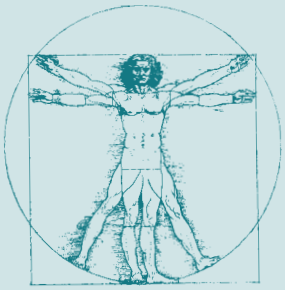
Research Update



HUMAN CENTERED

S Y S T E M S

The Human Centered Systems Research Program addresses human performance-related issues that affect highway system design. Current human centered research focuses on Highway Safety and Intelligent Transportation Systems (ITS).

Human centered research products include driver performance models, highway system design guidelines, and handbooks based upon empirical human performance data collected in the laboratory and in controlled, on-the-road tests.

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Federal Highway Administration

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IN-VEHICLE INFORMATION SYSTEMS DEMAND MODEL

Introduction

The goal of in-vehicle information system (IVIS) technologies is to increase the mobility, improve the efficiency, and increase the safety and/or convenience of the motoring public. To achieve this goal, in-vehicle information systems must be designed to include good human factors principles that consider the capabilities and limitations of the operators of these systems. The Federal Highway Administration (FHWA) initiated a research project with two main objectives: to provide designers of IVIS technologies with a set of tools and criteria that could be used in evaluating the attentional resources required by IVIS designs, and to provide highway planners and engineers with tools and criteria to evaluate proposed IVIS requirements.

When evaluating IVIS designs, human factors engineers and system designers need answers to several questions, including those related to usability, driver preference and, most importantly, driver safety. One promising approach for evaluating the safety of IVIS designs is to determine the amount of attention the driver must devote to these devices. Driving a vehicle imposes a particular load on a driver's attentional resources. These attentional resources are used to safely perform the primary task of driving the vehicle (i.e., vehicle control, navigation, and hazard detection). Interaction with IVISs can increase the load on these attentional resources, possibly interfering with the driver's ability to perform the primary task of driving. The design characteristics of an IVIS can affect the amount of driver attention needed to service the system. Attentional resources can be thought of as a pool from which all tasks and mental activities are drawn. Decreased resources for primary task performance may lead to decreased driving safety. It is from this theoretical basis that the IVIS evaluation software was designed.

IVIS Design Support Software

An IVIS design support software program was developed that allows evaluation of IVIS designs on the basis of the attention demand required of the driver. This program is called the In-Vehicle Information System (IVIS) Design Evaluation and Model of Attentional Demand (DEMAnD) software program. This program can be installed and run in a Windows operating environment.

What Does the IVIS DEMAnD Program Do?

The purpose of the IVIS DEMAnD program is to assist designers and engineers in evaluating the demands placed on the driver's attention resource pool by given IVIS designs and their associated tasks. More specifically, the program can be used to: (1) compare two or more candidate IVIS designs for performing the same task, (2) evaluate an upgrade for a current design, or (3) evaluate a given design, task, or subtask against a set of benchmark criteria. The benchmark criteria are safety-related measures that indicate when driving performance will be affected and substantially affected relative to baseline driving with no in-vehicle task. A sample list of these measures is shown in **Table 1** (see next page).

Individual Measures	Affected (coded yellow)	Substantially Affected (coded red)
Single glance time	1.6 seconds	2.0 seconds
Number of glances	6 glances	10 glances
Total visual task time	7 seconds	15 seconds
Auditory message complexity rating	Medium	High
Total task time	12 seconds	25 seconds
Speech command complexity rating	Medium	High

Table 1. Sample of Safety Related Measures and Critical Values.

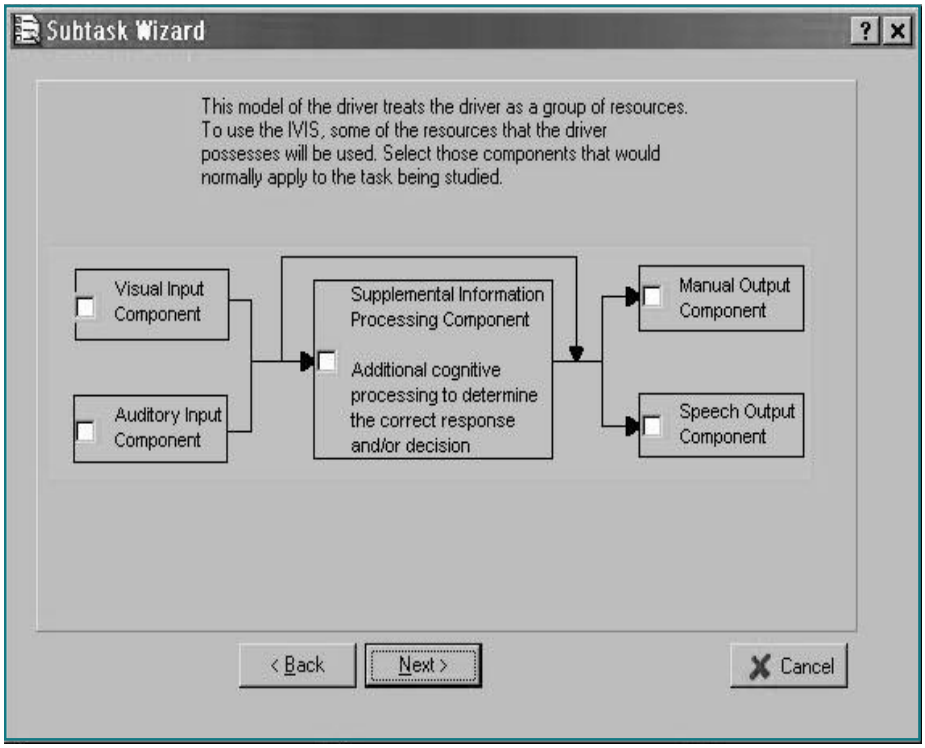

Figure 1. User Identifies Driver Resources Involved in Performing the Task.

How Does the IVIS DEMAnD Program Work?

The method by which the IVIS DEMAnD program evaluates IVIS designs consists of conducting an analysis of the tasks that the driver performs when interacting with the IVIS. **Figure 1** shows one of the initial program screens that helps users begin their evaluation by specifying the IVIS task(s). In specifying the task of interest, the user indicates what driver resources are involved in performing the task. As shown, the task can draw upon one or more of the following five resources: (1) Visual Demand, (2) Auditory Demand, (3) Supplemental Information Processing (SIP) Demand, (4) Manual Demand, and (5) Speech Demand.

After the designer (program user) has selected one or more resources that define the task of interest, the designer then selects a task from a library that closely matches the task of interest. Two libraries can be used: a library based on tasks taken from the technical literature, or a library based on tasks previously used by the designer. If the task cannot be found in either library (i.e., it is an uncommon task and/or a task without data), the user can specify the characteristics of the task by comparing it with other common tasks. An evaluation tool ("Wizard") is used to guide the user through the process of specifying the various characteristics of a task that is not in the libraries. Note that a task can either be a single item from the library or composed of multiple subtasks from the library.

Once a task has been selected, a set of primary measures associated with the resources of that task is extracted by the program. These nominal values can then be modified by the user by means of several unique categories of parameters at the task level or at the subtask level. Task modifiers, highlighted in **Table 2**, are applicable to all tasks. Subtask modifiers are subtask dependent and can vary from one subtask to another. Examples of subtask modifiers are also shown in **Table 2**.

At this point in the evaluation, the user has specified (1) the driver resource categories germane to the task of interest, (2) the task of interest or characteristics of the task of interest, and (3) modifiers relevant to the design. Once these items have been specified, the user can view the results of the evaluation. As shown in **Figure 2**, the evaluation is displayed graphically and illustrates the relative driving task performance (conceptual) and the degree to which driver resources are affected by the task. A Demand Measures Summary is also provided that outlines what measures are affected, and to what degree. In addition, the user can view a printable report at the system level, task level, or subtask level. This report can be saved and read into common spreadsheet and word processor programs. If it is determined that a task poses heavy demands on driver resources, the user can modify the IVIS design and try to lower these demands.

How Was the IVIS DEMAnD Program Developed?

The data used to develop the IVIS DEMAnD program came from two general sources: an extensive literature review and a set of four on-road field studies conducted by the research team specifically for this project. The literature review was used to gather existing data on driver-task measures. The field studies were used to supplement the existing data. The model equations and analytical tools were developed from these "real-world" data.

The IVIS DEMAnD program was developed in modules so that it can be easily modified and expanded. For example, as new data become available, the task library can be expanded to include new IVIS-related tasks. The modular design of the IVIS DEMAnD program promotes adaptability and paves the way for revisions, updates, and future versions.

Task Parameters	Subtask Parameters
Roadway complexity	Character height
Frequency of use	Luminance
Symbols/ labels reliance	Message length
Driver definition	Display density
Traffic density	Task-specific modifiers

Table 2. Sample of User Modifiable Parameters.

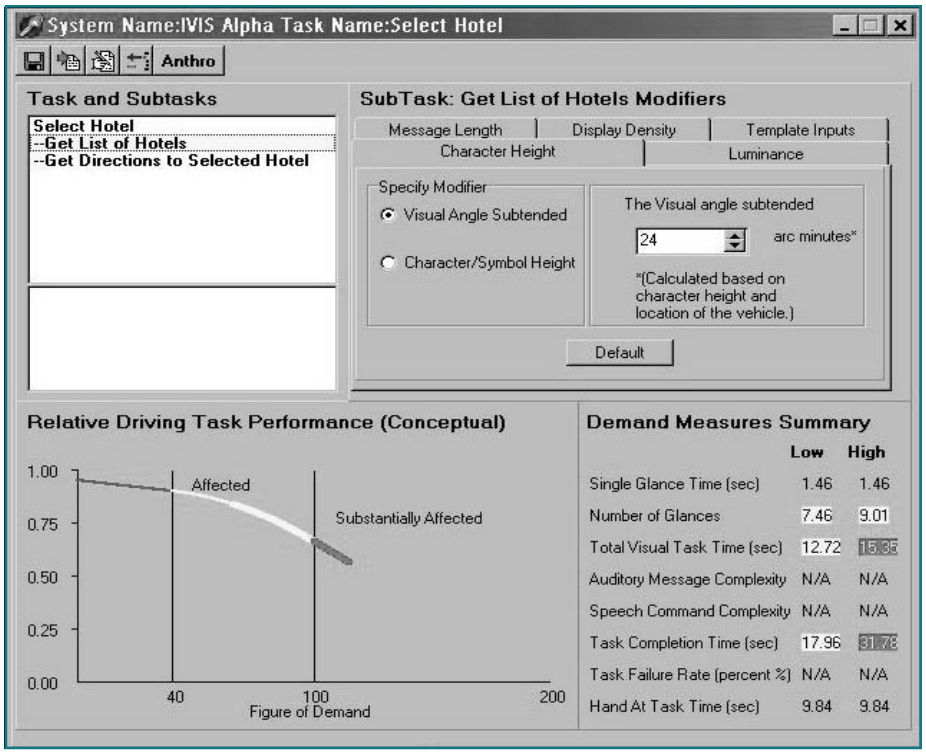

Figure 2. IVIS Program Window Shown at the Task Level.

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Distribution—This technical summary is being distributed according to a standard distribution. Direct distribution is being made to the Resource Centers, Divisions, and the customers in the automotive industry.

Availability—This software will be in limited release for alpha and beta testing in the summer of 2000.

Key Words—In-vehicle information systems, design support, design tool, behavioral model, model, attention demand, figure of demand.

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Issued April 2000 Publication No. FHWA-RD-00-092