Point of View

Intelligent Vehicle-Highway Systems:

A Smart Choice for Travelers and Society

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Using IVHS technologies, traffic management centers could receive information on traffic volume and speed and adjust traffic signals for optimal traffic flows.

A dramatic shift has occurred during the past 10 years in the options available to transportation planners to improve the efficiency, productivity, and benefits of surface transportation. The incrementalism of the 1980s has given way to excitement in the field and many new options involving the application of computer and communications technology to solve growing traffic congestion and safety problems.

Many reasons account for this shift. Transportation problems have increased. Ninety percent of the U.S. population growth from 1980 to 1990 occurred in metropolitan areas of more than 1 million people. For the first time, a majority of Americans—50.2 percent—lives in large metropolitan areas, compared with 45.9 percent in 1980 (*1*).

Congestion has grown with this population shift and the economic boom of the 1980s, with the result that the social cost of new highway travel has risen more quickly than its private cost. In addition, the components of the social cost of congestion—delays, air pollution, energy consumption, and housing and income distribution disparities—are moving much higher on the social agenda.

At the same time, solutions to transportation problems involving new technology are much more feasible than they were 10 years ago. An explosion of information confronts us in virtually every facet of daily life. Microchips and consumer electronics provide the ability to process large amounts of information with potential for great benefit. However, the rate of advancement of technology today is often more than society can assimilate. Nevertheless, there have been recognized successes; for example, in freight transportation (*2*).

> [A]dvanced logistics suggests the use of more efficient and versatile computers and other electronic devices that allow for more rapid and error free transmission of information over vast distances and accomplishing more tasks with fewer employees. To others the introduction of these new technological capabilities are altering the very definition of the logistical function within companies and expanding the traditional responsibilities and roles of logistics departments. More basic company decisions in areas of finance, marketing, and manufacturing itself are now being influenced by and integrated with the logistics function and capability of the firm. The logistics function is moving away from being a reactive or "derived demand" service function within the company that followed company production and marketing decisions.

Can intelligent vehicle-highway systems (IVHS) technologies similarly influence and benefit personal transportation and the environment? This is the real question.

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Evaluating IVHS Technologies

A new transportation information infrastructure has the potential to increase dramatically the efficiency with which transportation resources are spent by individuals and society. For example, at-home and in-vehicle traveler information systems will supply accurate prior and en route travel time and route information to drivers, and thus minimize travel times systemwide. This improved system performance information can be used by public and private transportation providers to manage available system capacity in real time. Advanced traffic control systems could make more efficient use of available highway network capacity. They could even change the modes of transportation options offered, for example, by setting up high-occupancy vehicle and transit options as conditions warrant (e.g., major accidents and other incidents that cause the majority of traffic delays).

A new transportation information environment will pinpoint recurrent bottlenecks that cause congestion and accidents and allow the most cost-effective new construction decisions to be made to increase the capacity of current transportation modes.

Further down the "road," automatic vehicle control (AVC) promises to provide two to four times the highway capacity on even narrower lanes (with lateral as well as longitudinal control) as vehicle spacings are reduced from two to zero seconds (with physical or electronic contact). This benefit will almost certainly extend to nondrivers through transit uses of AVC guideways (e.g., personal rapid transit and dual mode transit systems).

Given the need to travel, it is difficult to argue with the potential for IVHS to increase the efficiency with which a given trip is made. However, IVHS does raise legitimate concerns: some see it as one more way to promote "auto-mobility"—making personal travel easier by automobile—and thus continue the adverse effects of using private vehicles. In a recent op-ed article, "Smart Choices, Not Foolish Cars," Jane Holtz Kay, a prominent architectural critic and author of the forthcoming book *Carbound: Ending the Auto Age*, stated that pollution will increase because we continue to drive our way out of every advance with more cars and more miles traveled. According to Kay, we must "learn to control the way we live—to better the mass transit we take and the walkable places we create; to settle and repair our centers, to rehabilitate old structures and infrastructures. . . . Computerized roads or cars cannot alter a lifestyle and landscape that are economically costly, environmentally unsound, socially inequitable, culturally disastrous, and aesthetically ruinous," she wrote (3).

The contrary view is espoused by David Schulz, Manager of Milwaukee County, who believes that those concerned with transportation in urban America can no longer wait for people to behave as we would like them to—living in compact, high-density residential neighborhoods, working in compact business districts, using public transit in large numbers because they want to and not because they have to, plan nonwork travel in orderly and efficient ways, become socially conscious in the selection and limited personal use of automobiles, and so forth. People are unlikely to accept, and are in fact likely to strongly resist, such significant changes, especially if they perceive that such changes limit personal freedom (4).

These two views suggest that behavior can either be changed through some form of control, or that information and incentives can be provided to influence travel decisions without restricting personal freedom of choice. Although most citizens would favor the latter, the social and environmental cost of the added travel that may accompany these improvements should be minimized.

The questions remain. Is making travel easier through IVHS more benign than other transportation improvements? Does IVHS cause less air pollution, urban sprawl, and other social costs of travel than other transportation improvements? Indeed, can IVHS reduce the social costs of other types of transportation improvements? If so, we would not be confronted with either/or choices. Because transportation improvements of all kinds are still very much on the U.S. agenda, positive answers to these questions should increase the priority for IVHS.

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Advanced applications in traffic surveillance and control, such as this video imaging vehicle detection system, could further automate identification of congestion levels, detection of major incidents, and control of traffic signals.

Reducing the Social Cost of Added Highway Travel

The current automobile-highway system is a classic example of one that places individual interests above the public interest. Every time a driver enters a congested roadway, far more aggregate delay is imposed on others—on the system—than on that driver. This aggregate delay results, in turn, in far more air pollution and energy consumption by others than by the individual causing the delay and pollution in the first place. In fact, the more congested the highway, the greater the difference between the social and private costs of making an additional or longer trip by automobile. Individuals perceive only a fraction of the total congestion they cause.

Two strategies can be used to reduce the social cost of added highway travel: (a) operate highways at lower levels of congestion, and (b) present travelers with improved information on travel choices to influence their decisions.

I have already described how IVHS has the potential to do the first—at least in the short run before increased traffic volume threatens to wipe out the congestion-reduction benefits of "smarter" operation of highways. It only takes a small volume increase for congestion to return to where it was before the operational improvement. The real trick is to get and keep that small volume increase off the street or highway.

Any travel forecaster will tell you it does not take much of a change in travel conditions for a small volume of travelers to change their travel choices. This reflects the second strategy. People will change their behavior in their own interest if transportation systems are operated with information that provides viable choices. Because we do not know what we are going to "pay" for travel, we make poor choices of how much transportation to consume and the destinations at which to engage in trip-end activities.

Travel decisions involve a series of tradeoffs between the times and costs of travel on all available alternatives and the benefits of travel at the trip ends. Without adding capacity, IVHS advanced traveler information systems (ATIS) can increase the informed nature of these tradeoffs and all the adjustments people make to avoid congestion. These adjustments can involve changes in travel routes, mode, and destination, or decisions to make the trip at a different time or not at all. IVHS can change the nature of travel demand by allowing travelers to know in advance and control the levels of congestion at which they travel.

By itself, these systems can lower the congestion levels at which individuals choose to travel. Travel time is highly valued in travel decision making. Reliable information on travel times will result in minimizing those times to increase travel benefits. In addition, as travelers come to rely on more dependable information, they value it more highly. This has already happened in logistics and with overnight package delivery. The fax machine is another excellent example of how new technology has escalated concern for service quality. New technology makes time more valuable.

As important as time is, control over how we use it is even more important. John Kasarda stated at the TRB 2020 Conference (5): "Metropolitan areas have a strong hold on the externalities that promote population growth. Suburbanites want control over the temporal and spatial dimensions of their travel and will pay large sums of money for these."

Furthermore, reduced aggregate measures of congestion will underestimate the travel time benefits from IVHS. Individual travel behavior maximizes the utility or benefit from travel. For example, with reliable travel time information, many travelers for whom the benefits of certain trips are small will choose to travel shorter distances, change modes, or forego or defer trips when congestion is heavy. Others may choose to travel to destinations that are farther away or make more frequent trips with the confidence that they will not be caught in heavy congestion. The net increase in travel benefits is likely to be substantial, yet aggregate reductions in congestion and delay are not likely to reflect these benefits. It is reasonable to conclude that the user benefits of IVHS will be much greater than may be measured from aggregate measures of congestion.

Congestion is also the price of individual decisions to reside in sprawling regions and on larger plots of land, farther away from work and shopping. As we decide to spend increasing amounts of money on housing,

continued on page 34

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Travelers could receive information from in-vehicle displays on estimated trip duration or alternative routes or modes.

Obituaries

Theodore W. Forbes 1902–1991


MICHIGAN STATE UNIVERSITY

Theodore W. Forbes

Theodore W. Forbes, one of a small group who pioneered the application of psychology and human engineering to highway problems, died in November. Perhaps best known for his research on highway sign legibility and visibility, Forbes made contributions to a wide variety of highway and traffic safety areas involving human factors research. His work on behalf of human factors in organizations such as TRB, the Institute of Transportation Engineers, and the American Psychological Association established him as a leader in the area of highway system safety.

Forbes received a Ph.D. from Ohio State in 1931 and worked for five years at the New York Psychiatric Institute before accepting the position as research Assistant Professor of Transportation at Yale University. During World War II he carried out work on acoustics and guidance systems for the Office of Scientific Research and Development. He was later employed as Executive Secretary and then Technical Director for the National Academy of Sciences/National Research Council Committee on Highway Safety Research.

In 1954 Forbes was appointed Program Director for Highway Research at the American Institutes for Research. Three years later he joined Michigan State University's Highway Traffic Safety Center, later serving as Professor of Psychology and Engineering Research at the university.

Forbes was appointed chairman of the first Highway Research Board Committee on Road User Characteristics in 1950, a committee on which he served for 23 years. In 1956 he became a member of the Special Committee on Night Visibility, which later evolved into the TRB Committee on Visibility. His 25-year tenure on that committee ended in 1981 when he retired.

Carmen E. Turner 1931–1992


PENLAND/SMITHSONIAN INSTITUTION

Carmen E. Turner

Carmen E. Turner, former General Manager of the Washington Metropolitan Area Transit Authority, died in April. She had been Under Secretary of the Smithsonian Institution since December 1990.

As the chief executive officer of the Washington, D.C. Metro, Turner developed and managed an approximately $615 million annual operating budget for an organization of 9,000 employees. Under her leadership, the Metrorail system expanded by 40 percent and accommodated a daily ridership that reached 1 million.

A graduate of Howard University, Turner received a master's degree in public administration from American University in 1972 and was active in civil rights and equal employment opportunity programs in a number of positions at the U.S. Department of Transportation. She joined Metro in 1977 as Assistant General Manager for Administration.

Turner received many honors and awards during her career. These included an honorary doctor of humane letters from the University of the District of Columbia in 1990 and from Southeastern University in 1987. She received an honorary doctor of laws degree from Youngstown State University in 1985.

In 1988 the American Public Transit Association chose WMATA to receive its Public Transit Agency Outstanding Achievement Award, and the next year presented Turner with the Jesse L. Haugh award, given annually to the transit manager "who has done the most to advance the urban transit industry in the United States and Canada."

Turner's activities also included TRB committee work. She was a member of the Executive Committee from 1988 to 1991 and was a member of the Committee for a Strategic Transportation Research Study—Transit and of the Conference on Long-Range Trends and Requirements for the Nation's Highway and Public Transit Systems.

IVHS: Smart Choice *continued from page 10*

we do not know the transportation price we impose on ourselves and others. This leads to real inefficiency; the system has lost its ability to confront consumers with the real costs of their decisions. This is as true in the long run for land-use location decisions that generate congestion as it is in the short run for individual travel decisions (*6*).

According to Kay (*3*), "An intelligent vehicle is an oxymoron. We need smart choices, not more foolish cars." I agree that we need smart choices. However, people, not cars, make choices, and people cannot make the smart choices she calls for because they lack information.

Smart Choices

Is making travel easier through IVHS more environmentally benign than other types of transportation improvements? Does IVHS reduce the social costs of travel, including that from other types of transportation improvements? The answer to both questions is yes.

Allowing travelers and system operators to make smart choices is the key determinant of success. IVHS systems will reduce or modify demand based on congestion information and provide benefits from increases in effective network capacity. Their contribution to congestion reduction, increased safety, and the like results from demand management at the trip generation level, as well as at the levels of route and mode choice, which makes more effective use of the existing network capacity. In-

deed, changes can be expected in the structure of the activity system that gives rise to travel, allowing IVHS systems to operate even more effectively (7).

This also has enormous implications for land-use and settlement patterns. Controlling congestion means preserving the operational integrity of the publicly financed transportation system in order to preserve our individual private investment in metropolitan and rural lifestyles.

Unanticipated benefits from the new transportation information infrastructure are indeed likely, just as paving roads in the 1920s got us out of the mud and changed the face of prewar America, and just as the limited access highway allowed us to control access onto highway links and not throw away our highway capacity by allowing traffic friction from abutters. Now we anticipate that travelers will control their access onto and within the system so that we do not, for example, replace moving traffic with stopped traffic.

Smart choices made by informed travelers exercising freedom of choice is the goal. The time is right to make smart choices in exercising new technological options to improve the transportation system and the environment.

References

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4. D. F. Schulz. Keynote Address: Decision Makers Need Help. In *Special Report 231: Transportation, Urban Form, and the Environment,* TRB, National Research Council, Washington, D.C., 1991, p. 12.
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HOV: Conjestion and Mobility *continued from page 20*

allowing only vehicles that meet the occupancy requirements to use the facilities. Further, exploring methods to maximize the use of HOV lanes, through expanded use of supporting facilities, services, and programs, would be beneficial. Use of IVHS and other advanced technologies can assist in these efforts and enhance the operation of all types of HOV facilities. In addition, transportation professionals in all parts of the world would benefit from greater information sharing and the exchange of ideas and experiences with HOV facilities.

Transportation professionals and policy makers face a challenging time in attempting to address traffic congestion, air quality, and mobility issues. Creative and innovative approaches will be needed to meet the increasing demands being placed on the nation's transportation systems. HOV facilities, especially when implemented with supporting facilities, policies, programs, and advanced technologies, offer a promising approach for many areas.

Data for Decisions *continued from page 27*

within DOT, to be headed by a director reporting directly to the secretary and funded from a $90 million authorization over a six-year period. The director of the bureau is charged with the responsibility of "establishing and implementing, in cooperation with the modal administrators, the States, and other Federal officials, a comprehensive, long-term program for the collection and analysis of data relating to the performance of the national transportation system" [Section 6006, 111(c)(2)].

The leadership of DOT has already taken steps to improve its data capabilities through the formation of two data committees to coordinate both the internal and interagency collection of data, preliminary funding of national surveys of passenger and freight movements that have not been conducted in more than a decade, and creation of a new Office of Strategic Planning to help define the long-term strategic issues and policy questions facing the department. DOT has an opportunity to build on these initiatives to create and sustain an institution dedicated to developing the knowledge base to inform policy makers about the strategic choices that will shape the transportation system of the future. The report provides a blueprint for carrying out this objective.

Corrections

In the 71st TRB Annual Meeting Highlights section of *TR News* 159, a participant was inadvertently misidentified in the photograph below. The correct identity of the person pictured is John E. Steward, U.S. Department of Agriculture Forest Service, who made a presentation at the session on Assessing Worldwide Low-Volume Roads: Problems, Needs, and Impacts.

John E. Steward, USDA Forest Service.

In the caption for another photograph in the same article, there was a typographical error in the name of Donn E. Hancher. We apologize for these errors.