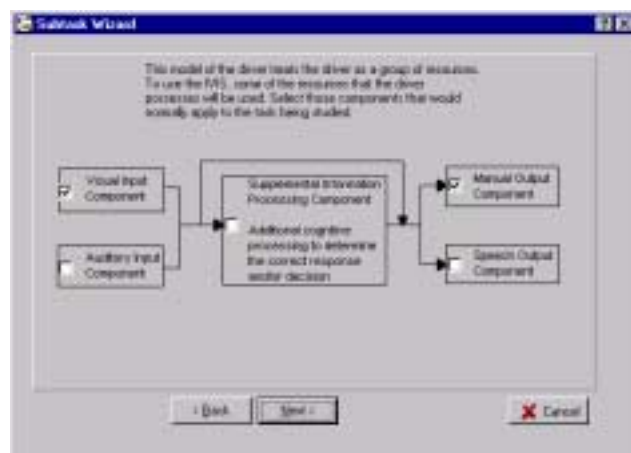
When none of the templates, nor any existing subtask, is suitable to estimate the nominal demand measures associated with a particular subtask, you may input the nominal values of the demand measures directly. Default relationships are used to estimate the effect different values of task and subtask modifiers have on your nominal measures.

Creating a Subtask

To create a subtask, open its parent task, then click the New Subtask wizard, . Begin by providing a unique name for the new subtask and, optionally, a description for it. Click **Next**.



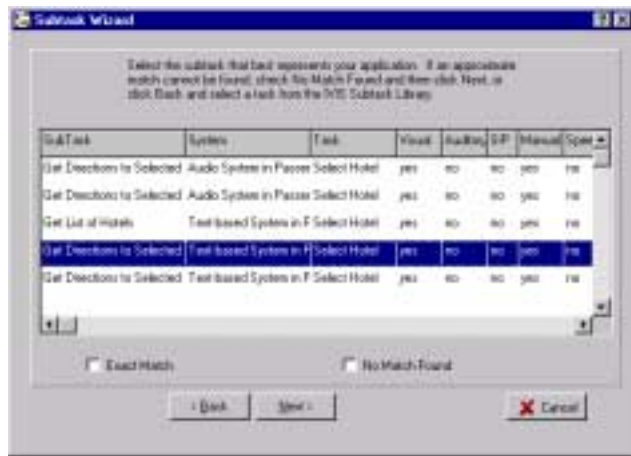
Next, select the driver resources required to complete the subtask. At least one resource is required, and all five may be selected.



Next, select the source for determining the mathematical relationships required to calculate nominal measures of demand and to adjust the nominals based on values of different driver and driving environment modifiers. You can either select a subtask from your personal library or select a template from the IVIS Subtask Library.



If the source you select is a subtask from your personal library, you may select from the subtasks of all the systems and tasks you have previously created. If none of the existing analyses is suitable, you may check **No Match Found** and continue, or return to the previous screen and try the IVIS Subtask Library. If you choose **No Match Found**, you will be asked to provide all the nominal measures of demand, and a default set of adjustment factors will be used to describe the effect of different values of driver or driving environment modifiers.



If the source you select is the IVIS Subtask Library, you may select from any of the templates that currently exist in the library. The template list will be scrolled to the first applicable template based on your selection of applicable driver resources. However, you may choose any template, not just one whose resources match those you have chosen. If none of the templates is suitable, you may check **No Match Found** and continue, or return to the previous screen to find a match in your personal library. If you choose **No Match Found**, you will be asked to provide all the nominal measures of demand, and a default set of adjustment factors will be used to describe the effect of different values of driver or driving environment modifiers.



Ultimately, all subtasks created in your personal library are based on either the default template (because **No Match Found** was checked in one or the other of the previous two screens) or a template from the IVIS Subtask Library. Whenever a subtask from your personal library is used as a template for a new subtask, the template used to create it is passed on to the new subtask. Thus the new subtask inherits the relationships of the template.



The model of driver demand uses the selected template (or subtask from your personal library) to calculate upper and lower bound values for each demand measure associated with the resources you selected as applicable to the subtask. If inputs are required, such as the number of buttons that need to be pushed in a panel, you will be prompted to provide them.

Nominal values are calculated or set assuming the following, wherever applicable:

Task Level Parameters

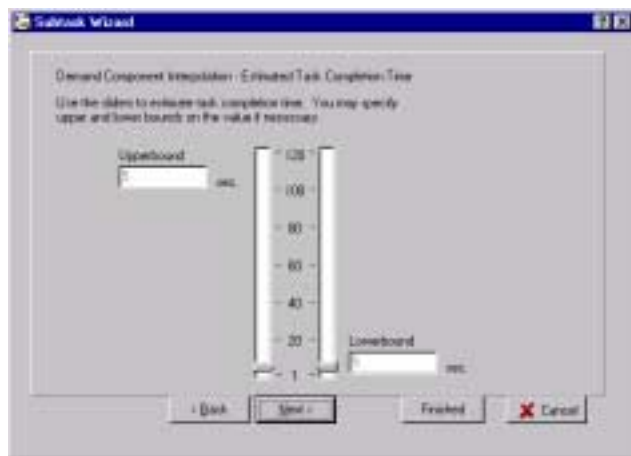
- Driver Age: All Ages
- Traffic Density: Medium
- Roadway Complexity: Medium
- Reliance on Symbols/Labels: Total

Subtask Level Parameters

- Character Height: 24 arc minutes
- Character Contrast: High (>7:1)
- Average Message Length: 4 words
- Average Display Density: 5 items

Once you have supplied all inputs required by the template, nominal values of all demand measures for the driver resources you selected are calculated or set. A template may not include calculations of all nominal demand measures you have selected. For example, you may indicate your subtask involves reading a small visual display and making some selection with push buttons and that this requires visual, supplemental information processing, and manual resources. You may select the “Select M of N Pushbuttons” template to create the task because it represents the closest match. The research used to develop this template only provided the relationships for visual and manual resources; it was assumed no other resources are required. The wizard will use the template to calculate the visual and manual demand measures, and the default values for supplemental information processing demand measures will be assigned.


You may review and edit the calculated or set values of all demand measures through a series of bounding screens. These screens allow you to adjust calculated values or set the nominal value to be bounded. For example, the template may calculate the nominal value of Estimated Task Completion Time for your subtask at 10.4 seconds, but with your own experience or research you prefer to use the range 9-12 seconds. You may adjust the lower and upper bounds to be 9 and 12 seconds, respectively.



You may review and modify any or all nominal values calculated by the template. If you are familiar with the template and do not wish to review the values or change the default subtask level parameters, you may click **Finished** at any time. To review all nominal values or modify the default subtask level parameters, continue paging through the wizard. After all nominal values for the resources you selected have been presented, the wizard will prompt you to modify, if necessary, the subtask-level parameters. You may change any or all of these parameters. When all nominal values and all subtask-level parameters are set to your satisfaction, click **Finished**.



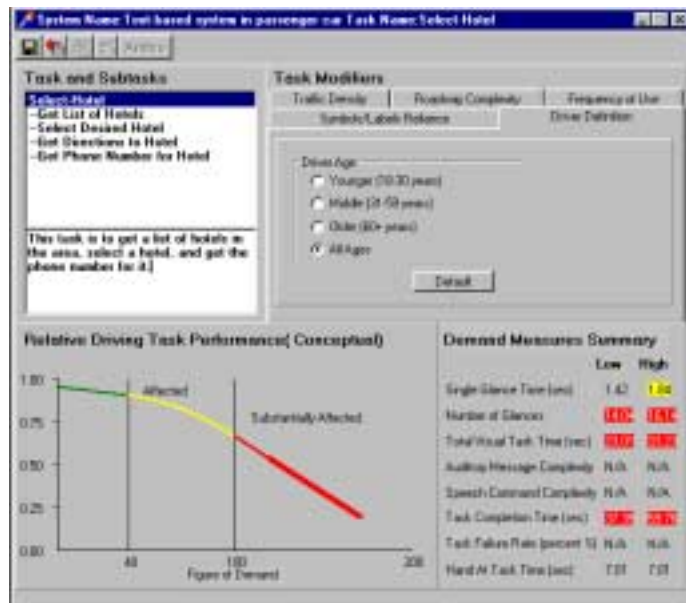
Saving a Subtask

When you have finished creating a subtask with the wizard, the new subtask is automatically saved and the open task is updated. If you modify the template inputs or subtask-level parameters in the Task Window, you may save the task and its subtasks by clicking the **Save Task** toolbar button, .

Analyzing Tasks and Subtasks With the Task Window

Overview

The Task Window describes the primary demand measures associated with a task and its subtasks. The measures under Demand Measures Summary represent the nominal values adjusted for the current values of all task and subtask-level parameters. When the task is selected in the Task and Subtasks list box, the task-level modifiers, conceptual effect on driving performance (Figure of Demand), and demand measures summary are displayed. If a subtask is selected, the subtask-level modifiers are displayed as well as the subtask-level demand measures summary and conceptual effect on driving performance.



The conceptual Relative Driving Task Performance graph indicates whether driving performance is estimated to be virtually unaffected (shown in green), affected (shown in yellow), or substantially affected (shown in red). On the horizontal axis, Figure of Demand is a unit-less, overall figure of demand. On the vertical axis, Relative Driving Task Performance ranges from 0.0 to 1.0 (completely unaffected). The graph is not intended to provide a quantitative comparison of driving performance for tasks or subtasks with different values of the overall figure of task demand. It is not intended to imply, for example, that a task with a task


demand of 100 affects driving performance 20 to 25 percent more than one with a task demand of 40. The graph is merely intended to conceptualize how driving performance might be affected.

Any or all of the nominal and estimated demand measures may be a single value or may be a range of values. The Demand Measures Summary panel shows the range for all primary measures. Each measure has its own yellow- and red-line values indicating where the measure is marginal or unacceptable, respectively. The overall task or subtask figure of task demand is calculated for all lower bound values and for all upper bound values. The graph is painted from 0 to the upper bound value of task demand. The thickened portion of the line indicates the actual range on Relative Driving Task Performance, calculated from the upper and lower bounds on the Figure of Demand. When the lower and upper bound values of all demand measures are the same, or when the difference in lower and upper values of Figure of Demand is negligible, the Relative Driving Task Performance is represented by the end point of the painted line.

Changing Task and Subtask Descriptions



To change the task description, select the task name in the Task and Subtasks list box and then edit the description in the edit box below. To change a subtask description, select the subtask name in the list box and then edit the description in the edit box below. You can also edit the subtask description through the Edit


Subtask wizard, .

Changing Task and Subtask Modifiers

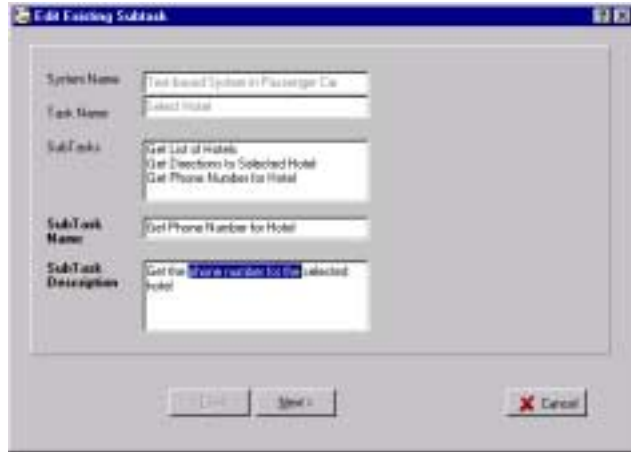


To change the task-level modifiers, select the task name in the Task and Subtask list box. The task-level modifiers are displayed as property pages. Any changes in parameter values are immediately reflected in the Demand Measures Summary measures and in the Relative Driving Task Performance (Figure of Demand) graph. To restore the default value for a modifier, click the **Default** button in the appropriate property page.

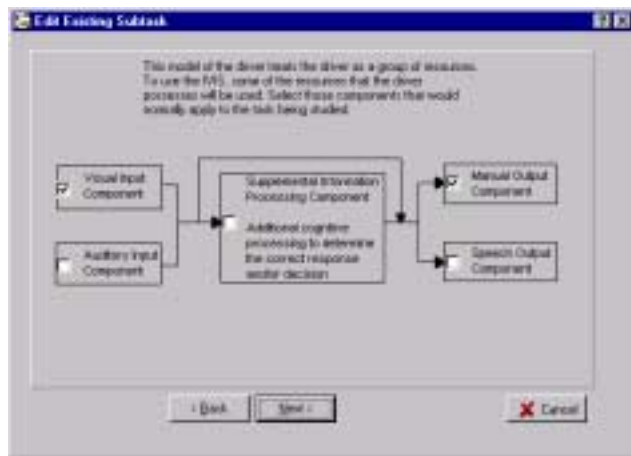
Changing the Nominal Demand Measures for a Subtask

You may change the nominal values of any of the demand measures for a subtask through the Edit Subtask wizard, . The Edit Subtask wizard is similar to the New Subtask wizard. The significant difference between the two is that you may not change the template describing the mathematical relationships. If you wish to redefine the task in terms of a different template, delete the task and re-create it with the desired template. Also, you may not change the name of a subtask through the wizard. To change the name of a subtask, use IVIS Explorer.

When you begin editing, the wizard will show you the current subtask name and description. You may change the description or click **Next**.



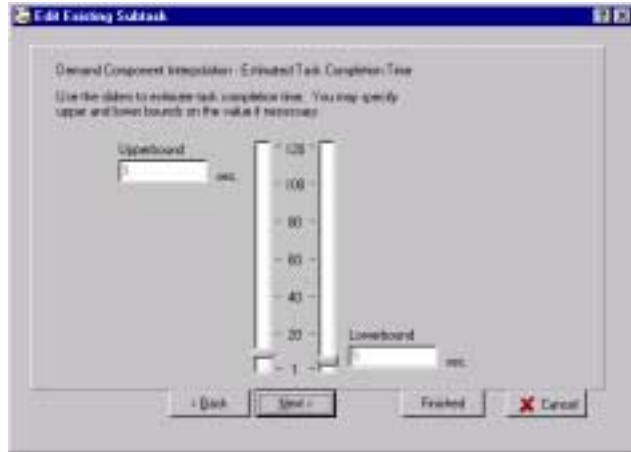
Next, the wizard will show you the driver resources you have selected as applicable to the subtask. You may change the selection, although at least one must be checked before continuing.



If inputs are required by the template to calculate nominal demand measures, the wizard will show you the current values of all inputs. You may change any of the inputs before continuing.




If you do not change any inputs, the nominal demand measures will not be re-evaluated using the relationships in the template. Your original adjustments, if any, in calculated nominal measures will be displayed in succeeding screens for you to review and modify. If you change any of the inputs, all nominal demand measures will be re-calculated. You can review and edit the updated values in the succeeding wizard screens.



Finally, after showing all demand measures, the wizard will display the current values of subtask modifiers. You may change any of the parameters. When you are done making changes to the subtask, click **Finished**. The subtask will be saved with the new changes and its parent task also will be updated.


Deleting a Subtask

To delete a subtask from a task, select the subtask in the Task and Subtasks list box and click the **Delete Subtask** toolbar button, . Once you confirm that you wish to delete the subtask its parent task will be updated.

Changing the Anthropometry for a Subtask

The subtask anthropometry refers to the location of display and/or control units in the vehicle relative to the driver. Anthropometry affects primarily the visual and manual resources. The coordinates of display and/or control units are recorded for each subtask since these may differ from subtask to subtask or task to task within a vehicle. For example, the location of the display and control for a task to tune the radio is different than that for a task to check the odometer or adjust the driver mirror.

Each template specifies whether the display and control units are co-located or separate units and the default locations. These coordinates correspond to the defaults used to generate nominal demand measures. The default coordinates are useful for comparing systems when the vehicle in which the system might be installed is of no importance. For example, you may wish to compare a system that is text-based and menu driven with one that incorporates auditory inputs and speech commands. You would want to compare how the method of accomplishing the task affects demand on the driver and eliminate the complicating affects of equipment location.

When location is important, you can specify the location of the display and control units required for a particular subtask. In the Task Window select the subtask in the Task and Subtasks list box and click the anthropometry toolbar button, . The Anthropometry wizard shows you the current settings for display and control dimensions and locations. All dimensions and coordinates are specified in millimeters.

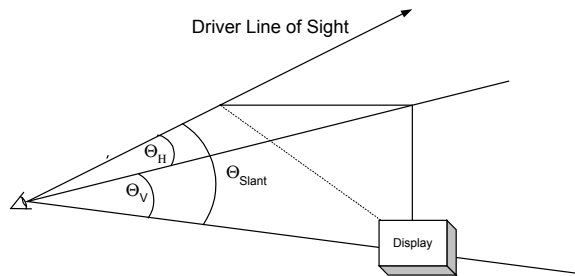
The Anthropometry wizard shows three views of the interior of the vehicle, allowing you to view the position of the display and control in three dimensions. Using a three-dimensional coordinate system, the left-most image shows the y-z plane, where y is the horizontal dimension in the image and z is the vertical dimension. The middle image shows the x-y plane and the right-most image shows the x-z plane.



The origin in this three-dimensional space is the driver's seated reference point. For the purposes of analysis with IVIS DEMAnD, the seated reference point is synonymous with the SAE standard Hip-point. The positions of the display and/or control relative to the steering wheel and driver's line of sight provide the data needed to adjust nominal values of visual and manual driver resources. The position of the steering wheel (purple circle or line), eyellipse (green ellipse), and seat (red circle) are determined by the dimensions specified in the Vehicle Options for the system. They may not be moved in the Anthropometry wizard. The vehicle dimensions determine the volume of space within which the in-vehicle information system, driver, and steering wheel exist. The images displayed merely provide a reference to help you specify the location of equipment.

If the display and control are separate units, the display is shown as a yellow square or rectangle and the control is shown as a blue square or rectangle. If the display and control are co-located, only a yellow square or rectangle is shown. To change the position of the display or control, click on the appropriate object in one of the three images and drag it to a new location. As you drag the object it will also move in the other two images. You may also directly enter the coordinates of the display and/or control. Keep in mind that the origin (0, 0, 0) is the driver's seated reference point and all coordinates are in millimeters.

The wizard shows several calculated angles and distances significant to the analysis. Vertical eye height is the vertical distance from the seated reference point to the eyellipse of the average driver. This figure illustrates the horizontal, vertical, and slant angles, θ_H , θ_V , and θ_{Slant} , respectively. The slant distance is the distance from the center of the eyellipse to the display.



Reach distance is the distance from the edge of the steering wheel to the control unit. If the control unit is to the right of the driver's line of sight, it is assumed the driver will use his/her right hand to manipulate the control. If the control unit is to the left of the driver's line of sight, it is assumed the driver will use his/her left hand to manipulate the control. It is also assumed the driver's hands will be at 9:00 and 3:00 on the steering wheel before being moved to manipulate the control.

The display and control units have default dimensions for each template. To change the dimensions, type the depth, width, and height, in millimeters, in the appropriate edit fields. Display and/or control coordinates may be adjusted to ensure they remain within the confines of the vehicle space.

The Anthropometry wizard displays several lines and objects in its three image panes. If you find some of the objects clutter the image, you can turn off their display by un-checking the appropriate **Show** check box. You can also toggle whether the display and control units are to be displayed separately.

To restore the default settings for display and control location, click the **Default** button. To accept the changes made in the Anthropometry wizard, click the **OK** button. If you want to discard any changes made in the Anthropometry wizard, click the **Cancel** button or the close window button, **X**.

Comparing Tasks and Subtasks

Overview

IVIS DEMAnD provides a set of reports designed to help you analyze and compare similar subtasks and tasks within a system and among multiple systems. This set of reports includes a Task Summary, Subtask Summary, and System Summary. Task and subtask comparisons may only be made among open tasks. Each report may be printed or saved to a text file for historical purposes or for manipulation with other applications such as spreadsheet or word processing applications. All reports are static and are not updated if changes are made to open tasks while the report window is still open.

Creating and Saving a Task Summary Report

To create a Task Summary Report, open the tasks for which a report is desired. Select **View | Report | Task Summary** from the main menu. IVIS DEMAnD will prompt you with a list of system and task names for all open tasks. This is a multiple-choice list. Select the tasks you wish to compare and click **OK**. To select a contiguous list, select the first task, press and hold the shift key and click the last task you wish to include. To select a random set, press and hold the control key while clicking on the desired tasks.

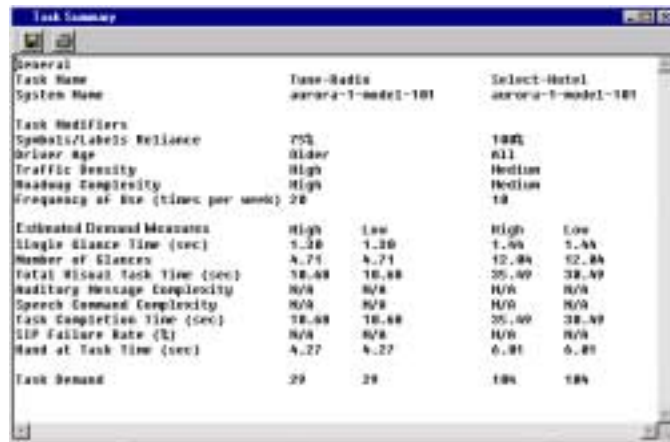
A Task Summary Report will be generated for your review. The Task Summary Report includes the following sections:

General – Task and system names.

Task Modifiers – The current values of all task-level modifiers.

Estimated Demand Measures – The low and high values of all primary demand measures at the task level.

The last entries in the report are the low and high values of the unit-less task-level figure of demand.



General				
Task Name	Task-Radius		Select-Hotel	
System Name	arora-1-model-101		arora-1-model-101	
Task Modifiers				
Symbols/Labels: Reliance	75%		100%	
Driver Age	Older		All	
Traffic Density	High		Medium	
Headway Complexity	High		Medium	
Frequency of Use (times per week)	20		10	
Estimated Demand Measures				
Single Glance Time (sec)	High	Low	High	Low
	1.20	1.20	1.96	1.96
Number of Glances	4.71	4.71	12.88	12.88
Total Visual Task Time (sec)	18.88	18.88	25.89	25.89
Auditory Message Complexity	N/A	N/A	N/A	N/A
Speech Demand Complexity	N/A	N/A	N/A	N/A
Task Completion Time (sec)	18.88	18.88	25.89	25.89
UIP Failure Rate (%)	N/A	N/A	N/A	N/A
Head at Task Time (sec)	4.27	4.27	6.81	6.81
Task Demand	29	29	100	100

To print the report, click the **Print** button in the report window toolbar. To save the report to a text file, click the **Save** toolbar button in the report window and specify the path and file name.

Creating and Saving a Subtask Summary Report

To create a Subtask Summary Report, open the parent tasks of all subtasks for which a report is desired. Select **View | Report | Subtask Summary** from the main menu. IVIS DEMAnD will prompt you with a list of system, task, and subtask names for all open tasks. This is a multiple-choice list. Select the subtasks you wish to compare and click **OK**. To select a contiguous list, select the first subtask, press and hold the shift key, and click the last subtask you wish to include. To select a random set, press and hold the control key while clicking on the desired subtasks.

A Subtask Summary Report will be generated for your review. This report includes the following sections:

General – Subtask, task and system names.

Template – The name of the template used to create the subtask and current input values, if any.

Subtask Modifiers – The current values of all subtask-level modifiers.

Nominal Demand Measures – The low and high nominal values of all relevant demand measures. These are the default demand measures calculated by the template, which you may have optionally adjusted through the New Subtask or Edit Subtask wizards.

Estimated Demand Measures – The low and high values of all primary demand measures at the subtask level.

The last entries in the report are the low and high values of the unit-less subtask-level figure of demand.

Subtask Summary				
General				
Subtask Name	H of H Pushbuttons-1		Select-Needed-Needed	
Task Name	Select-Needed		Select-Needed	
System Name	aurora-1-model-101			
Template				
Inputs	H of H		None	
	Number of buttons actuated 2.00			
	Number of buttons in array 10.00			
Driver Resources				
Visual	Yes		Yes	
Auditory	No		No	
SIP	No		Yes	
Manual	Yes		No	
Speech	No		No	
Subtask Modifiers				
Character Height (arc minutes)	24		24	
Contrast Ratio	7.00		1.50	
Message Length (# of words)	28		1	
Display Resolity (# of items)	10		1	
Nominal Demand Measures				
	High	Low	High	Low
Task Completion Time (sec)	7.20	7.20	20.00	15.00
Estimated Single Glance Time (sec)	1.20	1.20	1.60	1.60
Estimated Number of Glances	3.52	3.52	5.00	5.00
Estimated Eye Transition Time (sec)	0.11	0.11	0.11	0.11
Estimated Number of Message Presentations	N/A	N/A	N/A	N/A
Estimated Message Duration (sec)	N/A	N/A	N/A	N/A
Estimated Word Length	N/A	N/A	N/A	N/A
Subjective Message Complexity Rating	N/A	N/A	N/A	N/A
Subjective SIP Mental Demand Rating	N/A	N/A	1.00	1.00
Subjective SIP Frustration Level Rating	N/A	N/A	7.00	6.00
Subjective SIP Time-sharing Demand Rating	N/A	N/A	3.00	3.00
Hand at Task Time (sec)	3.00	3.00	N/A	N/A
Hand Travel Time to Task (sec)	0.74	0.74	N/A	N/A
Hand Travel Time from Task (sec)	0.74	0.74	N/A	N/A
Estimated Command Input Time per Attempt (sec)	N/A	N/A	N/A	N/A
Estimated Number of Command Attempts	N/A	N/A	N/A	N/A
Subjective Speech Ease of Use Rating	N/A	N/A	N/A	N/A
Subjective Speech Comfort Rating	N/A	N/A	N/A	N/A
Subjective Speech Distraction Rating	N/A	N/A	N/A	N/A
Estimated Demand Measures				
	High	Low	High	Low
Single Glance Time (sec)	1.20	1.20	1.60	1.60
Number of Glances	3.52	3.52	5.00	5.00
Total Visual Task Time (sec)	7.41	7.41	20.60	15.60
Auditory Message Complexity	N/A	N/A	N/A	N/A
Speech Command Complexity	N/A	N/A	N/A	N/A
Task Completion Time (sec)	7.41	7.41	20.60	15.60
SIP Failure Rate (%)	N/A	N/A	N/A	N/A
Hand at Task Time (sec)	3.00	3.00	N/A	N/A
Figure of Demand	28.85	28.85	86.1	85.85

To print the report, click the **Print** button in the report window toolbar. To save the report to a text file, click the **Save** toolbar button in the report window and specify the path and file name.

Creating and Saving a System Summary Report

The System Summary Report is intended to summarize the Vehicle Options for a set of existing systems. To create a System Summary Report, select **View | Report | System Summary** from the main menu. IVIS DEMAnD will prompt you with a list of currently defined systems. This is a multiple-choice list. Select the systems you wish to compare and click **OK**. To select a contiguous list, select the first system, press and hold the shift key, and click the last system you wish to include. To select a random set, press and hold the control key while clicking on the desired systems.

The System Summary Report includes the system name, vehicle class, and all dimensions from Vehicle Options. To print the report, click the **Print** button in the report window toolbar. To save the report to a text file, click the **Save** toolbar button in the report window and specify the path and file name.

System Summary	
General	
System Name	aurora-1-model-101
Vehicle class	Car
Vehicle Dimensions	
Steering Wheel Radius (mm)	193
Steering Wheel Height (mm)	204
Seat to Floor (mm)	216
Seat to Roof (mm)	808
Eye Height (mm)	711
Eye Offset (mm)	0
Wheel to Side Mirror (mm)	641
Wheel to Passenger Window (mm)	1117
Seat to Wheel (mm)	293
Wheel Forward (mm)	847
Back Mail to Seat (mm)	1080

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Overview

The IVIS Subtask Library consists of textual configuration files that describe mathematically how to calculate the relevant nominal demand measures and how to adjust the nominal values based on current settings of relevant modifiers. Templates are organized in the library according to the driver resources that are applicable to the task being described. The library may cover all combinations of the five driver resources.

Specifications for each of the templates were derived from one or more of the following human factors studies. In the following sections the research used to develop each template is described in more detail.

- Antin, J.F., Dingus, T.A., Hulse, M.C., and Wierwille, W.W. (1986). *Human Factors Test and Evaluation of An Automobile Moving-Map Navigation System. Part II: Methodology Issues - Effectiveness, Efficiency, and Strategy*. (IEOR Department Report No. 86-04). Blacksburg, VA: Virginia Polytechnic Institute and State University, Vehicle Analysis and Simulation Laboratory.
- Biever, W.J. (1999). *Auditory Based Supplemental Information Processing Demand Effects on Driving Performance*. Unpublished master's thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA.
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- Hayes, B.C., Kurokawa, K., and Wierwille, W.W. (1988). *Results of An In-Car Data Gathering Experiment To Support a General Approach to Instrument Panel Evaluation*. (IEOR Department Report No. 88-03). Blacksburg, VA: Virginia Polytechnic Institute and State University, Vehicle Analysis and Simulation Laboratory.

- Imbeau, D. (1987). *Effects of Instrument Panel Luminance and Hue on Simulator Driver Performance and Driver Preferences*. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Imbeau, D., Wierwille, W.W., and Beauchamp, Y. (1993). Age, display design, and driving performance. In B. Peacock and W. Karwowski (eds.), *Automotive Ergonomics* (pp. 339-357). London: Taylor and Francis.
- Kurokawa, K., McFarlane, J., Hayes, B.C., and Wierwille, W.W. (1989). *Simulator Measurement of I.P. Attentional Demand Parameters, With Emphasis on Validation, Clutter, and Label Abbreviation..* (Tech. Report, ISE Department No. 86-08). Blacksburg, VA: Virginia Polytechnic Institute and State University, Vehicle Analysis and Simulation Laboratory.
- Kurokawa K., and Wierwille, W.W. (November, 1990). *Development of an Evaluation Program for Automotive Instrument Panel Design*. (Tech. Report, ISE Department No. 90-04). Blacksburg, VA: Virginia Polytechnic Institute and State University, Vehicle Analysis and Simulation Laboratory.
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- Wierwille, W.W. (1993). Visual and manual demands of in-car controls and displays. In B. Peacock and W. Karwowski (eds.), *Automotive Ergonomics* (pp. 299-320). London: Taylor & Francis.

Visual Template Descriptions

Check Driver-Side Mirror

Task Description: In this task the driver glances left at the driver-side mirror. The only requirement of the driver is to direct the eyes to a target area (i.e., driver-side mirror) and determine if an object is present. An object will either be present or not present.

References: Details of the data collection effort can be found in:

- Rockwell, 1983
- Kurokawa and Wierwille, 1990

Check Odometer

Task Description: In this task the driver glances down at the odometer and checks the mileage. It is assumed the display is digital.

Reference: Details of the data collection effort can be found in:

- Kurokawa and Wierwille, 1990

Check Passenger-Side Mirror

Task Description: In this task the driver glances right at the passenger-side mirror. The only requirement of the driver is to direct the eyes to a target area (i.e., passenger-side mirror) and determine if an object is present. An object will either be present or not present. An example of the type of passenger-side mirror that was used to collect the data is shown below. As can be seen, the location of the passenger-side mirror requires the driver to look at an area that is forward, right, and, perhaps, down slightly (depending on the driver's height).

References: Details of the data collection effort can be found in:

- Rockwell, 1983
- Kurokawa and Wierwille, 1990

Example of Passenger-Side Mirror



Check Rearview Mirror

Task Description: In this task the driver glances up and right at the rearview mirror. The only requirement of the driver is to direct the eyes to a target area (i.e., rearview mirror) and determine if an object is present. An object will either be present or not present.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Check Remaining Fuel

Task Description: In this task the driver glances down at the fuel gauge and checks the remaining fuel. It is assumed the display is digital.

References: Details of the data collection effort can be found in:

- Hayes et al., 1988
- Kurokawa and Wierwille, 1990

Check Speedometer

Task Description: In this task the driver glances down at the speedometer and checks the speed. It is assumed the display is digital.

Reference: Details of the data collection effort can be found in:

- Kurokawa and Wierwille, 1990

Check Warning Lights

Task Description: In this task the driver glances down at the instrument panel and checks the warning lights. The only requirement of the driver is to direct the eyes to a target area (i.e., warning lights) and retrieve the information. The information is either on (illuminated) or off (not illuminated) on the instrument panel. An example of the type of instrument panel that was used to collect the data is shown below. As can be seen, the location of the warning lights requires the driver to look at an area that is forward and down.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Instrument Panel



Typical dash with warning lights illuminated (top left portion of instrument panel).

Commercial Vehicle Visual Tasks

The IVIS Subtask Library includes 40 templates describing the demand associated with gathering information from a visual display presented to drivers of commercial vehicles by an in-vehicle information system. These templates involve visual resources only, and both visual and supplemental information processing (SIP) resources. The templates can be categorized as follows:

Task objective: To search for specific targets or routes on the display matching certain criteria, to find a hotel or other destination matching certain criteria, to find a route matching certain criteria, to find the lowest cost route to a specific destination, or to find the quickest route to a specific destination.

Required mental processing: Planning based on current location and desired destination, computation, interpretation of presented information, or a combination of these.

Display type: Map with graphic icons, map with textual information, paragraph, table or tabular list.

Display density: Number of options and/or descriptors presented to the driver categorized as low (3 options and 2 to 3 descriptors), medium (3 options by 3-4 descriptors), or high (5 options by 4-5 descriptors).

The study data used to develop the templates covered the definition of nominal demand measures and age modifiers. However, workload modifiers (adjusting for roadway complexity and traffic density) and identifier modifiers (adjusting for reliance on symbols, character size, and location in the vehicle) are based on light vehicle data because heavy vehicle data that might be used to calculate the modifiers was not available. Although research suggests that this approach produces a valid estimate of the identifier effect, it is likely the magnitude of the workload effect is underestimated.

The set of templates involving only visual resources includes:

- CVO Search for Route, High Density Graphic Icon Display
- CVO Search for Route, High Density Graphic Text Display
- CVO Search for Route, High Density Paragraph Display
- CVO Search for Route, High Density Table Display
- CVO Search for Route, Low Density Graphic Icon Display
- CVO Search for Route, Low Density Paragraph Display
- CVO Search for Route, Low Density Table Display
- CVO Search for Route, Medium Density Graphic Icon Display
- CVO Search for Route, Medium Density Graphic Text Display
- CVO Search for Route, Medium Density Paragraph Display
- CVO Search for Route, Medium Density Table Display

References: Details of the data collection effort can be found in:

- Gallagher, 2000
- Westat, 1999

Light Vehicle Visual Tasks

Two studies were used to develop a set of templates describing the demand associated with gathering information from a visual display presented to drivers of light vehicles by an in-vehicle information system. Sixty-eight templates were developed from the data in the studies, involving visual resources, supplemental information processing (SIP) resources, or both. The templates can be categorized as follows:

Task objective: To search for specific targets or routes on the display matching certain criteria, To find a hotel or other destination matching certain criteria, to find a route matching certain criteria, to find the lowest cost route to a specific destination, or to find the quickest route to a specific destination.

Required mental processing: Planning based on current location and desired destination, computation, interpretation of presented information, or a combination of these.

Display type: Map with graphic icons, map with textual information, paragraph, table or tabular, list.

Display density: Number of options and/or descriptors presented to the driver categorized as low (3 options and 2 to 3 descriptors), medium (3 options and 3 to 4 descriptors), high (5 options and 4 to 5 descriptors), or very high (5 options and 6 to 7 descriptors).

Note that route selection tasks, which involved searching for information, used a display that contained at least one route descriptor: type of road. Map displays contained at least two route descriptors: type of road and distance to destination. Some route selection tasks used a display that contained more than two route descriptors. These additional route descriptors included one or more of the following: delays in minutes, delay description, hazards, toll booth location, toll road cost, gas station location, number of lanes closed, amount of congestion, traffic density, and speed limit. The number of route descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high. However, across tasks, within a density category, the descriptors may or may not have been the same. For example, within a high-density category, one task may have had a certain set of descriptors while a different high-density task may have had a different set of descriptors. Because of this, caution must be used in making comparisons across tasks within a density category and between density categories.

Also note that hotel selection tasks, which involved searching for information, used a display that contained at least two hotel descriptors: name of hotel and distance to hotel. Map displays contained at least three descriptors: name of hotel, distance to hotel, and type of road. Some hotel selection tasks used a display that contained more than two hotel descriptors (and more than three hotel descriptors for map displays). These additional hotel descriptors included one or more of the following: vacancy, cost, quality rating, and restaurant. The number of hotel descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high.

The set of templates involving only visual resources includes:

- Search for Generic Target, High Density Paragraph Display
- Search for Generic Target, High Density Table Display
- Search for Generic Target, Low Density Paragraph Display
- Search for Generic Target, Low Density Table Display
- Search for Generic Target, Medium Density Paragraph Display
- Search for Generic Target, Medium Density Table Display
- Search for Generic Target, Very High Density Table Display
- Search for Hotel, Medium Density Graphic Icon Display
- Search for Route, High Density Graphic Icon Display
- Search for Route, High Density Graphic Text Display
- Search for Route, Low Density Graphic Icon Display
- Search for Route, Medium Density Graphic Icon Display
- Search for Route, Medium Density Graphic Text Display
- Search for Route, Very High Density Graphic Text Display

Determine Direction to Destination Relative to Driver's Vehicle Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to locate the direction-to-destination arrow on the Navigator (always displayed). Once the driver finds this arrow, he/she points out the window in the direction that the arrow on the Navigator is pointing.

This task has both visual and manual components i.e., the driver must locate the arrow on the Navigator by looking at the display (visual) and point in the direction of the arrow (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Determine Distance to Destination Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to locate the distance-to-destination number on the Navigator (always displayed). Once the driver locates this number, he/she reads it aloud.

This task has a visual component i.e., the driver must locate the distance-to-destination number on the Navigator by looking at the display (visual) and then read the number aloud to indicate that the number had been located. The Navigator display is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Auditory Template Descriptions

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a prose format spoken at a normal or fast speech rate. The display density was classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select the route with no gas station." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

“Interstate 17 to Highway 44 is a distance of 165 miles and has a gas station.
U.S. Route 29 to Highway 19 is a distance of 180 miles and has a gas station.
U.S. Route 29 to Highway 44 is a distance of 177 miles and has no gas station.”

Question: Select the route with no gas station.

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a list format spoken at a normal speech rate. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select the route with no monetary cost." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to Route 18, light congestion, clear weather, \$4.25 toll.
Route 19 to Route 18, light congestion, rainy weather, \$3.75 toll.
Route 29 to Route 46, moderate congestion, clear weather, \$2.00 toll.
Route 29 to Route 12, light congestion, rainy weather, \$1.00 toll.
Route 29 to Highway 19, moderate congestion, foggy weather, no toll."

Question: Select the route with no monetary cost.

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a list format spoken at a normal speech rate. The display density is classified as "Medium," where there are 3

options and 3 categories of information (3x3). The message presented is shown below. The driver is asked: "Which route has a 22 minute delay." The driver responded verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to Highway 54, 20 miles, 40 minute delay.
Route 89 to Highway 19, 22 miles, 15 minute delay.
Route 29 to Highway 26, 77 miles, 22 minute delay."

Question: Which route has a 22 minute delay.

Listen to the IVIS Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the IVIS to find the information that matches the specified criteria. An auditory message is presented to the driver in prose format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select the route that has a gas station." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to U.S. Route 18 has light congestion, has clear weather, and has no gas station.
U.S. Route 19 to U.S. Route 18 has light congestion, has rainy weather, and has no gas station.
U.S. Route 29 to U.S. Route 46 has moderate congestion, has clear weather, and has no gas station.
U.S. Route 29 to U.S. Route 12 has light congestion, has rainy weather, and has no gas station.
U.S. Route 29 to Highway 19 has moderate congestion, has foggy weather, and has a gas station."

Question: Select the route that has a gas station.

Supplemental Information Processing (SIP) Template Descriptions

Light Vehicle Visual and SIP Tasks

Two studies were used to develop a set of templates describing the demand associated with gathering information from a visual display presented to drivers of light vehicles by an in-vehicle information system. Sixty-eight templates were developed from the data in the studies, involving visual resources, supplemental information processing (SIP) resources, or both. The templates can be categorized as follows:

Task objective: To search for specific targets or routes on the display matching certain criteria, to find a hotel or other destination matching certain criteria, to find a route matching certain criteria, to find the lowest cost route to a specific destination, or to find the quickest route to a specific destination.

Required mental processing: Planning based on current location and desired destination, computation, interpretation of presented information, or a combination of these.

Display type: Map with graphic icons, map with textual information, paragraph, table, or tabular list.

Display density: Number of options and/or descriptors presented to the driver categorized as low (3 options and 2 to 3 descriptors), medium (3 options and 3 to 4 descriptors), high (5 options and 4 to 5 descriptors), or very high (5 options and 6 to 7 descriptors).

Note that route selection tasks, which involved searching for information, used a display that contained at least one route descriptor: type of road. Map displays contained at least two route descriptors: type of road and distance to destination. Some route selection tasks used a display that contained more than two route descriptors. These additional route descriptors included one or more of the following: delays in minutes, delay description, hazards, toll booth location, toll road cost, gas station location, number of lanes closed, amount of congestion, traffic density, and speed limit. The number of route descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high. However, across tasks, within a density category, the descriptors may or may not have been the same. For example, within a high-density category, one task may have had a certain set of descriptors while a different high-density task may have had a different set of descriptors. Because of this, caution must be used in making comparisons across tasks within a density category and between density categories.

Also note that hotel selection tasks, which involved searching for information, used a display that contained at least two hotel descriptors: name of hotel and distance to hotel. Map displays contained at least three descriptors: name of hotel, distance to hotel, and type of road. Some hotel selection tasks used a display that contained more than two hotel descriptors (and more than three hotel descriptors for map displays). These additional hotel descriptors included one or more of the following: vacancy, cost, quality rating, and restaurant. The number of hotel descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high.

The set of templates involving only SIP resources include:

- Find Low Cost Route Using Computation, High Density Paragraph Display
- Find Quickest Route Using Computation, High Density Graphic Text Display
- Find Quickest Route Using Computation, High Density Paragraph Display
- Find Route Using Planning and Computation, High Density Paragraph Display
- Find Route Using Planning and Computation, High Density Table Display

Manual Template Descriptions

Adjust Center Rearview Mirror

Task Description: In this task the driver glances up and right at the center rearview mirror and manually adjusts it to see out the back window. This is a complex manipulative task in which the driver moves the mirror into the correct position while looking into the mirror and, at the same time, monitoring the roadway in front. This task has both visual and manual components i.e., the driver must locate the mirror and monitor its position (visual) and manipulate it into position (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Press Stalk-End Button

Task Description: In this task the driver presses the button at the end of the steering wheel stalk (e.g., turn signal lever). It is assumed that this is a manual-only task and that the driver does not have to glance at the stalk-end (i.e., there is no visual resource component). For this task, the driver is required to manually press the stalk-end button. An example of the type of stalk-end button that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Stalk-End Button



Typical stalk-end button (circled).

Operate Turn Signal

Task Description: In this task the driver operates the turn signal. It is assumed that this is a manual-only task and that the driver does not have to glance at the turn signal lever (i.e., there is no visual resource component). For this task, the driver is required to manually position the turn signal lever with the left hand in either the up (right turn) or down (left turn) position. An example of the type of turn signal lever that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Turn Signal Lever



Typical turn signal lever.

Speech Template Descriptions

Overview

Eighteen tasks were developed from Gellatly's 1998 study, "The Use of Speech Recognition Technology in Automotive Applications." Templates in the IVIS Subtask Library associated with these tasks include the following:

- Activate Cruise Control and Set Cruise Speed to Current Travel Speed
- Activate Turn Signals, Change Lanes, and Deactivate Turn Signals
- Activate Windshield Wipers
- Adjust Fan Speed on Climate System
- Adjust Temperature Control on Climate System
- Change Climate Mode to Bi-Level on Climate System
- Change Climate Mode to Panel Vents on Climate System
- Dial 7-digit Home Telephone Number Using the Cell Phone
- Dial a Number Stored in Memory Using the Cell Phone
- Display Average Fuel Economy on Driver Information Computer
- Display Trip Distance on Driver Information Computer
- Lock Vehicle Doors
- Mute Radio
- Resume Cruise Speed
- Seek Up to Next Receivable Radio Station Using Seek Function on Radio
- Tune Radio to Specific Radio Frequency
- Tune Radio to Station Stored in Preset or Memory
- Unlock Vehicle Doors

The tasks involved speech, manual, and SIP resources. However, the manual component of the task was minor and consisted of pushing one of two buttons mounted on the two sides of the steering wheel hub. No manual data were directly collected (however, data related to the manual resource were included in the estimated total task completion times). In addition, though the tasks involved the SIP resource, there were no data collected for SIP. Also, the data from Gellatly (1997) suggest that the visual resource was also taxed during some of the tasks; however, there were no visual measures presented. It is suggested that further research might gather data on these other resources. Nonetheless, the two measures that were collected for the data set were: (1) Estimated Task Completion Time (TCT), and (2) Estimated Total Voice Time (TVT).

Estimated TCT was measured from the end of the experimenter's verbal instruction word "Begin" until the beginning of a tone sound indicating the system was actuated. Estimated TVT includes the total time it takes for the user to verbalize the command(s).

Error Definitions

The nominal presentation assumes there are no errors in the speech recognition system, and the nominal data are based on this assumption. The user can modify the nominal data by providing the assumed probability of the recognition system committing a (1) Recognition Error or (2) Substitution Error. A Recognition Error is defined as an error where the system does not recognize or understand the driver's command. For example, the driver will issue a verbal command and the system will respond "Please Repeat." A Substitution Error is defined as an error where the wrong system or function is actuated. For example, the driver will issue a verbal command regarding the radio and the windshield wipers will activate. The driver will then recognize the error and tell the system to cancel the operation. The original command is then repeated by the driver.

The equations used in the templates for the speech tasks have the error probability modifiers built in. Probabilities will range from 0.0 to 1.0. If, for example, 3 percent of commands result in recognition errors and 5 percent of commands result in substitution errors, then the user would enter 0.03 for the probability of a recognition error and 0.05 for the probability of a substitution error.

Task Analysis

To illustrate how these tasks were performed, consider the following gross task analysis:

Assuming No Errors:

- Timing begins at the end of the instructional word "Begin"
- Driver depresses one of two thumb switches located at the sides of the airbag/hub
- Driver speaks command
- System responds with a short tone and simultaneously performs command
- Driver releases thumb switch after tone indicates completion
- Timing ends at beginning of tone.

Assuming a Recognition Error:

- Timing begins at the end of the instructional word "Begin"
- Driver depresses one of two thumb switches located at the sides of the airbag/hub
- Driver speaks command
- System responds with "Please Repeat"
- Driver speaks command
- System responds with a short tone and simultaneously actuates
- Driver releases thumb switch
- Timing ends at beginning of tone.

Assuming a Substitution Error:

- Timing begins at the end of the instructional word "Begin"
- Driver depresses one of two thumb switches located at the sides of the airbag/hub
- Driver speaks command
- System responds with a short tone and simultaneously actuates WRONG system or sequence
- Driver recognizes error and speaks "Cancel"
- System responds with a short tone and corrects to previous state
- Driver speaks command
- System responds with a short tone and simultaneously actuates correctly
- Driver releases thumb switch
- Timing ends at beginning of third tone.

Important Note: It is important to note that raw data needed to support the equations and analyses appearing in the templates are not contained in Gellatly's dissertation. The raw data were obtained by re-analyzing the videotapes recorded during the data gathering sessions on which Gellatly's dissertation is based.

Notes:

1. Voice times may include short delays (perhaps up to 0.25 second) between words in sequence. For longer delays, the words were timed separately and added.
2. For spoken 7-digit numbers, the driver used a visual display to determine if the number was entered correctly.
3. For spoken radio frequencies, the driver used the radio display (possibly supplemented by the station program itself) to determine if the frequency was entered correctly.

4. The driver's senses provided verification of the system response to all other commands (e.g., door locking makes an audible "click" sound).

Activate Cruise Control and Set Cruise Speed to Current Travel Speed

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver activating the cruise control and setting it to the current travel speed. The driver issues the command "Cruise On Set." The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
"Cruise On Set"	None	Tone	None
"Cruise On Set"	Recognition	"Please Repeat"	Driver commands "Cruise On Set" and receives response tone
"Cruise On Set"	Substitution	Tone	Driver detects substitution error; Driver issues "Cancel" command and receives response tone; Driver commands "Cruise On Set" and receives response tone.

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Activate Turn Signals, Change Lanes, and Deactivate Turn Signals

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver activating the turn signals, changing lanes, and deactivating the turn signals. The driver issues the command "Turn Left." The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
"Turn Left"	None	Tone	None
"Turn Left"	Recognition	"Please Repeat"	Driver commands "Turn Left" and receives response tone
"Turn Left"	Substitution	Tone	Driver detects substitution error Driver issues "Cancel" command and receives response tone Driver commands "Turn Left" and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Activate Windshield Wipers

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver activating the windshield wipers. The driver issues the command “Wipers Low.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Wipers Low”	None	Tone	None
“Wipers Low”	Recognition	“Please Repeat”	Driver commands “Wipers Low” and receives response tone
“Wipers Low”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Wipers Low” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Adjust Fan Speed on the Climate System

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver adjusting the fan speed on the climate system, setting it down. The driver issues the command “Climate Fan Down.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Climate Fan Down”	None	Tone	None
“Climate Fan Down”	Recognition	“Please Repeat”	Driver commands “Climate Fan Down” and receives response tone
“Climate Fan Down”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Climate Fan Down” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Adjust Temperature Control on the Climate System

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver adjusting the temperature control on the climate

system, setting it to 70 degrees. The driver issues the command “Climate Temperature 70.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Climate Temperature 70”	None	Tone	None
“Climate Temperature 70”	Recognition	“Please Repeat”	Driver commands “Climate Temperature 70” and receives response tone
“Climate Temperature 70”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Climate Temperature 70” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Change Climate Mode to Bi-Level on the Climate System

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver changing the climate mode to Bi-Level on the climate system. The driver issues the command “Climate Mode Bi-Level.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Climate Mode Bi-Level”	None	Tone	None
“Climate Mode Bi-level”	Recognition	“Please Repeat”	Driver commands “Climate Mode Bi-Level” and receives response tone
“Climate Mode Bi-Level”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Climate Mode Bi-Level” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Change Climate Mode to Panel Vents on the Climate System

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver changing the climate mode to panel vents on the

climate system. The driver issues the command “Climate Mode Panel.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
“Climate Mode Panel”	None	Tone	None
“Climate Mode Panel”	Recognition	“Please Repeat”	Driver commands “Climate Mode Panel” and receives response tone
“Climate Mode Panel”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Climate Mode Panel” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Dial a 7-digit Home Telephone Number Using the Cell Phone

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver dialing a 7-digit home telephone number using the cell phone. The driver issues the command “Phone On {7-Digit Number} Dial.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
“Phone On {7-Digit Number} Dial”	None	Tone	None
“Phone On {7-Digit Number} Dial”	Recognition	“Please Repeat”	Driver commands “Phone On {7-Digit Number} Dial” and receives response tone
“Phone On {7-Digit Number} Dial”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Phone On {7-Digit Number} Dial” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Dial a Number Stored in Memory Using the Cell Phone

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver dialing a number stored in memory using the cell phone. The driver issues the command “Phone On {Memory 3 or Preset 3} Dial.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Phone On {Memory 3 or Preset 3} Dial”	None	Tone	None
“Phone On {Memory 3 or Preset 3} Dial”	Recognition	“Please Repeat”	Driver commands “Phone On {Memory 3 or Preset 3} Dial” and receives response tone
“Phone On {Memory 3 or Preset 3} Dial”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Phone On {Memory 3 or Preset 3} Dial” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Display Average Fuel Economy on the Driver Information Computer

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver displaying the average fuel economy on the driver information computer. The driver issues the command “Info Economy.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Info Economy”	None	Tone	None
“Info Economy”	Recognition	“Please Repeat”	Driver commands “Info Economy” and receives response tone
“Info Economy”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Info Economy” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Display Trip Distance on the Driver Information Computer

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver displaying the trip distance on the driver information computer. The driver issues the command “Info Trip.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Info Trip”	None	Tone	None
“Info Trip”	Recognition	“Please Repeat”	Driver commands “Info Trip” and receives response tone
“Info Trip”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Info Trip” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Lock Vehicle Doors

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver locking the vehicle's doors. The driver issues the command “Doors Lock.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Doors Lock”	None	Tone	None
“Doors Lock”	Recognition	“Please Repeat”	Driver commands “Doors Lock” and receives response tone
“Doors Lock”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Doors Lock” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Mute the Radio

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver muting the radio. The driver issues the command “Radio Mute.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Radio Mute”	None	Tone	None
“Radio Mute”	Recognition	“Please Repeat”	Driver commands “Radio Mute” and receives response tone
“Radio Mute”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Radio Mute” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Resume Cruise Speed

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver resuming the cruise control travel speed. The driver issues the command “Cruise Resume.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Cruise Resume”	None	Tone	None
“Cruise Resume”	Recognition	“Please Repeat”	Driver commands “Cruise Resume” and receives response tone
“Cruise Resume”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Cruise Resume” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Seek “Up” to Next Receivable Radio Station Using Seek Function on the Radio

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver seeking "up" to the next receivable radio station by using the seek function on the radio. The driver issues the command “Radio Seek Up.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Radio Seek Up”	None	Tone	None
“Radio Seek Up”	Recognition	“Please Repeat”	Driver commands “Radio Seek Up” and receives response tone
“Radio Seek Up”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Radio Seek Up” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Tune Radio to a Specified Frequency

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver tuning the radio to a specified frequency. The stations were either 92.3, 94.9, or 104.5. The driver issues the command “Radio Tune {92.3, 94.9, or 104.5}.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver

Command	System Error	System Response	Subsequent actions
“Radio Tune {92.3, 94.9, or 104.5}”	None	Tone	None
“Radio Tune {92.3, 94.9, or 104.5}”	Recognition	“Please Repeat”	Driver commands “Radio Tune {92.3, 94.9, or 104.5}” and receives response tone
“Radio Tune {92.3, 94.9, or 104.5}”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Radio Tune {92.3, 94.9, or 104.5}” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Tune Radio to Station Stored in Preset (or Memory)

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver tuning the radio to a station stored in preset/memory. The stations were either preset to 1, 2, 3, or 4. The driver issues the command “Radio Preset {1, 2, 3, or 4}.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
“Radio Preset {1, 2, 3, or 4}”	None	Tone	None
“Radio Preset {1, 2, 3, or 4}”	Recognition	“Please Repeat”	Driver commands “Radio Preset {1, 2, 3, or 4}” and receives response tone
“Radio Preset {1, 2, 3, or 4}”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Radio Preset {1, 2, 3, or 4}” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Unlock Vehicle Doors

Task Description: This task involves an in-vehicle information system that actuates upon verbal commands. This particular task involves the driver unlocking the vehicle doors. The driver issues the command “Doors Unlock.” The system may respond correctly, in which case the task is complete. The system may have a recognition error, in which it does not recognize the command given and requests that it be repeated. It may also have a substitution error, where it reacts to the wrong command. The following are possible command sequences.

Initial Driver Command	System Error	System Response	Subsequent actions
“Doors Unlock”	None	Tone	None
“Doors Unlock”	Recognition	“Please Repeat”	Driver commands “Doors Unlock” and receives response tone
“Doors Unlock”	Substitution	Tone	Driver detects substitution error Driver issues “Cancel” command and receives response tone Driver commands “Doors Unlock” and receives response tone

Reference: Details of the data collection effort can be found in:

- Gellatly (1997)

Visual and Manual Template Descriptions

Adjust Temperature

Task Description: In this task the driver adjusts the in-cab temperature by depressing one of two pushbuttons to increment a digital temperature display. One pushbutton adjusts the temperature “cooler,” while the other pushbutton adjusts the temperature “warmer.” The pushbutton control for this task, along with the display, is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual). An example of a temperature control system that has pushbuttons to adjust the temperature, and was used to collect the data, is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Temperature Control System on Which Driver Can Adjust Temperature



Dash-mounted temperature control system



Select AM/FM on the Radio and Tune

Task Description: In this task the driver selects AM/FM on the in-car, dash-mounted radio and then tunes the radio to a specified frequency. This is accomplished by depressing the AM/FM pushbutton and then turning the tuning knob while watching for the specified frequency to appear on the digital display. The tuning control and the display are both continuous for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the pushbutton and tuning knob (manual). An example of the type of radio controls and display that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Radio Controls and Display



View 1 of typical radio controls and display.



View 2 of typical radio controls and display.

Select AM/FM and Tune Radio With Digital Display, Deflection Tuning Knob

Task Description: In this task the driver depresses the AM/FM pushbutton on an in-car radio and then tunes the radio to a specified frequency. The radio has a digital display and a deflection tuning knob. A deflection tuning knob is a spring-centered rotary knob that the driver turns clockwise to increase the tuning frequency and counterclockwise to decrease the tuning frequency. Deflection for actuation is approximately 20 degrees, and there is a single rate of change for the increase/decrease in tuning frequency. When the driver releases the knob it returns to the center position and the tuning frequency remains constant. The tuning knob is a continuous control, and the display used was discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the AM/FM pushbutton and tuning knob (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

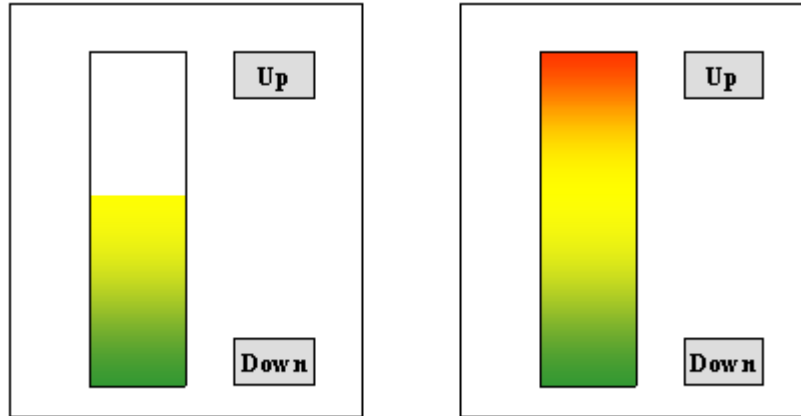
Continuous LED Bar Display With Discrete Controls (Up and Down) Adjustment; Gross Adjustment

Task Description: In this task the driver operates a continuous LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display or hold the pushbutton down to continue incrementing/decrementing. The LED bar will continue incrementing/decrementing as long as the pushbutton is depressed and the limit of the bar has not been reached. The specifics of this particular task call for the driver to make a gross (large) adjustment. The pushbutton controls for this task are discrete, while the LED bar display is continuous. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual). An example of a continuous LED bar display with up/down pushbuttons is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Continuous LED Bar Display With Discrete Up and Down Controls



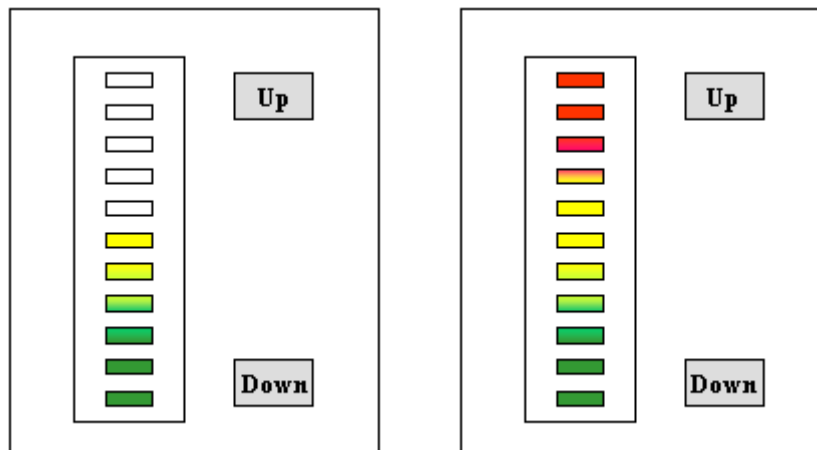
Discrete LED Bar Display With Discrete Controls (Up and Down) Adjustment; Fine Adjustment

Task Description: In this task the driver operates a discrete LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display one position. Each button press corresponds to a one-step increase/decrease in the height of the display bar regardless of how long the button is depressed. The specifics of this particular task call for the driver to make a fine (small) adjustment. The pushbutton controls for this task, along with the display, are discrete. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual). An example of a discrete LED bar display with up/down pushbuttons is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Discrete LED Bar Display With Discrete Up and Down Controls



Discrete LED Bar Display With Discrete Controls (Up and Down) Adjustment; Gross Adjustment

Task Description: In this task the driver operates a discrete LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display one position. Each button press corresponds to a one-step increase/decrease in the height of the display bar regardless of how long the button is depressed. The specifics of this particular task call for the driver to make a gross (large) adjustment. The pushbutton controls for this task, along with the display, are discrete. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Discrete LED Bar Display With Discrete Controls (Up and Down) Adjustment; Step-Wise Adjustment

Task Description: In this task the driver operates a discrete LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display one position. Each button press corresponds to a one-step increase/decrease in the height of the display bar regardless of how long the button is depressed. The specifics of this particular task call for the driver to make a step-wise (i.e., from one position to a neighboring position) adjustment. The pushbutton controls for this task, along with the display, are discrete. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Operate Driver-Side Power Window

Task Description: In this task the driver operates the power window control for the driver-side window by pressing the power window button located on the driver-door armrest. In collecting data for this task, the driver was asked to raise or lower the window approximately 2 inches. This task has both visual and manual components, i.e., the driver must locate the control (visual) and then manipulate the button (manual). An example of the type of power window control that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Driver-Side Power Window Control



View 1 of typical power window control.



View 2 of typical power window control.

Automatic Radio Tuning: Select Frequency Scan

Task Description: In this task the driver depresses the frequency scan button on the in-car radio. Once depressed, the radio tunes automatically. This task involves a single pushbutton actuation. The control and the display are both discrete for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the pushbutton (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Insert Cassette Tape

Task Description: In this task the driver inserts an audio cassette tape into an in-car cassette player. This is a complex, manipulative task that involves the driver retrieving an unboxed cassette tape from the seat cushion to his/her right, orienting it correctly, and inserting it into the cassette player. This task has visual and manual components, i.e., the driver must locate the cassette tape and player (visual) and manipulate the cassette and insert it (manual). An example of the type of cassette player that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Turn On Interior Light

Task Description: In this task the driver turns on the interior light by rotating a control knob, thumbwheel, or flipping a rocker switch. In the research vehicle in which the data were collected, the interior light control was located on the dash to the left of the driver. In many other vehicles the control is located mid-ceiling. This task has both visual and manual components, i.e., the driver must locate the control (visual) and then turn the light on (manual). An example of the type of control, and its location, that was used to collect the data is shown below. (Note that the control shown is similar but not identical to the control used.)

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Interior Light



Control and control location similar to that used to collect data for this task.

Continuous LED Bar Display With Discrete Controls (Up and Down) Adjustment; Fine Adjustment

Task Description: In this task the driver operates a continuous LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display or hold the pushbutton down to continue incrementing/decrementing. The LED bar will continue incrementing/decrementing as long as the pushbutton is depressed and the limit of the bar has not been reached. The specifics of this particular task call for the driver to make a fine (small) adjustment. The pushbutton controls for this task are discrete, while the LED bar display is continuous. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Continuous LED Bar Display With Discrete Controls (Up and Down) Adjustment; Step-Wise Adjustment

Task Description: In this task the driver operates a continuous LED bar display with up and down pushbutton discrete controls. The driver can push the up/down pushbutton one time to increment/decrement the LED bar display or hold the pushbutton down to continue

incrementing/decrementing. The LED bar will continue incrementing/decrementing as long as the pushbutton is depressed and the limit of the bar has not been reached. The specifics of this particular task call for the driver to make a step-wise adjustment (i.e., from one position to a neighboring position). The pushbutton controls for this task are discrete, while the LED bar display is continuous. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Turn On Map Light

Task Description: In this task the driver turns on the map light, which is located on the ceiling just above the rearview mirror. The driver turns on the light by operating a pushbutton or switch control. This task has both visual and manual components, i.e., the driver must locate the control (visual) and then turn the light on (manual). An example of the type of map light control that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Map Light



Typical map light.

Select M of N Pushbuttons

Task Description: This task refers to a generic case of selecting M buttons from N buttons. Examples of the types of instrument panels that were used to collect data are shown. As can be seen, the first generic instrument panel with the red pushbuttons is an array of 15 buttons (3 rows X 5 columns). The second instrument panel of a car radio contains 12 buttons with two outside columns with three buttons each (3 rows X 1 column) and a bottom array of 6 buttons (2 rows X 3 columns).

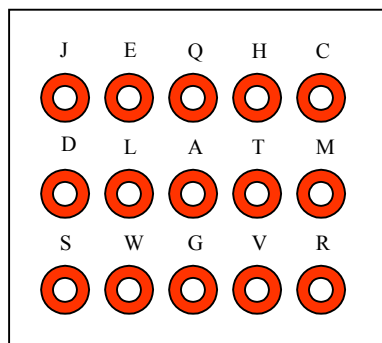
Drivers (subjects) were asked to perform the following tasks:

- Example 1: *In the BOTTOM row of red pushbuttons, press button W.* In this task, M = 1 and N = 5.
- Example 2: *In the LEFT column of red pushbuttons, press D then J.* In this task, M = 2 and N = 3.
- Example 3: *In the red pushbuttons, press H, W, then G.* In this task, M = 3 and N = 15.
- Example 4: *On the radio, decrease the volume, then press Fade Up.* M = 2 and N = 12.
- Example 5: *On the BOTTOM 6 controls of the radio, press Mute.* M = 1 and N = 6.

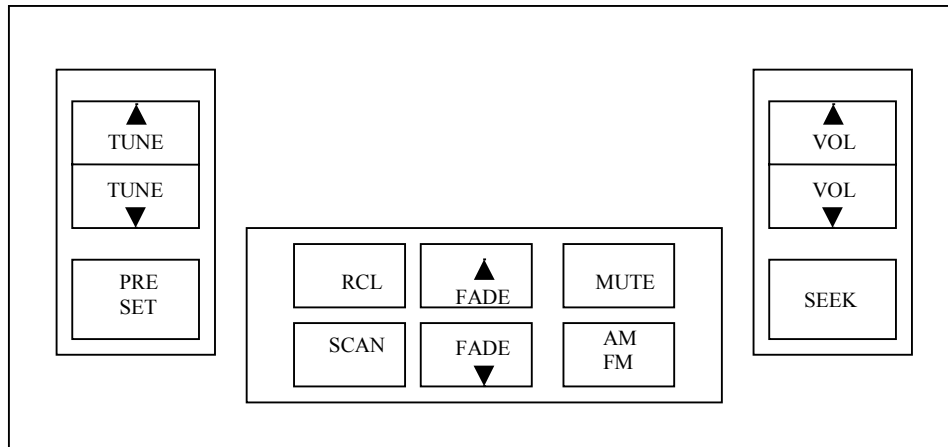
References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, Wierwille, 1988
- Imbeau and Wierwille, 1987
- Kurokawa, McFarlane, Hayes, Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Instrument Panels



Example Instrument Panel 1: 15-button array with 3 rows X 2 columns.



Example Instrument Panel 2: 12 buttons divided into two outside columns of three buttons (3 rows X 1 column) and a bottom array of 6 buttons (2 rows X 3 columns).

Open Center Vent

Task Description: In this task the driver opens the air vent, located in the center of the dash, by moving a tab laterally, which causes all louvers on the vent to move simultaneously. In collecting data for this task, the vent was initially closed. This task has both visual and manual components, i.e., the driver must locate the control (visual) and then manipulate the tab (manual). An example of the type of vent that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Center Vent



Typical center vent.

Passenger-Side Power Mirror

Task Description: In this task the driver adjusts the passenger-side power mirror to an appropriate position (starting from an inappropriate position). To accomplish this task, the driver manipulates a control, such as a small joystick, located on the dash. The mirror moves in the direction that the joystick is pointed. The mirror will continue to move in any direction until the limit is reached. The joystick control for this task is discrete, while the mirror position (i.e., display) is continuous. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual). An example of the type of passenger-side power mirror control that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Passenger-Side Power Mirror Control



Passenger-side power mirror control (far view).



Passenger-side power mirror control (close view).

Operate Passenger-Side Power Window

Task Description: In this task the driver operates the power window control for the passenger-side window by pressing the power window button located on the driver-door armrest. In collecting data for

this task, the driver was asked to raise or lower the window approximately 2 inches. This task has both visual and manual components, i.e., the driver must locate the control (visual) and then manipulate the button (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Driver-Side Power Mirror

Task Description: In this task the driver adjusts the driver-side power mirror to an appropriate position (starting from an inappropriate position). To accomplish this task, the driver manipulates a control, such as a small joystick, located on the driver-side door-panel/arm-rest. The mirror moves in the direction that the joystick is pointed. The mirror will continue to move in any direction until the limit is reached. The joystick control for this task is discrete, while the mirror position (i.e., display) is continuous. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual). An example of the type of driver-side power mirror control that was used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of Driver-Side Power Mirror Control



Driver-side power mirror control.

Auditory Feedback Task: Pull and Turn Balance

Task Description: In this task the driver pulls the balance control to engage it and then turns the balance for the left and right speakers. In this task, the balance control knob is initially pushed in, requiring the driver to pull it out to engage it. Additionally, the initial setting for the balance control is balanced (i.e., centered) and the driver purposely moves (offsets) it either to the left or right. Using the rotary knob that controls the balance between the left and right speakers, the driver rotates the knob to an off-center position. This task has visual, auditory, and manual components i.e., the driver must locate the control (visual), listen to the audio balance between the left and right speakers (auditory), and manipulate the rotary knob (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Pushbutton Telephone Keypad

Task Description: In this task the driver dials a pushbutton telephone keypad. The number of digits pressed can vary from 1 digit to 14 digits (based on the range of data that were collected). The control and the display are both discrete for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the pushbuttons (manual). An example of a pushbutton telephone keypad is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Telephone Keypad



Typical telephone keypad.

Auditory Feedback Task: Reset Balance

Task Description: In this task the driver resets the balance for the left and right speakers (the initial setting is unbalanced). Using a rotary knob that controls the balance between the left and right speakers, the driver rotates the knob to the middle position. This task has visual, auditory, and manual components, i.e., the driver must locate the control (visual), listen to the audio balance between the left and right speakers (auditory), and manipulate the rotary knob (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Auditory Feedback Task: Reset Tone

Task Description: In this task the driver resets the in-car radio tone controls for the treble and bass (the initial setting is not set properly). Using separate slide controls for the treble and bass, the driver sets the treble and bass to a proper-sounding setting. This task has visual, auditory, and manual components, i.e., the driver must locate the control (visual), listen to the audio settings for treble and bass (auditory), and manipulate the slide controls (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Actuate Rotary Control With Detent; Labeled With Random Letters of the Alphabet

Task Description: In this task the driver operates a rotary control with detent (stopping points). In this particular configuration, the rotary control was labeled with random letters of the alphabet. The driver operates the control by turning a rotary knob. The driver's task is to move the selector to a specified letter. The rotary control and the display are both discrete for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the rotary control (manual). An example of the type of rotary control with detent that was used to collect the data is shown below. Note that the display shown is not labeled with random letters of the alphabet. Nonetheless, it does give an indication of the type of control that was used to collect data.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Rotary Controls With Detent



Typical rotary controls with detent.

Actuate Rotary Control With Detent; Labeled With Consecutive Numbers

Task Description: In this task the driver operates a rotary control with detent (stopping points). In this particular configuration, the rotary control was labeled with consecutive numbers. The driver operates the control by turning a rotary knob. The driver's task is to move the selector to a specified number. The rotary control and the display are both discrete for this task. This task has both visual and manual

components, i.e., the driver must locate the control and watch the display (visual) and manipulate the rotary control (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Automatic Radio Tuning: Select Seek Station

Task Description: In this task the driver depresses the seek station button on the in-car radio. Once depressed, the radio automatically seeks and selects the next station where the frequency is strong enough to be received. This task involves a single pushbutton actuation. The control and the display are both discrete for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the pushbutton (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Select and Read Fuel Data

Task Description: In this task the driver presses a pushbutton on an IVIS (e.g., “Fuel Data Center”) to determine fuel data for the vehicle. A digital display is used to present the fuel data information. The pushbutton control for this task, along with the display, is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual). An example of an IVIS that has a pushbutton to access fuel data information is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Example of IVIS Where Driver Can Select and Read Fuel Data



IVIS where driver can select and read fuel data (far view).



IVIS where driver can select and read fuel data (close view).

Select and Read Fuel Economy

Task Description: In this task the driver presses a pushbutton on an IVIS (e.g., “Fuel Data Center”) to determine the fuel economy of the vehicle. A digital display is used to present the fuel economy information. The pushbutton control for this task, along with the display, is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Select and Read Fuel Range

Task Description: In this task the driver presses a pushbutton on an IVIS (e.g., “Fuel Data Center”) to determine the fuel range of the vehicle. A digital display is used to present the fuel range information. The pushbutton control for this task, along with the display, is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Select and Read Time

Task Description: In this task the driver presses a momentary pushbutton on an in-car radio to select between a display of either time or radio frequency. Each time the pushbutton is pressed, the display alternates between time and frequency. A digital display is used to present the time/frequency information. The pushbutton control for this task, along with the display, is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the control (manual). An example of the type of radio that might have a momentary pushbutton to alternate between a display of time and frequency is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Example of Radio on Which Driver Can Select and Read Time



Radio on which driver can select and read time.

Slide Control With Detent; Fine Adjustment

Task Description: In this task the driver operates a slide control with detent (stopping points). The driver's task is to move the slide control of a graphic equalizer on a radio to a specified position. The task requires the driver to perform a fine adjustment (i.e., to a specified position between two detents). The slide control is continuous, and the display (with detents) is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the slide control (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Slide Control With Detent; Gross Adjustment

Task Description: In this task the driver operates a slide control with detent (stopping points). The driver's task is to move the slide control of a graphic equalizer on a radio to a specified position. The task requires the driver to perform a gross (large) movement. The slide control is continuous, and the display (with detents) is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the slide control (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989

- Kurokawa and Wierwille, 1990

Slide Control With Detent; Step-Wise Adjustment

Task Description: In this task the driver operates a slide control with detent (stopping points). The driver's task is to move the slide control of a graphic equalizer on a radio to a specified position. The task requires the driver to perform a step-wise adjustment (i.e., from one detent to a neighboring detent). The slide control is continuous, and the display (with detents) is discrete. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the slide control (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Tune Radio to Frequency

Task Description: In this task the driver tunes the in-car, dash-mounted radio to a specified frequency. This is accomplished by turning the tuning knob on the radio and watching for the specified frequency to appear on the digital display. Both the operational control and display are continuous for this task. This task has both visual and manual components, i.e., the driver must locate the control and watch the display (visual) and manipulate the tuning knob (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Auditory Feedback Task: Turn Balance

Task Description: In this task the driver turns the balance for the left and right speakers. In this task, the initial setting is balanced and the driver purposely moves (offsets) the auditory balance to either the left or right. Using a rotary knob that controls the balance between the left and right speakers, the driver rotates the knob to an off-center position. This task has visual, auditory, and manual components, i.e., the driver must locate the control (visual), listen to the audio balance between the left and right speakers (auditory), and manipulate the rotary knob (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Turn On, Tune, and Adjust Volume of Radio With Digital Display, Deflection Tuning Knob, and Rotary Volume

Task Description: In this task the driver turns on the radio, tunes it, and then turns up the volume. The radio has a digital display, a deflection tuning knob, and a rotary volume control. A deflection tuning knob

is a spring-centered rotary knob that the driver turns clockwise to increase the tuning frequency and counterclockwise to decrease the tuning frequency. Deflection for actuation is approximately 20 degrees, and there is a single rate of change for the increase/decrease in tuning frequency. When the driver releases the knob it returns to the center position and the tuning frequency remains constant. For this task, the driver depresses the On/Off pushbutton and then tunes the radio to a specified frequency using the deflection tuning knob and by watching the digital display. Once the specified frequency is reached, the driver then adjusts the volume upward. The tuning knob and rotary volume control are continuous controls, and the display used was discrete. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the controls (manual).

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Turn On, Tune, and Set Volume on Radio

Task Description: In this task the driver turns on the radio, selects AM/FM, tunes to a specified frequency, and then adjusts the volume. This is accomplished by turning on the radio using a rotary knob, depressing the AM/FM pushbutton, turning the tuning knob while watching for the specified frequency to appear on the digital display, and then adjusting the volume using a rotary knob. The tuning and volume controls and the display are continuous for this task. This task has both visual and manual components, i.e., the driver must locate the controls and watch the display (visual) and manipulate the knobs and pushbuttons (manual). An example of the type of radio controls and display that were used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa, McFarlane, Hayes, and Wierwille, 1989
- Kurokawa and Wierwille, 1990

Auditory Feedback Task: Turn Volume

Task Description: In this task the driver changes the volume on the in-car radio by an incremental amount. This is accomplished by turning the volume control rotary knob on the radio until the volume is lower/higher. This task has visual, auditory, and manual components, i.e., the driver must locate the control (visual), listen to the volume setting (auditory), and manipulate the rotary knob (manual). An example of the type of radio controls and display that were used to collect the data is shown below.

References: Details of the data collection effort can be found in:

- Hayes, Kurokawa, and Wierwille, 1988
- Kurokawa and Wierwille, 1990

Visual and SIP Template Descriptions

Light Vehicle Visual and SIP Tasks

Two studies were used to develop a set of templates describing the demand associated with gathering information from a visual display presented to drivers of light vehicles by an in-vehicle information system. Sixty-eight templates were developed from the data in the studies, involving visual resources, supplemental information processing (SIP) resources, or both. The templates can be categorized as follows:

Task objective: To search for specific targets or routes on the display matching certain criteria, to find a hotel or other destination matching certain criteria, to find a route matching certain criteria, to find the lowest cost route to a specific destination, or to find the quickest route to a specific destination.

Required mental processing: Planning based on current location and desired destination, computation, interpretation of presented information, or a combination of these.

Display type: Map with graphic icons, map with textual information, paragraph, table, or tabular list.

Display density: Number of options and/or descriptors presented to the driver categorized as low (3 options and 2 to 3 descriptors), medium (3 options and 3 to 4 descriptors), high (5 options and 4 to 5 descriptors), or very high (5 options and 6 to 7 descriptors).

Note that route selection tasks, which involved searching for information, used a display that contained at least one route descriptor: type of road. Map displays contained at least two route descriptors: type of road and distance to destination. Some route selection tasks used a display that contained more than two route descriptors. These additional route descriptors included one or more of the following: delays in minutes, delay description, hazards, toll booth location, toll road cost, gas station location, number of lanes closed, amount of congestion, traffic density, and speed limit. The number of route descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high. However, across tasks, within a density category, the descriptors may or may not have been the same. For example, within a high-density category, one task may have had a certain set of descriptors while a different high-density task may have had a different set of descriptors. Because of this, caution must be used in making comparisons across tasks within a density category and between density categories.

Also note that hotel selection tasks, which involved searching for information, used a display that contained at least two hotel descriptors: name of hotel and distance to hotel. Map displays contained at least three descriptors: name of hotel, distance to hotel, and type of road. Some hotel selection tasks used a display that contained more than two hotel descriptors (and more than three hotel descriptors for map displays). These additional hotel descriptors included one or more of the following: vacancy, cost, quality rating, and restaurant. The number of hotel descriptors that were contained in a display was used to classify displays into one of four density categories: low, medium, high, and very high.

The set of templates involving both visual and SIP resources includes the following.

- Find Hotel Using Planning, High Density Graphic Icon Display
- Find Hotel Using Planning, High Density Graphic Text Display
- Find Hotel Using Planning, High Density Paragraph Display
- Find Hotel Using Planning, High Density Table Display
- Find Hotel Using Planning, Low Density Graphic Icon Display
- Find Hotel Using Planning, Low Density Graphic Text Display
- Find Hotel Using Planning, Low Density Paragraph Display
- Find Hotel Using Planning, Low Density Table Display
- Find Hotel Using Planning, Medium Density Graphic Icon Display
- Find Hotel Using Planning, Medium Density Graphic Text Display

- Find Hotel Using Planning, Medium Density Paragraph Display
- Find Hotel Using Planning, Medium Density Table Display
- Find Hotel Using Planning, Very High Density Graphic Icon Display
- Find Hotel Using Planning, Very High Density Graphic Text Display
- Find Hotel Using Planning, Very High Density Table Display
- Find Low Cost Route Using Computation, High Density Graphic Text Display
- Find Low Cost Route Using Computation, High Density Table Display
- Find Low Cost Route Using Computation, Medium Density Paragraph Display
- Find Low Cost Route Using Computation, Medium Density Table Display
- Find Quickest Route Using Computation, High Density Graphic Text Display, Visual
- Find Quickest Route Using Computation, High Density Table Display
- Find Quickest Route Using Computation, Medium Density Graphic Text Display, Visual
- Find Quickest Route Using Computation, Medium Density Paragraph Display
- Find Quickest Route Using Computation, Medium Density Table Display
- Find Route Using Planning and Computation, High Density Graphic Text Display
- Find Route Using Planning and Computation, Medium Density Paragraph Display
- Find Route Using Planning and Computation, Medium Density Table Display
- Find Route Using Planning and Interpretation, High Density Graphic Icon Display
- Find Route Using Planning and Interpretation, High Density Graphic Text Display
- Find Route Using Planning and Interpretation, High Density Table Display
- Find Route Using Planning and Interpretation, Low Density Paragraph Display
- Find Route Using Planning and Interpretation, Low Density Table Display
- Find Route Using Planning and Interpretation, Medium Density Graphic Icon Display
- Find Route Using Planning and Interpretation, Medium Density Graphic Text Display
- Find Route Using Planning and Interpretation, Medium Density Paragraph Display
- Find Route Using Planning and Interpretation, Medium Density Table Display
- Find Route Using Planning and Interpretation, Very High Density Graphic Icon Display
- Find Route Using Planning, High Density Graphic Icon Display
- Find Route Using Planning, High Density Graphic Text Display
- Find Route Using Planning, High Density Table Display
- Find Route Using Planning, Interpretation and Computation, High Density Table Display
- Find Route Using Planning, Low Density Graphic Icon Display
- Find Route Using Planning, Low Density Paragraph Display
- Find Route Using Planning, Low Density Table Display
- Find Route Using Planning, Medium Density Graphic Icon Display
- Find Route Using Planning, Medium Density Graphic Text Display
- Find Route Using Planning, Medium Density Paragraph Display
- Find Route Using Planning, Medium Density Table Display
- Find Route Using Planning, Very High Density Graphic Icon Display

References: Details of the data collection effort can be found in:

- Gallagher, 2000
- Westat, 1999

Commercial Vehicle Visual and SIP Tasks

The IVIS Subtask Library includes 40 templates describing the demand associated with gathering information from a visual display presented to drivers of commercial vehicles by an in-vehicle information system. These templates involve visual resources only, and both visual and supplemental information processing (SIP) resources. The templates can be categorized as follows:

Task objective: To search for specific targets or routes on the display matching certain criteria, to find a hotel or other destination matching certain criteria, to find a route matching certain criteria, to find the lowest cost route to a specific destination, or to find the quickest route to a specific destination.

Required mental processing: Planning based on current location and desired destination, computation, interpretation of presented information, or a combination of these.

Display type: Map with graphic icons, map with textual information, paragraph, table, or tabular list.

Display density: Number of options and/or descriptors presented to the driver categorized as low (3 options and 2 to 3 descriptors), medium (3 options and 3 to 4 descriptors), or high (5 options and 4 to 5 descriptors).

The study data used to develop the templates covered the definition of nominal demand measures and age modifiers. However, workload modifiers (adjusting for roadway complexity and traffic density) and identifier modifiers (adjusting for reliance on symbols, character size, and location in the vehicle) are based on light vehicle data because heavy vehicle data that might be used to calculate the modifiers was not available. Although research suggests that this approach produces a valid estimate of the identifier effect, it is likely the magnitude of the workload effect is underestimated.

The set of templates involving both visual and SIP resources includes the following.

- CVO Find Route Using Computation, High Density Graphic Text Display
- CVO Find Route Using Computation, High Density Paragraph Display
- CVO Find Route Using Computation, High Density Table Display
- CVO Find Route Using Computation, Medium Density Graphic Text Display
- CVO Find Route Using Computation, Medium Density Paragraph Display
- CVO Find Route Using Computation, Medium Density Table Display
- CVO Find Route Using Planning and Computation, High Density Table Display
- CVO Find Route Using Planning and Computation, Medium Density Table Display
- CVO Find Route Using Planning and Interpretation, High Density Table Display
- CVO Find Route Using Planning and Interpretation, Low Density Paragraph Display
- CVO Find Route Using Planning and Interpretation, Low Density Table Display
- CVO Find Route Using Planning and Interpretation, Medium Density Graphic Icon Display
- CVO Find Route Using Planning and Interpretation, Medium Density Graphic Text Display
- CVO Find Route Using Planning and Interpretation, Medium Density Paragraph Display
- CVO Find Route Using Planning and Interpretation, Medium Density Table Display
- CVO Find Route Using Planning, High Density Graphic Icon Display
- CVO Find Route Using Planning, High Density Graphic Text Display
- CVO Find Route Using Planning, High Density Paragraph Display
- CVO Find Route Using Planning, High Density Table Display
- CVO Find Route Using Planning, Interpretation and Computation, High Density Graphic Text Display
- CVO Find Route Using Planning, Interpretation and Computation, High Density Paragraph Display
- CVO Find Route Using Planning, Interpretation and Computation, High Density Table Display
- CVO Find Route Using Planning, Low Density Graphic Icon Display
- CVO Find Route Using Planning, Low Density Paragraph Display
- CVO Find Route Using Planning, Low Density Table Display
- CVO Find Route Using Planning, Medium Density Graphic Icon Display
- CVO Find Route Using Planning, Medium Density Graphic Text Display
- CVO Find Route Using Planning, Medium Density Paragraph Display
- CVO Find Route Using Planning, Medium Density Table Display

Determine General Vehicle Heading Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to locate the North arrow on the Navigator (always displayed). Once the driver locates the North arrow, he/she uses it to judge the current direction (vehicle heading) relative to north.

This task has visual and SIP components, i.e., the driver must locate the North arrow on the Navigator by looking at the display (visual) and then make a judgment as to the current direction of the vehicle relative to the North arrow (SIP). The Navigator display is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Determine if Current Direction of Travel is Appropriate to Get to Destination Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to locate the direction-to-destination arrow on the Navigator (always displayed). In addition, the driver looks at the current roadway being traveled and associated roadways that are nearby (always displayed for this task). Using this information, the driver judges whether the current roadway and direction are appropriate to reach the destination.

This task has visual and SIP components, i.e., the driver must locate the direction-to-destination arrow and look at nearby roadways displayed on the Navigator (visual) and then make a judgment as to whether the direction of travel is appropriate (SIP). The Navigator display is shown below.

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Determine if Current Direction of Travel is Appropriate to Get to Destination Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to look at the Navigator map display and locate an appropriate nearby turn-off roadway. From the current location, the driver is then required to interpolate the distance to the turn-off roadway using his/her knowledge of the map scale. Once this distance is determined, the driver then states the distance aloud.

This task has visual and SIP components, i.e., the driver must look at the Navigator map display (visual) and estimate the distance, using the map scale, to the turn-off roadway (SIP).

References: Details of the data collection effort can be found in:

- Dingus, 1987

- Kurokawa and Wierwille, 1990

Auditory and SIP Template Descriptions

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a prose format spoken at a normal or fast speech rate. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select the route with no gas station." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

“Interstate 17 to Highway 44 is a distance of 165 miles and has a gas station.
U.S. Route 29 to Highway 19 is a distance of 180 miles and has a gas station.
U.S. Route 29 to Highway 44 is a distance of 177 miles and has no gas station.”

Question: Select the route with no gas station.

Select the Least Expensive Route to the Airport or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). The driver is required to perform arithmetic computations with the information in the message. An auditory message is presented to the driver in prose format at a normal speech rate. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select the least expensive route to the airport." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

“Interstate 17 to U.S. Route 18 has a \$4.75 toll and a \$3.75 toll.
U.S. Route 29 to U.S. Route 18 has a \$4.25 toll and a \$2.50 toll.
U.S. Route 29 to U.S. Route 46 has a \$5.75 toll and a \$2.50 toll.”

Question: Select the least expensive route to the airport.

Select a Hotel or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria and then use the information in selecting an option (SIP). The information in the message is used to aid in decision planning. An auditory message

is presented to the driver in prose format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select a hotel." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

“The Best Western has a vacancy, costs \$85, and is a distance of 34 miles away.
The Ramada has a vacancy, costs \$61, and is a distance of 17 miles away.
The Holiday Inn has no vacancy, costs \$52, and is a distance of 13 miles away.
The Comfort Inn has no vacancy, costs \$71, and is a distance of 21 miles away.
The Marriott has a vacancy, costs \$82, and is a distance of 16 miles away.”

Question: Select a hotel.

Select a Hotel or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a supplemental information processing (SIP) component: the driver must listen to the system to find the information that matches the specified criteria and then use the information in selecting an option (SIP). The information in the message is used to aid in decision planning. An auditory message is presented to the driver in list format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select a hotel." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Comfort Inn, vacancy, \$55, 44 miles.
Marriott, no vacancy, \$71, 18 miles.
Holiday Inn, vacancy, \$79, 12 miles.
Ramada, vacancy, \$82, 17 miles.
Best Western, no vacancy, \$65, 10 miles."

Question: Select a hotel.

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a list format spoken at a normal speech rate. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select the route with no monetary cost." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to Route 18, light congestion, clear weather, \$4.25 toll.
Route 19 to Route 18, light congestion, rainy weather, \$3.75 toll.
Route 29 to Route 46, moderate congestion, clear weather, \$2.00 toll.
Route 29 to Route 12, light congestion, rainy weather, \$1.00 toll.
Route 29 to Highway 19, moderate congestion, foggy weather, no toll."

Question: Select the route with no monetary cost.

Select a Route to the Hospital or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria and then use the information in selecting an option (SIP). The information in the message is used to aid in decision planning. An auditory message is presented to the driver in list format. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select a route to the hospital." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

"Route 29 to Route 18, light congestion, train crossing delay.
Interstate 17 to U.S. Route 89, moderate congestion, construction delay.
Route 29 to Route 46, moderate congestion, school bus delay."

Question: Select a route to the hospital.

Select the Least Expensive Route to the Airport or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). The driver is required to perform arithmetic computations with the information in the message. An auditory message is presented to the driver in list format at a normal speech rate. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select the least expensive route to the airport." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Beaver, 1999

Example of task: The auditory message is as follows:

"Route 89 to Route 18, \$2.25 toll, \$1.50 toll.
Interstate 17 to Route 54, \$2.75 toll, \$1.75 toll.
Route 29 to Route 46, \$1.75 toll, \$3.25 toll."

Question: Select the least expensive route to the airport.

Select the Least Expensive Route to the Airport or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). An auditory message is presented to the driver in list format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The driver is required to perform arithmetic computations with the information in the message. The message presented is shown below. The driver is asked to: "Select the least expensive route to the airport." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Route 89 to Route 19, 21 miles, \$3.75 toll, \$4.75 toll.
 Interstate 17 to Highway 41, 58 miles, \$6.25 toll, \$1.75 toll.
 Route 29 to Highway 26, 74 miles, \$3.75 toll, \$2.50 toll.
 Interstate 17 to Route 54, 33 miles, \$3.25 toll, \$1.75 toll.
 Route 34 to Highway 44, 26 miles, \$2.75 toll, \$3.25 toll."

Question: Select the least expensive route to the airport.

Select a Hotel or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria and then use the information in selecting an option (SIP). The information in the message is used to aid in decision planning. An auditory message is presented to the driver in list format. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select a hotel." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Comfort Inn, vacancy, 32 miles.
 Howard Johnson's, no vacancy, 25 miles.
 Ramada, vacancy, 47 miles."

Question: Select a hotel.

Select a Route to the Hospital or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). Some of the information in the message requires interpretation. The information in the message is used to aid in decision planning. An auditory message is presented to the driver in list

format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select a route to the hospital." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Route 89 to Route 54, light congestion, construction delay, 1 of 1 lane closed.
Interstate 17 to Route 37, moderate congestion, train crossing delay, 1 of 2 lanes closed.
Interstate 17 to U.S. Route 46, heavy congestion, accident delay, 2 of 2 lanes closed.
Route 37 to Highway 26, light congestion, funeral procession delay, 1 of 2 lanes closed.
Interstate 17 to Route 18, moderate congestion, drawbridge delay, 2 of 2 lanes closed."

Question: Select a route to the hospital.

Listen to a Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the system to find the information that matches the specified criteria. An auditory message is presented to the driver in a list format spoken at a normal speech rate. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked, "Which route has a 22 minute delay?" The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to Highway 54, 20 miles, 40-minute delay.
Route 89 to Highway 19, 22 miles, 15-minute delay.
Route 29 to Highway 26, 77 miles, 22-minute delay."

Question: Which route has a 22-minute delay?

Select the Least Expensive Route to the Airport or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). The driver is required to perform arithmetic computations with the information in the message. An auditory message is presented to the driver in prose format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select the least expensive route to the airport." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"U.S. Route 29 to U.S. Route 12 is 35 miles, has a \$5.75 toll and a \$3.75 toll.
Interstate 17 to U.S. Route 12 is 12 miles, has a \$6.25 toll and a \$1.25 toll.
U.S. Route 29 to Highway 19 is 47 miles, has a \$5.75 toll and an \$8.50 toll.
Interstate 17 to Highway 19 is 58 miles, has a \$5.25 toll and a \$1.75 toll.
U.S. Route 29 to Highway 44 is 62 miles, has a \$2.50 toll and a \$3.50 toll."

Question: Select the least expensive route to the airport.

Select a Hotel or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria and then use the information in selecting an option (SIP). The information in the message is used to aid in decision planning. An auditory message is presented to the driver in prose format. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select a hotel." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"The Ramada has a vacancy and is a distance of 48 miles away.
The Howard Johnson's has no vacancy and is a distance of 40 miles away.
The Motel 8 has a vacancy and is a distance of 52 miles away."

Question: Select a hotel.

Select a Route to the Hospital or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). Some of the information in the message requires interpretation. The information in the message is used to aid in decision planning. An auditory message is presented to the driver in prose format. The display density is classified as "Medium," where there are 3 options and 3 categories of information (3x3). The message presented is shown below. The driver is asked to: "Select a route to the hospital." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"U.S. Route 29 to U.S. Route 44 has moderate congestion, and has a train crossing delay.
U.S. Route 12 to U.S. Route 54 has light congestion, and has a school bus delay.
Interstate 17 to U.S. Route 37 has heavy congestion, and a construction delay."

Question: Select a route to the hospital.

Select a Route to the Hospital or Other Specified Facility

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task has both an auditory component and a SIP component: the driver must listen to the system to find the information that matches the specified criteria (auditory) and then use this information in selecting an option (SIP). Some of the information in the message requires interpretation. The information in the message is used to aid in decision planning. An auditory message is presented to the driver in prose format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select a route to the hospital." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to U.S. Route 18 has moderate congestion, a drawbridge delay, and 2 of 2 lanes are closed. U.S. Route 29 to Highway 44 has light congestion, a funeral procession delay, and 1 of 2 lanes is closed. Interstate 17 to U.S. Route 46 has heavy congestion, an accident delay, and 2 of 2 lanes are closed. U.S. Route 29 to U.S. Route 18 has light congestion, a school bus delay, and 1 of 1 lane is closed. Interstate 17 to U.S. Route 12 has moderate congestion, a train crossing delay, and 1 of 2 lanes is closed."

Question: Select a route to the hospital.

Listen to the IVIS Message To Identify a Route Matching Specified Criteria

Task Description: This task involves listening to a message presented by an in-vehicle information system. This task only has an auditory component: the driver must listen to the IVIS to find the information that matches the specified criteria. An auditory message is presented to the driver in prose format. The display density is classified as "High," where there are 5 options and 4 categories of information (5x4). The message presented is shown below. The driver is asked to: "Select the route that has a gas station." The driver responds verbally.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The auditory message is as follows:

"Interstate 17 to U.S. Route 18 has light congestion, has clear weather, and has no gas station. U.S. Route 19 to U.S. Route 18 has light congestion, has rainy weather, and has no gas station. U.S. Route 29 to U.S. Route 46 has moderate congestion, has clear weather, and has no gas station. U.S. Route 29 to U.S. Route 12 has light congestion, has rainy weather, and has no gas station. U.S. Route 29 to Highway 19 has moderate congestion, has foggy weather, and has a gas station."

Question: Select the route that has a gas station.

Conversation Task With a Pre-Recorded Voice

Task Description: This task involves listening and responding to pre-recorded questions. This task has both an auditory component and a SIP component: the driver must listen (auditory) and respond to (SIP) to the question. As shown below, nine questions are presented to the driver. The driver responds verbally to each question.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The conversation is as follows:

"Did you feel safe while doing the auditory tasks?"

YES NO

Would you purchase a navigation system for your vehicle, if it were available and affordable?

YES NO

Did you find the visual information displays distracting?"

YES NO

Which was more difficult for you, the graphics with icons or the graphics with text?"

GRAPHICS WITH ICONS GRAPHICS WITH TEXT

Would you feel comfortable reading a one-paragraph-length letter while driving?"

YES NO

Do you own a cell phone?"

YES NO

Would you use a cell phone while driving in heavy traffic?"

YES NO

Would you read a simple map while driving?"

YES NO

Do you prefer to drive in the daytime or at night?"

DAYTIME NIGHT"

Conversation Task With a Live Voice

Task Description: This task involves listening and responding to an experimenter's "live" (i.e., not pre-recorded) questions. This task has both an auditory component and a SIP component: the driver must listen (auditory) and respond to (SIP) to the question. As shown below, nine questions are presented to the driver. The driver responds verbally to each question.

Reference: Details of the data collection effort can be found in:

- Biever, 1999

Example of task: The conversation is as follows:

"Did you feel safe while doing the visual tasks?"

YES NO

Would you purchase an electronic mail system for your vehicle, if it were available and affordable?

YES NO

Did you find the auditory information displays distracting?

YES NO

Which was more difficult for you, the text in table form or the text in paragraph form?

TEXT IN TABLES TEXT IN PARAGRAPHS

Would you feel comfortable listening to a one-paragraph-length letter while driving?

YES NO

Do you own a car stereo?

YES NO

Would you use a car stereo while driving in heavy traffic?

YES NO

Would you read simple directions while driving?

YES NO

Do you prefer to drive on the highway or in town?

HIGHWAY TOWN"

Visual, SIP, and Manual Template Descriptions

Set Proper Zoom Level on ETAK Navigator Based on Destination Distance

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to look at the distance-to-destination number (always displayed) on the Navigator. In addition, the driver looks at the scale levels on the navigator (always displayed). The driver then sets the proper zoom level based on the destination distance by depressing the next higher scale level number than the destination distance number.

This task has visual, SIP, and manual components, i.e., the driver must locate the destination number and scale levels displayed on the Navigator (visual), consider what action to take based on this information (SIP), and then set (depress) the zoom level (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Determine Name of Next Cross Street Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to look at the scale level number on the navigator (always displayed). In addition, the driver looks at the navigator map display (always displayed) and determines whether a cross street appears. The driver makes a judgment as to whether any cross street that appears is the next cross street based on the current scale level. The driver then zooms in or zooms out, as appropriate, if the cross street does not appear or if the cross street displayed is not likely to be the next cross street. Once this process is complete, the driver reads aloud the label of the cross street, if one is present, or responds "no label appears."

This task has visual, SIP, and manual components, i.e., the driver must look at the scale level number and the Navigator map displayed (visual), determine if a cross street appears and decide to zoom in or out as necessary (SIP), and then perform the action of zooming in or out (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990

Determine Name of Near Roadway Appropriate to Get to Destination Using ETAK Navigator

Task Description: In this task the driver interacts with a navigation aid. The navigation aid that was used in the study to collect the data was developed by ETAK and called the Navigator. For this particular task, the driver is required to look at the Navigator map display and find the destination star (always displayed for this task). Using this information, the driver then plans a route from the current point to the destination. The driver must also determine whether a scale change is required to determine the appropriate nearby turn-off roadway. As required, the driver then zooms in or out to find the roadway. Once the roadway is found, the driver responds by reading the roadway label or stating, "no label appears."

This task has visual, SIP, and manual components, i.e., the driver must look at the Navigator map display (visual), plan a route and locate a nearby turn-off roadway (SIP), and zoom in or out as needed (manual).

References: Details of the data collection effort can be found in:

- Dingus, 1987
- Kurokawa and Wierwille, 1990