User Information Systems
Developments and Issues for the 21st Century

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The Committee on User Information Systems focuses on information exchange between the transportation mode and the user. User information, broadly interpreted by the committee, is any stimulus in a transportation environment that can be sensed by a transportation user and aids the user to better complete a trip or perform a trip-related operation. The committee's purview includes all modes of transportation and also addresses the interface between the modes. Traditional means of conveying information include traffic control devices. In recent years, the advancement of technology has added such devices as variable message signs and in-vehicle displays. Thus, the scope of this paper addresses the latest developments and issues in some critical areas of user information systems as the transportation profession moves into the 21st century.

INTRODUCTION

Transportation facilities and systems must serve the needs of transportation users, helping vehicle operators and passengers to travel safely and efficiently and at a reasonable cost. Improvements to safety and efficiency and reductions in cost are constantly sought through new knowledge of users' needs. As such knowledge changes, users' needs change. As more is understood about individual user characteristics, new designs in facilities and systems are tried in response to that new knowledge. Over the past two decades, there has been a considerable increase in the number of transportation users with special information needs. These include older drivers and pedestrians disadvantaged by impaired mobility or low vision. The fastest-growing group in the United States is elderly women. Although much research has been done during the past decade, we need to know more about how best to communicate with these users.

INFORMATION SYSTEMS

The effectiveness of information systems for transportation users has often been affected by the following constraints:

- Insufficient testing of messages on potential users under task-loaded conditions;
- Lack of understanding of changing user population requirements;
- Lack of understanding of user problems associated with specific transportation environments;
- Absence of cost-effective technologies;
- Inadequate integration of physical and system designs and human requirements; and
- Inadequate design and implementation of information systems, which often fail to meet users' needs.

Much of the design and positioning of information displays and messages makes its way into practice without the benefit of a comprehensive, valid, and reliable evaluation by the users for whom they are intended. A credible evaluation relies on a fairly extensive knowledge of experimental design techniques and the experience to know how to apply that knowledge in the field. Field validations of laboratory experiments are always desired. However, these validations are more difficult to analyze since the "real world" is involved. The use of subjects as information users in complementary field and laboratory experiments is ideal but expensive and labor intensive. The following sections outline some of the more recent advancements in providing information to both the users of the transportation system and the professionals working to improve those systems.

Simulators

In view of the resource and time commitments required for a proper field evaluation of a system or new design, it is essential to do much of the preliminary testing in the laboratory. Driving simulators are being used more often for this purpose, and they can serve as a means to at least reduce the set of preliminary test or design alternatives.

The history of driving simulators can be traced back to the 1920s, when such simulation was first used to evaluate the skill and competence of public transit operators. Since then, driving simulators have been used to investigate the complex set of parameters that govern driver choice and behavior, driver training, and evaluation of vehicle design. Researchers have found that driving simulators offer many advantages, for example: (*a*) a high degree of control by the researcher on situational and environmental variables, (*b*) evaluation of driver performance and behavior relating to the impacts of nonexistent road elements or rarely occurring traffic events, (*c*) avoidance of potentially hazardous driving conditions and accompanying legal restrictions that may be caused by the experiment, and (*d*) a cost-effective method to produce an artificial environment as a valid substitute for one or more aspects of the actual driving experience.

The use of simulators that employ realistic visualization techniques should be encouraged both in research and in design processes, where appropriate, to improve the quality and effectiveness of user information systems in transportation. However, limitations to the use of simulators (especially the less expensive ones) include motion sickness suffered by many older drivers and difficulty in replicating the real world effectively.

Three- and Four-Dimensional Visualization

An extension of the use of simulation in transportation research and design is the use of three-dimensional (3D) and four-dimensional (4D) visualization. With the advent of 3D, 4D, virtual reality, and 3D simulation visualization tools, facilities and systems do not have to be installed or built to determine their usability. They can be thoroughly visualized, reviewed, tested, and improved at much earlier conceptual stages, before millions of dollars are spent, even on design. Residing in computer memory, conceptual designs can be evaluated via the trained eyes of many types of experts. Quantities, costs, and functional faults can be more accurately discovered, and barriers to construction or installation can be removed more easily. Projects illustrated with 3D tools are gaining public acceptance.

Three-dimensional tools for effective planning, research, and engineering have never been more readily available than they are now. Recent and continuing advancements in 3D and 4D computer graphics, 3D simulation, and virtual reality have made it easier for professionals to develop, better illustrate, and understand transportation systems, environments, and plans.

One of the latest developments in the application of 3D tools is to show how people can move around and within designed environments (vehicles, intermodal transfer facilities, street environments, etc.). The view of the designed environment can be shown from the eyes of a moving human model. For example, the Boeing 777 was evaluated from the perspective of a 3D-simulated mechanic trying to repair equipment placed within the aircraft. Also, a view of how well that human can move within a designed environment can be evaluated. It has been difficult to guess how this tool will be used next, but one can be sure that innovative uses will continue to surprise us all.

Dynamic Message Signs

As technology has advanced and permeated society, the transportation industry has capitalized on its efficiency in the form of the dynamic message sign (DMS). Whether permanent or temporarily mounted on trailers, the DMS is used for a variety of purposes, including, but not limited to

- Freeway management;
- Traffic operations and incident management and alert;
- Adverse weather;
- Road conditions;
- Flight, train, and bus schedules in transportation terminals;
- Congestion management;
- Limited access (high-occupancy vehicles);
- Special events;

- Reversible lanes;
- Work zones; and
- Road closures.

A variety of technologies are used in the design of the DMS, such as flip-disk, fiber-optic, light-emitting diode (LED), fiber-optic–flip-disk, rotating-drum, bulb-matrix, and neon. The DMS is a key tool in providing information to the roadway user. It is mainly used on expressways, freeways, portions of Interstates, and other limited-access facilities. However, it may also be placed in other locations, such as exit ramps, entrance ramps, and entrances to tunnels or bridges. It is often placed at the approach to an interchange, at key decision-making points, or in areas likely to experience poor visibility because of adverse weather conditions such as fog. Temporary installations are also used in maintenance, accident, or construction work zones.

The benefits of the DMS are obvious in that it can provide the roadway user with critical information in a timely fashion. However, the key is that it must be used appropriately with an effective message. It is anticipated that as technology advances during the 21st century, the DMS will advance accordingly and continue to provide users with information effectively and efficiently.

Visual Information Acquisition

In-vehicle displays present vast opportunities and unique problems to transportation engineers and to the motorists who use these displays. Since driving is largely a matter of visual information processing and vehicle control, it is essential to understand how drivers acquire this information. Recent advances in eye movement monitoring allow determination of drive visual scan patterns and the impact of visual overload, evaluation of the design and layout of in-vehicle messages and traffic signs, and so forth. Evaluation of eye movements can assist in learning how drivers divide their attention while they are driving. Attention difficulties have been found to be major factors in traffic accidents.

A recent computer technique for evaluating legibility of visual displays (e.g., signs) uses the recursive blur technique, whereby a defocused stimulus is gradually brought into focus until the subject can clearly distinguish all of its components. This procedure allows a determination of which elements (e.g., letter strokes, gaps between parts of a symbol) need to be modified. The procedure has been used successfully to enhance legibility of traffic signs.

With the advance of technology, it is now possible to present a great deal of information to drivers from inside the vehicle. Examples are collision avoidance and navigational information. The design of these systems, with the accompanying potential for overload, presents a challenge to designers and evaluators alike. The systems have the potential to provide critical information that a driver might need, but they also increase the workload of the driver. Optimal development and deployment of in-vehicle display systems will depend on our ability to avoid operator overload. To achieve this goal, we will need to develop and validate an economical technique for assessing the information-processing demands imposed by in-vehicle displays in both simulated and real-world driving contexts. Multiple-camera video-based recording techniques yielding accurate off-line estimates of both the number of eye fixations as well as the total eyes-off-the-road time required to read a display represent a promising workload assessment approach.

Advanced Traveler Information Systems

In the new millennium, personalized advanced traveler information systems (ATIS) will be available through commercial means, including cellular phones, personal digital devices, watches, in-vehicle personal computers, and in-vehicle navigation systems. With these new sources, users will be able to obtain real-time traveler information specifically tailored to their individual needs. Travelers will be able to make informed travel decisions to avoid congestion. Although a broad issue with the ATIS is its long-term impact on mobility, the immediate research need is to address the following issues:

- How users perceive information obtained through different media with respect to accuracy, reliability, and usefulness for their trip;
- How individuals make choices among competing information sources that are available to them through radio, television, telephone, website, pager, or cellular phone and how they trade off the acquisition of information from different sources; and
- What information travelers value and how they change their travel behavior on the basis of the information they obtain.

As the ATIS deploys, individuals will make adjustments according to new information. People have adjusted their travel behavior and will continue to make adjustments to improve their quality of life. The ATIS will influence people to modify their habits of information acquisition and their travel patterns. By disseminating real-time information, the ATIS will reduce the uncertainty of travel conditions and will increase the reliability of traveler information. From the user perspective, it will be important to have predictive knowledge of travel conditions and confidence in use of the system.

Along with the deployment of ATIS technologies, advanced methods for estimating the benefits of ATIS will be required. Travel time savings will continue to be an important frame of reference in measuring the benefits of ATIS in relation to transportation network or systemwide performance. In addition, travel budgets and intangible benefits such as a sense of control, predictability, and certainty will be considered as part of the benefit evaluation formula.

The ATIS promotes demand adjustment, especially during peak hours, and facilitates market-driven solutions to increase mobility and net benefits from travel; in that regard, the ATIS fosters more or longer trips. Information technology has reduced distance. Although travel costs increase with distance, communication costs do not. The effects of ATIS technologies on travel are largely unknown and will need to be addressed in the new millennium.

FINAL REMARKS

One area that will most likely receive more attention in the new millenium is integrated technological deployment. Rather than unrelated bits of the vehicle, the road, and the transportation infrastructure, transportation professionals need to think in terms of a seamless integration of systems that communicate with each other. Currently, there is a lack of continuity and focus on this issue. Therefore, more integration may be the key to resolve some of the impending overload problems mentioned earlier. Furthermore, the future may also see more diverse and increased research in and use of other information systems such as websites, real-time kiosks, highway advisory radio, low-power television, highway advisory telephone systems, and others that have yet to be invented. In short, it is believed that the transportation industry will provide information to users in any and all feasible formats, which will enable them to gain access to the information they need when and where they need it.