National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

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These **Digests** are issued in the interest of providing an early awareness of the research results emanating from projects in the NCHRP. By making these results known as they are developed and prior to publication of the project report in the regular NCHRP series, it is hoped that the potential users of the research findings will be encouraged toward their early implementation in operating practices. Persons wanting to pursue the project subject matter in greater depth may obtain, on a loan basis, an uncorrected draft copy of the agency's report by request to the NCHRP Program Director, Highway Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418

Development of Information Requirements and Transmission Techniques for Highway Users

An NCHRP staff digest of the essential findings from the final report on NCHRP Project 3-12, "Development of Information Requirements and Transmission Techniques for Highway Users," prepared by G. F. King and H. Lunenfeld, Airborne Instrument Laboratory, Deer Park, New York

THE PROBLEM AND ITS SOLUTION

This study addressed itself to the question, "What information is needed by highway users for safe, convenient, efficient, and comfortable performance of the driving task?" The systematic approach used to determine the nature of the information needed by highway users provided a framework for conceptualizing the form and timing of information so that it can be used most effectively by drivers. In this solution to the problem, the driver was viewed as an element of the highway system. The "human-engineering" or "man-machine-systems analysis" techniques more commonly used by the aerospace industry were applied to the highway information problem. In the empirical part of this study, the driving task was investigated through the use of a task analysis. Although the task-analysis methodology is used extensively in military systems analysis, its use in driver-related research had been limited. This research stands alone and does not have to be combined with the results of other research to be useful. The research results are defined explicitly enough to permit direct application to practice.

FINDINGS

Task Analysis

Through the task analysis technique, a body of information needs was identified, the satisfaction of which enables drivers to perform the driving task safely, conveniently, efficiently, and comfortably. Principal factors were defined that organize the information needs into functional groups, delineate the

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interactions between the information needs, and identify the criteria for selecting and transmitting information so that the drivers' needs are satisfied.

The driving task analysis disclosed that the operations performed by a driver can be characterized in terms of a hierarchy. It has been found that the basic tasks of tracking and speed control (called microperformance) are at one end of the hierarchy, direction finding and trip planning (called macroperformance) are at the other end of the hierarchy, and driver responses to road and traffic situations are in the middle. A demanding priority (primacy) exists in satisfying information needs, with micro needs having priority over situational and macro needs. It was found that satisfying this primacy of information needs is basic to the design of a highway information system.

Expectancy

A key factor in the performance of the driving task was found to be expectancy. When a trip is planned, the driver forms expectations of the conditions to be encountered in transit. These expectations operate in such a manner as to provide the driver with a basis for planning his trip, as well as providing him with information about what directional information he should expect in transit, when to expect it, and what it should look like.

Design Manual

On the basis of the foregoing principles, as applied to actual sections of Interstate and rural arterial highways, a procedure was developed to permit the systematic application of pertinent human-factors principles to the review of information system designs. The procedure was formalized into a "Manual on Information System Design Procedures." This manual, in addition to an iterative formal procedure that can be used for the review of proposed signing plans, contains a section in which are abstracted and defined human factors principles useful to the traffic engineer.

Sign Legibility

The role of signs in a highway information system, as well as several aspects important in the design and use of fixed highway signing, was analyzed in detail. It was found that signs could, and should, continue to be the main highway information carriers.

Detailed attention was given to the design of signs for night legibility, and a computer program was developed to determine night legibility of signs and the variation of legibility with variations in environmental and geometric parameters. The computer program was used to analyze existing signs on a stretch of I-85 in North Carolina.

Conclusions were drawn concerning the adequacy of sign design criteria contained in present manuals. It was found that sign legibility varies greatly with minor changes in horizontal and vertical approach alignment. It was also found that overhead signs are inadequate if illuminated only by the low-beam headlamps of an approaching vehicle.

Sign Blockage and Lateral Displacement

The possibility of blockage of signs by trucks was modeled mathematically. Under certain conditions, it was found that this potential blocking could represent a serious problem in the proper reception of visual information by drivers.

The effect of lateral displacement of signs on required letter height was analyzed and it was found that considerable increases in required letter height may be required if signs are offset to create clear recovery areas.

APPLICATION

As a result of this research, the following ten specific concepts and conclusions are presented. These concepts can be applied by highway signing engineers when designing future roadway information systems, because they can be readily implemented and have already been translated into the working tools with which the practicing traffic engineer is familiar. The research results have been evaluated sufficiently to insure a high probability of success when applied to practice.

1. Driver information needs occur throughout the entire driving task, and include pretrip planning.

2. Driver information needs fall into a hierarchy with a distinct primacy relative to satisfying those needs. The hierarchy in the descending order of primacy can be summarized as:

    (a) Microperformance Information Needs -- those associated with the two main tasks of tracking and speed control.
    (b) Situational Performance Information Needs -- those associated with obstacle avoidance and maintenance of the most efficient and safe course in the traffic stream.
    (c) Macroperformance Information Needs -- those associated with trip preparation and direction finding.

3. Use of the primacy concept of information needs is an important requirement of highway information system design; that is, directional (macro) information (lowest on the primacy scale) should not be transmitted when the driver is busy handling micro or situational performance needs. Application of this concept provides the bridge needed to make driver-needs analysis a formal part of field applications of the highway information system.

4. The highway information system must consider all informal and formal information transmission -- for example, pavement and landscaping layout and design, and signs and markings, respectively.

5. The basic requirements of the highway information system are:

    (a) User centered.
    (b) Applicable to existing highways.
    (c) Serve all drivers at all times.
    (d) Fail-safe.
    (e) Compatible and evolutionary.
    (f) Economically feasible.

6. The basic design principles for the systematic presentation of information to the driver are:

    (a) Observe the primacy concept of transmitting first things first.
    (b) Do not overload the driver's processing capabilities.
    (c) Require the driver to prepare himself by trip planning.

(d) Spread the transmission of information to avoid overloading and vigilance problems.
(e) Do not surprise the driver -- make information transmitted conform to his expectancy.

7. The transmission of information to satisfy the macroperformance (directional) needs can best be accomplished by using visual communications in the following manner:

(a) Formalizing and improving drivers' trip planning capability. This includes improvements in mapping to correlate highway information and maps, and a system to make maps readily available to drivers. It would also be desirable to have a means of conveniently storing and using the trip plan in the car. This would serve as a step toward eventual automation of display of routing information in the car.
(b) Making maximum use of signs as information transmitters by optimizing the use of signs as to location, message content, and design. The major changes in location will result from conforming to the aforementioned primacy and spreading requirements. Major changes in message content result from the emphasis on route following instead of destination.

8. Procedures, and a computer simulation, have been developed for the design of signs under conditions of darkness.

9. A procedure has been developed for information system design review that incorporated driver needs analysis, the concept of primacy, and the use of informal aiding techniques in the design of the sign system.

10. Electronic aiding techniques were found to have their maximum potential use in meeting situational and microperformance needs.

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