JANUARY–FEBRUARY 2003
NUMBER 224

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The Transportation Research Board is a division of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation through research. In an objective and interdisciplinary setting, the Board facilitates the sharing of information on transportation practice and policy by researchers and practitioners; stimulates research and offers research management services that promote technical excellence; provides expert advice on transportation policy and programs; and disseminates research results broadly and encourages their implementation. The Board's varied activities annually draw on approximately 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

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LAUREN HOBART/FEMA NEWS PHOTO

Cover: Evacuation orders were in effect for coastal areas in Lake George, Louisiana, in October 2002, preparing for Hurricane Lily.

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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LETTERS

Getting on Track with High-Speed Dynamic Forces

The Research Pays Off article, "Limiting the Effects of High-Speed Dynamic Forces on Track Structure: New Method for Evaluating Equipment" (September–October 2002 *TR News*, pages 25–26), by Allan M. Zarembski and John G. Bell, is interesting as well as timely. However, I have difficulty with the declaration that "a method for evaluating the potential damage associated with the new high-speed equipment was not available and had to be developed."

A wealth of information on this subject dates back to the early 1970s. British Rail developed the dynamic wheel–rail forces in 1973 (*1*) during HST (high-speed train) development, and a detailed explanation of the technology was published in 1977 (*2*). CN Rail in Canada did additional work, reported at the 1977 American Society of Mechanical Engineers and Institute of Electrical and Electronics Engineers Joint Rail Conference (*3*); CN Rail adopted the theory to optimize operating speeds for locomotives. The computer program was presented at the second Office for Research and Experiments, International Union of Railways Symposium in 1979 (*4*), correlating unsprung weight with damage to the track substrate.

In 1993, a paper was presented to the TRB Committee on Intercity Guided Ground Transportation (*5*), comparing various amounts of unsprung weight for several locomotives. The F40PH locomotive with axle-hung motors was used as the baseline, since it then dominated Amtrak's fleet. Curves of P_2 force and V_s speed were plotted for each locomotive type. These showed that to cause no more substrate damage than that caused by the F40PH at 90 mph, the AEM7 locomotive with truck frame–mounted motors should be restricted to 105 mph; a body-mounted hydraulic transmission-type similar to the Turboliner Powercars, to 140 mph; and a TGV-A type with body-mounted motors, to 165 mph. This assumed a 0.02 radian dip angle or equivalent rail or wheel defect. Higher-quality maintained track would raise the operating limits.

P_2 force is an important criterion for establishing maximum rail vehicle speeds. The paper recommended follow-up research on a number of issues, including validation of the Vertical Dynamic Track Force Model for high-quality continuous welded rail and a program to quantify track damage with P_2 forces. I'm not aware of any recent work in these areas.

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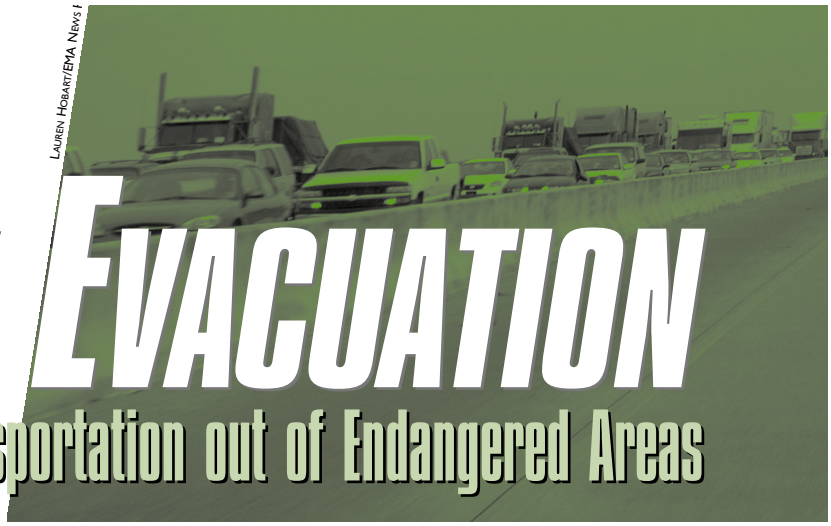
— Jerome R. Pier, Consultant, J. R. Pier & Associates, Carlisle, Ontario

"Research Pays Off" coauthor Allan M. Zarembski, President, ZETA-TECH Associates, Inc., Cherry Hill, New Jersey replies:

Pier is correct in stating that the work is based on previous studies and applications, and that there is information on the subject from the early 1970s. The full report to Amtrak cited many of Pier's references. However, the earlier applications of this type of approach have been relative rather than absolute—that is, they were based on relative comparisons with a theoretical model.

The *TR News* article described an application of the results on an absolute basis to address key issues such as concrete tie cracking. Thus, there was a major calibration of the cited theoretical models to wheel impact data from Amtrak's wheel impact detector on the Northeast Corridor. This represents an extension of the previous theoretical model into a more specific model for evaluating impact forces and the resulting damage, not only to the substrate but also to the key track components of rails and ties.



LAUREN HOBART/FEMA NEWS PHOTO

EMERGENCY EVACUATION

Ensuring Safe and Efficient Transportation out of Endangered Areas

BRIAN WOLSHON AND BRANDY HICKS MEEHAN

Wolshon is Assistant Professor, Department of Civil and Environmental Engineering, Louisiana State University (LSU) and LSU Hurricane Center, Baton Rouge; and Meehan is Transportation Specialist, Office of Operations, Federal Highway Administration, Washington, D.C.

Until recently evacuation was a relatively obscure concern within the transportation community. But the topic has gained significance with several high-profile evacuations and with the realization that it may become necessary to evacuate areas of the United States under threat of man-made, as well as natural, catastrophes.

Many man-made hazards now have joined the list of catastrophic natural events that can threaten populations. Moreover, unprecedented population growth has occurred in many of the areas of the United States that are most susceptible to hurricanes (*1*).

Two recent events have demonstrated the critical need to improve the efficiency and management of evacuations:

- In 1999, Hurricane Floyd threatened the coastal areas of the southeastern United States. The largest evacuation in American history commenced—an estimated 4 million people fled their homes in Florida, Georgia, South Carolina, and North Carolina. Monumental traffic congestion developed on the Interstate evacuation routes.
- In response to the terrorist attacks in New York City and Washington, D.C., on September 11, 2001, officials ordered the movement of hundreds of thousands of people out of the endangered areas. Although the evacuation of the nation's capital was shorter in duration and scope than the Floyd evacuation, an estimated 400,000-plus people left Washington, D.C.—many on foot—in the hours after the Pentagon attack. Washington, D.C., transportation officials believe that more effective planning and management can reduce significantly the time to clear the city (*2*).

Handling Evacuation

Historically, evacuations have come under the purview of civil defense or emergency management agencies. Engineers have played supporting roles by providing the agencies with expertise in the survivability of structures, as well as flood modeling, contaminant dispersion, and other issues.

Engineers have had little involvement in the planning and management of transportation systems for evacuation. There are many reasons for this. One is that evacuations have been rare, typically occurring only once or twice in a decade and usually only in hurricane emergencies. Many previous evacuations also had been local events, occurring in rural areas or smaller coastal cities. As a result, the highway infrastructure has been able to accommodate the movement of smaller populations.

Transportation's Task

A misperception has prevailed in the transportation community that little can be done to increase the efficiency of an evacuation, since the evacuation of a major city would create demands that would overwhelm the capacity of the transportation infrastructure—and did not seem likely. For these reasons and others, evacuation needs have not been incorporated into day-to-day transportation planning, design, and analysis.

But the context has changed—people are more aware of hazards that may necessitate an evacuation. In addition to hurricanes, U.S. populations face threats from hazardous materials spills, nuclear power plant accidents, and terrorist attacks. With the enormous growth in coastal areas—particularly

Dave Gatley/FEMA News Photo

In the exodus before Hurricane Floyd hit Wilmington, North Carolina, most of the traffic headed west out of harm's way.

in the Southeast—the probability that a hurricane would affect a populous area has increased. In the coastal areas, the population is projected to grow to 76 million in 2010—more than double the 1993 total of 36 million—but the number of new roadway lane miles is expected to increase only by 1 percent (3).

Since Hurricane Floyd, the transportation community has taken a more active role in addressing evacuation issues. Transportation officials in hurricane-prone states are working to improve evacuation operations—for example, by drafting contraflow evacuation plans, to increase system capacity by reversing one or more lanes or shoulders in the inbound direction for use by outbound traffic. Other techniques apply intelligent transportation systems (ITS) technologies to monitor and manage evacuation flows.

The Federal Highway Administration (FHWA) has developed a working relationship with the Federal Emergency Management Agency (FEMA) and is assisting with efforts to coordinate regional evacuations that cross state lines. Research and development initiatives are analyzing and testing improved methods to design, plan, monitor, control, manage, and model evacuation infrastructure and traffic. In addition, the Transportation Research Board (TRB) has sponsored a technical subcommittee to focus on transportation issues in evacuation.

Approaches to Evacuation

Worldwide, evacuations have countered such hazards as volcanoes, wildfires, floods, chemical spills, nuclear power plant accidents, and terrorist attacks. However, evacuations are disruptive and expensive and therefore politically sensitive issues.

Hurricane evacuations can cost more than $1 million per mile of coastline through losses in tourism, commerce, and general productivity. Orders for hurricane evacuations also can be difficult because storm movement and development can change abruptly. The scope and breadth of an evacuation must be in proportion to the threat—the order must be extensive enough to protect lives without needlessly disrupting the economic activity of the entire region or creating a "cry wolf" perception among the public.

Unlike most other countries, the United States uses evacuations to respond to hurricanes. The U.S. highway infrastructure permits the movement of large numbers of people over significant distances in a timely and safe manner to suitable shelters away from the hazard zone. Some argue that this has fostered an overreliance on evacuations, which could be reduced by strengthening building codes and increasing the availability of local shelters.

Continuum of Threats

From the perspective of transportation, the scope of the threat and the amount of advance warning time to move people to safety are keys to determining the size and urgency of an evacuation. The relationship can be presented as a continuum encompassing the range of hazard threats.

At one end of the continuum are hurricane evacuations. Hurricanes are the largest and potentially one of the most catastrophic natural hazards. However, compared with other threats, hurricanes move slowly and can be tracked for days before landfall. With advance warning, emergency managers can determine the extent of the area to evacuate and can begin the evacuation before the storm reaches land.

At the other end of the continuum are terrorist attacks. Unless weapons of mass destruction are involved, terrorist attacks affect a comparatively small area—perhaps a city block or several buildings. However, the attacks would give little or no advance warning, so that evacuation could not begin until after the event. Table 1 (page 5) illustrates relative threat versus advance warning time for various natural and man-made hazards (*4*)—the advance warning time and potential area of impact generally increase toward the bottom of each list.

Evacuation Research

Research interest in evacuation as a behavioral, geographic, or engineering topic has ebbed and flowed. During World War II and the subsequent Cold War era, interest in evacuations focused on moving pop-

ulations away from urban centers that could become targets of nuclear attack.

In the 1960s and 1970s the advent of satellite technology and improvements in weather forecasting allowed the tracking of hurricanes that were still several days out at sea. With more reliable forecasts, planning and study activities began to focus on the evacuation of coastal areas for hurricanes.

Interest in evacuation analysis and modeling expanded with concerns about nuclear power plants, particularly after the Three Mile Island incident in the late 1970s. Evacuation simulation and modeling have advanced significantly since then, mostly for handling hazards associated with the storage, transport, and disposal of chemical, biological, and nuclear weapons.

Despite the history of evacuations in the United States, the general transportation research literature includes comparatively few published studies on the topic. A recent study at Louisiana State University (LSU) sought to synthesize hurricane evacuation literature from a transportation perspective. Among the findings of the study was that most evacuation research was in the domain of the social and behavioral sciences (5). The transportation-oriented material comprised unpublished planning studies for local communities, DOT reports, operational manuals for law enforcement and emergency management, and other location-specific and difficult-to-access reports and studies.

With the goal of creating a single-source document on hurricane evacuation and state of the practice in the United States, LSU researchers conducted a survey of coastal state and county transportation and emergency management agencies, to synthesize plans and policies for hurricane evacuations. The survey identified evacuation needs and issues and assisted in developing research statements.

In a parallel effort, FHWA convened a series of regional workshops in winter 2002 so that transportation and emergency management officials in hurricane-prone states could share plans, policies, experiences, techniques, and systems, and begin to coordinate activities. The workshops also enabled state and local transportation agencies to understand emergency management needs and issues. Several key findings from the LSU study and outcomes of the FHWA workshops are discussed below.

Remedial Actions

After the most recent evacuations, the general conclusion was that transportation and emergency management officials were not sufficiently prepared for the mass movement of threatened populations. Some of the problems during Hurricane Floyd have been attributed to the storm's uniqueness and to the memory of damage from other storms. Nonetheless, the Hurricane Floyd experience revealed necessary changes in the approach to evacuations.

TABLE 1 Advance Warning Time for Evacuation and Area of Impact for Hazardous Events (*11*)

HAZARDS REQUIRING EVACUATION		
Man-Made Events		**Natural Events**
Terrorist Attack	**Advance Warning Time and Potential Impact Area Both Increase**	Earthquake
Chemical Release		Volcanic Eruption
Nuclear Power Plant Accident		Tornado
Dam Failure		Tsunami
		Wildfire
		Flood
		Hurricane

Limiting Travel Demand

Perhaps the most significant issue associated with evacuation is the need to control travel demand. With the increase in U.S. coastal populations and a relatively static number of evacuation routes, influencing the number of evacuees on the roads becomes essential.

Most emergency management officials agree that roadway capacity and mass transit assets are not sufficient to evacuate major metropolitan centers like New Orleans, Louisiana, or Miami, Florida, in two or three days. A contributing problem is evacuation overresponse, or "shadow evacuation," which

LAUREN HOBART/FEMA NEWS PHOTO

Bridges on the coast of Louisiana were closed in October 2002 when evacuation orders were issued in preparation for Hurricane Lily.

LAUREN HOBART/FEMA NEWS PHOTO

Personnel at Louisiana Emergency Operations Center, Baton Rouge, monitor traffic, weather, flood, and bridge scour near evacuation routes.

occurs when people receive incorrect information or overreact to a threat. For example, during Hurricane Floyd, the Florida Division of Emergency Management estimated that about 35 percent of the approximately 2 million evacuees on state roads did not need to leave their homes (*6*).

By occupying limited transportation resources, shadow evacuations can prevent threatened populations from reaching safety. Therefore, controlling when and where people evacuate can ensure the efficient movement of the most critically threatened people.

Evacuation demand has a significant effect on speed and efficiency. One of the ways that officials are working to limit demand is through better public information and education, so that the public knows which areas are at risk and so that the news media can give accurate descriptions of threat levels. Other techniques to curtail demand include stricter building codes and in-place shelters that diminish the need for evacuation.

Maximizing Infrastructure

Recent evacuations have failed to take full advantage of the obvious counterpart to limiting demand—maximizing the use of the available transportation infrastructure. One technique to increase evacuation capacity is the use of contraflow freeway segments—reversing one or more lanes or shoulders in the inbound direction for use by outbound traffic.

Preliminary studies have shown that contraflow strategies can increase the outbound volume by about 70 percent (*7*). Other methods of infrastructure maximization include the coordination of traffic controls on parallel, nonfreeway routes; the use of mass transit systems; and limiting the interruptions to evacuation flow at railroad crossings and drawbridges.

Improving Communication

Transportation officials involved in evacuations have cited the need for better communication among the various emergency management, transportation, and law enforcement agencies involved. Communication difficulties with the public also were significant.

Many states are combining emergency management personnel and resources in single facilities. Emergency officials in Florida now also have agreements with the state's network of public radio stations to broadcast traffic and shelter information during evacuations.

Another communication issue is the collection and transfer of traffic information during an evacuation. Traffic information is critical to the strategic management of evacuation routes and to the effective allocation of transportation resources.

Access to accurate and timely traffic information was difficult during the evacuations for Hurricanes Georges and Floyd. Emergency management officials often were "working blind," with little quantitative information about which routes were flowing and which were gridlocked. As a result, officials were unable to redirect traffic from routes that were over capacity to nearby roads that were less congested.

In addition to traffic flow rates and speeds, information about the location of incidents that block lanes or that slow traffic and about weather conditions and flood levels is critical. States are turning to ITS technologies to gain this input—however, the concentration of ITS deployment is in urban areas, and evacuation travel mostly occurs in rural areas.

One system now in testing addresses the lack of rural ITS resources—the Louisiana Department of Transportation and Development's traffic, weather, and flooded-road alert system (*8*). The system combines low-tech traffic data recorders with the U.S. Geological Survey's Louisiana HydroWatch stream monitoring stations, to collect traffic, weather, flood, and bridge scour data at critical locations along key evacuation routes in the southern third of the state. The data then are relayed via satellite to the state emergency operations center.

The system does not require an additional major capital investment, since most of the basic infrastructure is already in place, and retraining field personnel and adding land-based utility services are not necessary. Another advantage is that the system will transfer data via the Geostationary Operational Environmental Satellites, so that the information can be available almost instantly, regardless of the weather.

Enhancing Coordination

Crossing jurisdictional and state boundaries can complicate the planning of contraflow operations. Until recently, hurricane evacuation planning was seldom regionwide, primarily because evacuation orders follow a more localized, county-by-county, procedure.

Florida DOT found that a lack of coordination between counties produced congestion when evacuations intersected and traffic from one county entered the already-crowded evacuation routes of another. With increased coastal populations, regionwide evacuations must be prepared to move substantially larger numbers of people. States like Florida are addressing these problems with statewide evacuation plans (*9*).

A metropolitan planning organization, the Metropolitan Washington Council of Governments, has developed a Regional Emergency Coordination Plan (RECP) with the states of Maryland and Virginia, the federal government, public agencies, the private sector, volunteer organizations, and local schools and universities. The RECP facilitates collaboration on planning, communication, information sharing, and coordination, before, during, or after regional emergencies. The transportation portion focuses on preventing disruptions to the regional transportation system from surges in demand and emergency response needs, through interjurisdictional coordination and information sharing (*10*).

Interstate evacuation coordination is also critical, as shown in the state-to-state overlap of evacuation traffic during Hurricane Floyd. During the Hurricane Floyd evacuation, traffic from Florida and Georgia contributed to congestion on evacuation routes in South Carolina.

South Carolina, Georgia, and Florida DOTs are working together to correct the deficiencies. Interstate regional plans now incorporate interstate contraflow and the use of secondary highways to keep local traffic from interstate routes whenever possible.

Another critical location is the I-59 crossing between Louisiana and Mississippi. The road network and the geography of New Orleans force a significant portion of Louisiana evacuees into Mississippi. The evacuation proposal would create contraflows in all lanes of I-10 eastbound out of New Orleans and northbound on I-59 into Mississippi. However, the plan could hamper Mississippi's ability to serve its citizens, and negotiations are under way to resolve the problem.

Assisting Low-Mobility Groups

The reliance on personal transportation causes significant challenges for emergency evacuation management. Nonetheless, some segments of the population do not have the option of evacuating by personal vehicle. In New Orleans, for example, 25 to 30 percent of the population—more than one-quarter million people—are without access to personal transportation.

In addition to people without vehicles, the indigent, the elderly, prisoners, the infirm, and tourists must be evacuated. Although most state emergency operation plans include these groups, many DOTs have not addressed the evacuation of low-mobility and special-needs populations.

Busing is the most common solution, and emergency management agencies have contracted with local transit authorities, school districts, and tour operators, but with uneven success. However, many heavily populated cities do not have a bus fleet sufficient to move all low-mobility evacuees. For example, all the buses in New Orleans would supply only a fraction of the required capacity. Louisiana emergency management officials therefore are working with local churches to encourage "good neighbor" strategies—people with means of transportation would assist low-mobility neighbors during an evacuation.

LAUREN HOBART/FEMA NEWS PHOTO

Christus St. Mary's Hospital, Port Arthur, Texas, evacuated patients to other hospitals before Hurricane Lily. State plans must include low-mobility groups.

Passing Work Zones

Highway work zones are another overlooked issue in evacuation planning and preparedness. In 1998, during Hurricane Georges, evacuation routes in Alabama, Mississippi, and Louisiana encountered construction zones. Recognizing the problem, DOT officials asked contractors to clear construction equipment and to open partially constructed lanes to the outbound traffic. The quick action minimized delays. Less than one year later, however, during Hurricane Floyd, North

MICHAEL REGER/FEMA NEWS PHOTO

Local fire commander briefs residents of Palmer Lake, Colorado, on what to do if evacuation is necessary because of the Hayman fire, June 2002.

Carolina evacuation routes experienced the same kinds of problems with construction sites.

Improving Operations

Programs are under way at various levels of government to improve transportation operations during an evacuation. Although transportation infrastructure cannot accommodate evacuation-level traffic demand, efficiency can increase with techniques like contraflow, ITS monitoring, communication, data processing systems, and strategic planning and management. However, the benefits of these techniques are yet unproved.

FHWA Initiatives

In spring 2002, FHWA awarded grants to several states susceptible to hurricanes for projects such as

- The integration of real-time weather and traffic information with state emergency operations centers and traffic operation centers and
- The improvement of public information about evacuation routes and procedures.

To qualify for the grants, state agencies were required to collaborate with emergency management and the highway patrol to identify needs and resources.

FHWA, along with FEMA, the U.S. Army Corps of Engineers, and state agencies, supports the Evacuation Traffic Information System (ETIS), a web-based, geographic information system tool for sharing information among states and agencies. Developed in response to the evacuation for Hurricane Floyd, the ETIS graphically displays the evacuation status of coastal counties, contraflow segments in use, and the number of vehicles expected to cross state lines. The ETIS is the first step in using technology to improve coordination among the various state and federal agencies involved in hurricane evacuations.

In addition, FHWA has been studying operational improvements for major emergencies that may occur with little or no advance warning, such as terrorist attacks, and hosted a series of workshops on transportation's role in response and recovery. The workshops incorporated lessons from Arlington, Virginia, and New York City, along with customized tabletop exercises. Similar efforts are focusing on transit and freight operations.

A key goal of the FHWA programs is to increase the understanding and interaction among emergency managers, first responders, and the transportation community. Knowing whom to call and what resources are available can make the difference in effective emergency evacuations.

Focal Point for Research

In 2001, TRB established the Subcommittee on Emergency Evacuation within the standing committee on Transportation Safety Management, to coordinate and disseminate evacuation-related research and information. Membership includes transportation professionals in the private and public sectors involved in the design, planning, management, operation, enforcement, and research of transportation resources for evacuation. The mission of the committee is to

> serve as the national focal point for evacuation-related transportation activities…to provide leadership for the cooperation and coordination of individuals and groups involved in this field, and to promote the advancement, dissemination, and implementation of state-of-the-art methods and systems for the enhancement of evacuation efficiency and safety.

The committee's scope encompasses "all preparedness and operational issues associated with evacuations for both natural and man-made threats," including

> …evacuation transportation policy; evacuation planning and travel-behavioral analysis and forecasting; the planning and design of transportation infrastructure for evacuation; evacuation transportation operations and management; evacuation traffic control and enforcement; the development, implementation, and operation of ITS data acquisition and communication systems;

[and] the use of mass transit and other means for the movement of low-mobility individuals.

The first official meeting of the subcommittee was at the January 2002 TRB Annual Meeting in Washington, D.C. Speakers from the public and private sectors presented many of the evacuation issues and strategies described above.

Refining the Agenda

Highway and transportation professionals have become more involved in the development of evacuation plans since 1998—a significant step and a necessary change. Transportation planners and engineers have contributed expertise and experience in dealing with transportation-related issues in evacuation, including forecasting travel demand, traffic analysis and modeling, and the application of ITS technologies.

Nonetheless, research is needed on many transportation-related issues in evacuation:

- The forecasting and modeling of evacuation travel demand behavior;
- Cost–benefit analyses for evacuation strategies;
- The costs and benefits of contraflow, secondary routes, intermediate crossovers for contraflow operations, and the installation of evacuation traffic signs and ITS devices;
- The application of web-based systems for communicating real-time traffic conditions, shelter availability, and route guidance;
- Effective re-entry of areas after evacuation;
- The development of micro- and macro-level traffic models to analyze bottlenecks and to evaluate storm scenarios, routing options, and contraflow strategies;
- Accommodating evacuation traffic through work zones; and
- Planning mass transit assets for the evacuation of people with special needs or low mobility.

Practical and operational needs include a greater and more efficient exchange of data and information, such as traffic data collection for the monitoring, assessment, and management of evacuations and better communication of guidance from emergency management officials to evacuees.

Evacuation planning guidance and a checklist for transportation professionals should be developed. Although evacuation plans should allow flexibility, checklists and basic guidance could benefit state and local DOT and emergency management officials in making specific plans. Guidance also would help ensure basic uniformity of practice from location to location, important in regionwide evacuations.

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Planning and Directing Military Routes On

Spatial Data Application Refines Marching Orders in Real Time

SARAH A. SHEA

The author is an analyst with GeoDecisions®, Camp Hill, Pennsylvania.

In the rapid deployment of U.S. military forces, understanding the real-time events that affect transportation logistics and operations is critical. The U.S. Department of Defense center primarily responsible for meeting the military's transportation and deployment needs is the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) in Newport News, Virginia. The center performs deployment engineering and analysis.

MTMCTEA needed a system that would enable decision makers to obtain detailed, timely, and relevant information about infrastructure, road conditions, construction, traffic incidents, and weather throughout the continental United States. For years, MTMCTEA had used geographic information system (GIS) technology to maintain, store, analyze, and display information about U.S. highways, bridges, traffic patterns, installations, and seaports.

Photographic montage from IRRIS website.

line››

Working from this success, MTMCTEA developed a concept for a system to report military road and rail status, incorporating real-time information and accessibility via the World Wide Web. The system would couple the GIS database with real-time information on traffic, incidents, construction, and weather.

Web-Based Portal

MTMCTEA contracted with GeoDecisions, a division of Gannett Fleming, Inc., to develop the Intelligent Road–Rail Information Server (IRRIS). This state-of-the-art information technology system enables military logistics staff to log onto a single website during a national emergency or training exercise to obtain information about road conditions, construction, accidents, and weather that might interfere with the movement of troops and materials between forts and ports.

A 1999 pilot version of IRRIS provided live traffic, construction, and weather data. The full version of IRRIS is now online (Figure 1), continually enhanced with innovative tools to expand its functions.

IRRIS is a first-of-its-kind web-based portal to military and U.S. infrastructure information. The application leverages the latest advances in information technology and GIS. The powerful system provides planners with an intuitive real-time tool for routing personnel and equipment in the most efficient and effective way and is accessible anytime, anywhere, and on any device.

Spatial data solutions, such as IRRIS, are on the rise. The trend is to house customized spatial applications on the Internet, taking advantage of the accessibility. A user can access spatial data from a GIS with any device that connects to the Internet. The IRRIS interface is responsive and perceptive—that is, it makes spontaneous and direct visual-physical connections—allowing users to display, browse, and query dynamic maps and real-time information at the click of a button. This reduces costs for GIS training and for the acquisition of hardware and software.

FIGURE 1 IRRIS Web interface.

MTMCTEA Director Bill Cooper explains: "It costs $50,000 to $100,000 to train and equip an operator to use our high-tech GIS equipment, which means that we needed another medium for this critical information. Since everybody can use the Internet, we decided to make our information available on the Web."

The IRRIS website uses state-of-the-art transportation and information systems technology to provide the user with transportation infrastructure data and real-time travel information, including road characteristics, bridge locations, attribute data, video logs, aerial photos, traffic cameras, road closures, and construction detours.

Functions within the application are diverse and can be tailored to the needs of a variety of users. Operators can apply such tools as automated mapping, overhead flight simulation, an interface to video log

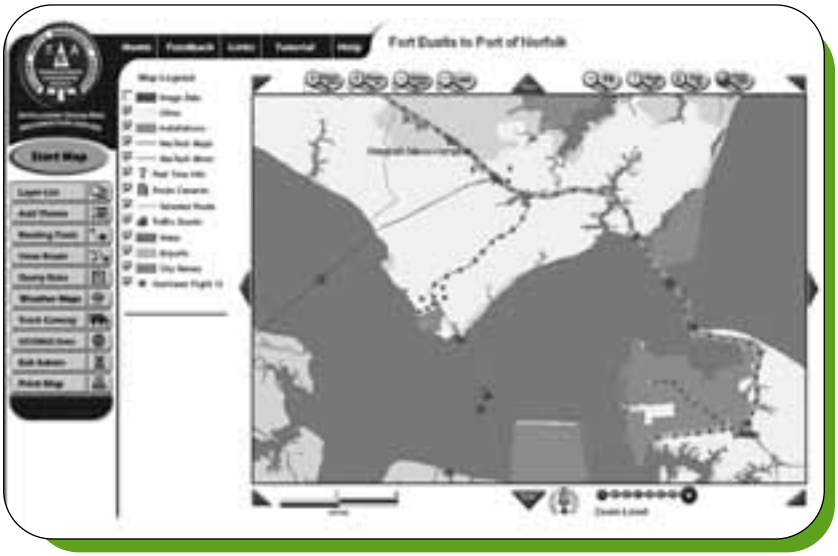


FIGURE 2 Detailed on-screen mapping.

files, access to real-time traffic data and weather information, point-to-point routing, and vehicle tracking. All of these tools are accessible through the Web—even with wireless devices.

Automated Mapping

Automated mapping tools are the basic function in IRRIS. Interactive maps offer options to display transportation-related geographic data sets, such as roads, cities, and railroads (Figure 2). The IRRIS interface includes aids for nontechnical users: step-by-step instructions, a user-friendly tool for selecting a geographic area of interest, the ability to add or remove map layers instantly, and displays of tips for using the tools and other features.

The system automatically zooms to the area of interest selected. Then military staff can call up aerial photographs or topographic backdrop images, which are displayed behind the main mapping features, to gain more realistic views.

IRRIS offers thematic mapping as well as general location mapping—in other words, maps can illustrate various themes—for example, color-coding roadways by speed category or by pavement surface condition to assist in determining travel times. At any stage, users can print out a map display for hard-copy documentation.

GIS allows the linking of coordinately correct geographic information with associated attributes in the database. In IRRIS, pointing and clicking on a feature will display a list of the feature's records. For example, if the fleet manager clicks on a bridge, a pop-up window will display detailed information about the bridge's maximum load and width, to aid in determining a route for oversize or overweight vehicles. IRRIS also exhibits a digital image of the feature if available.

Video Logs and Flight Visualization

The Federal Highway Administration (FHWA) has provided IRRIS with video logs assembled from digital camera images. This information enables military users to view video clips for a selected route. The images were captured from cameras mounted on vehicles that drove along the primary deployment routes.

The video logs are linked to a GPS for georeferencing to latitude and longitude and are accessible through the dynamic map in IRRIS, displaying 1-mile sequences at each log point. Time intervals for the images can be set to 1/10 second, creating a fluid, movie-like effect. A symbol on the map indicates the geographic area along the route for each video frame, so that users are aware of the video's geographic location in relation to other map features.

The animated overhead flight function required gathering, processing, and integrating raster-image data into IRRIS. Users view a fluid series of overhead aerial images, enhanced in 3-D to give an impression of flying through the route (Figure 3). These Digital Ortho Quarter Quads—spatially corrected aerial photos pieced together to simulate flying—were chosen as the ideal image format for clarity, coverage area, and efficient processing speed.

The video logs and 3-D overhead flight data familiarize military planners with routes before deployment, minimizing the uncertainties at complex and busy interchanges and at shifts in traffic patterns.

Real-Time Data

Real-time information from sources including route cameras, traffic data, and weather reports greatly

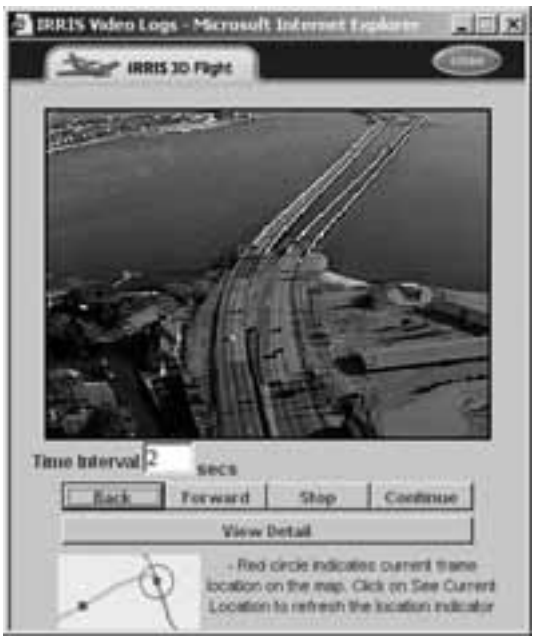


FIGURE 3 Overhead flight visualization.

enhance IRRIS' automated mapping function. Real-time data are integral to any land-based transportation information system. Key decisions about vehicle routing and estimated time of arrival depend on accurate and timely traffic congestion and weather data.

Route Cameras

Route cameras supply IRRIS with up-to-the-minute color snapshots of traffic conditions at points along routes. The images primarily come from state departments of transportation. Cameras at key arteries and other strategic points in the road network transmit images of actual traffic along highways and bridges. This information allows military planners to make better-informed routing decisions, avoiding delays and giving drivers more control over travel plans.

Instant Traffic Reports

Operation on a national scale, encompassing many cities and deployment routes, required a nationwide, real-time data source provider. Many characteristics were essential in determining the appropriate data source to complement the IRRIS functions. TrafficCast was chosen for the high quality of data, the frequency of updates, the large coverage area, and compatible techniques for connecting to information.

An interface was developed with TrafficCast's real-time predictive modeling system to obtain accurate traffic conditions and speeds for road segments throughout the United States. TrafficCast also delivers to IRRIS text-based incident information, as well as construction updates, for major deployment routes.

Weather Conditions and Forecasts

GeoDecisions worked with Meteorlogix to incorporate the state-of-the-art Metroworks weather server technology into the IRRIS application (Figure 4). A satellite receiver at GeoDecisions headquarters receives a real-time signal that delivers NEXRAD (Next-Generation Weather Radar) storm cells, precipitation data, National Weather Service (NWS) warning areas, and NWS watch boxes. GeoDecisions converts these highly accurate data into a GIS-compatible format, classified for display within the IRRIS website.

Military planners access critical information about weather conditions and forecasts, including wind gust potential, winter weather travel hazards, surface temperature, precipitation intensities, and storm cell locations. This information overlays other base mapping features, including travel routes, for a clear presentation of the driving environment.

Customized Analysis Tools

The automation of routine processes is one of the compelling cost justifications for implementing a spatial data solution such as IRRIS. Two key functions of IRRIS are vehicle routing and tracking.

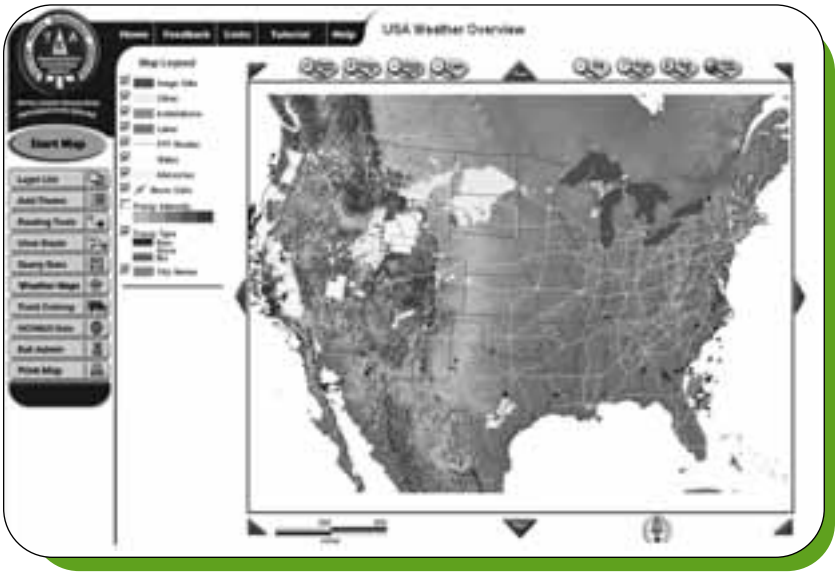


FIGURE 4 Real-time intelligent weather map.

Routing

Route planners have had to generalize arrival times because of a lack of information about traffic congestion and weather conditions. IRRIS can generate quick, on-demand routes that take current weather and traffic into account. GeoDecisions has integrated into IRRIS an advanced routing engine produced by IntelliWhere of Huntsville, Alabama (Figure 5). Users can create ad hoc routes or reroute convoy vehicles in real time.

The detailed road base map serves as the routable network. Real-time and predictive weather data, as well as current traffic conditions, are taken into account, to provide the most accurate routing and

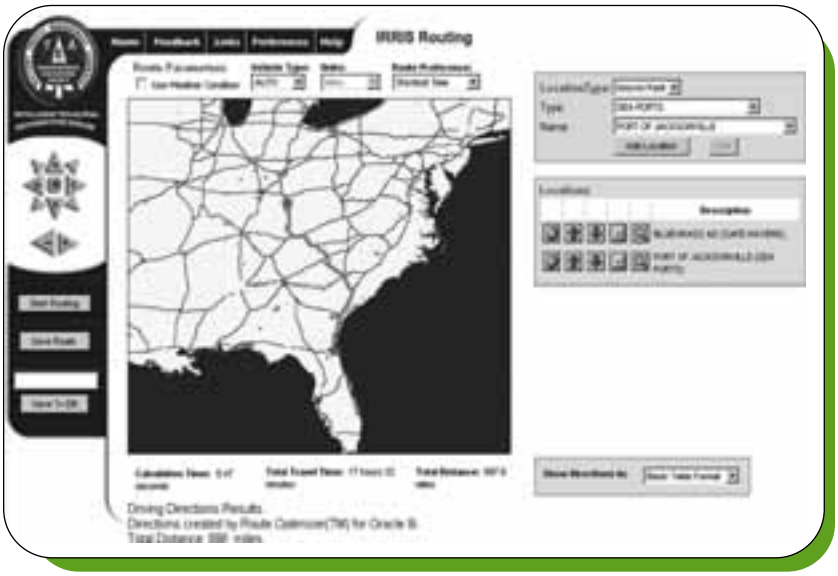


FIGURE 5 Dynamic routing and driving directions.

Staff at the Military Traffic Management Command Transportation Engineering Agency in Newport News, Virginia, review ongoing expansion of features in Intelligent Road–Rail Information Server.

estimated time of arrival possible. Military planners indicate the vehicle type—for example, E911 (enhanced emergency service), HAZMAT (hazardous materials), or truck—as well as the route preference, such as shortest time or shortest distance.

In addition to a map, planners receive detailed turn-by-turn directions and estimates of the time and the total distance of travel. Driving directions can be exported and saved in tabular or XML (extensible markup language) format. Graphic routes are saved in a database for recall.

Tracking

The IRRIS tracking module provides military decision makers with the exact location of a convoy or carrier at any time, anywhere in the world. Planners can respond to a convoy or carrier in an emergency, or can reroute the convoy or carrier to avoid unpredictable events like tornadoes or washed-out bridges.

The tracking system requires additional hardware, including a GPS unit, a personalized computer device, and a communications card. The driver signs in to the vehicle's secure on-demand tracking system. GPS coordinate positions then are sent to the tracking application, parsed, encrypted, and finally sent back to the centralized IRRIS database via a wireless communications device.

Alternative Delivery

During a significant weather or traffic event, key military decision makers may not be logged into the IRRIS website. Therefore real-time notification and wireless access were developed as alternatives for communicating IRRIS updates.

Real-Time Notification

To notify decision makers, GeoDecisions developed the IRRIS Server, an application that continuously monitors weather and traffic events. For example, if a tornado or severe thunderstorm occurs, specific users receive notice via e-mail, pager, fax, or telephone.

The IRRIS Server employs text-to-speech and speech-to-text conversion technology, so that NWS warnings can be read automatically over the phone. Users can speak an e-mail message and send it to a list of other users. Instead of receiving an e-mail for each event, users can opt for an e-mail digest of noncritical warnings. Sent out every midnight, the digest is a compendium of the previous 24 hours of notifications.

Wireless Applications

IRRIS is evolving as new applications of the core technology are implemented. Wireless delivery of IRRIS weather, traffic, and construction events via Web-enabled cellular phones is nearing completion. The information is broken down by specific roads, and real-time data are also available.

The Compaq iPaq palm device, an electronic organizer, also will permit linking to a limited version of IRRIS. Military users then will be able to receive real-time weather, traffic, and construction information—and to create route maps and querying attributes—with handheld computers.

Real-Time Decision Making

IRRIS has evolved rapidly from a relatively simple roadway analysis-and-query tool to a sophisticated real-time road and rail status system. The integration of highly accurate spatial data, imagery, and real-time information constitutes a strategic advantage. The system continues to grow with more functions and data.

IRRIS has enhanced MTMCTEA training, improved deployment reliability, and reduced costs. Similar systems for other transportation organizations will facilitate the safer use of road and rail networks, benefiting all travelers.

For more information about the IRRIS project, contact Jonathan Pollack, Vice President of Advanced Technologies, GeoDecisions, 207 Senate Avenue, Camp Hill, PA 17011 (telephone 717-763-7211, fax 717-763-8150, e-mail jpollack@geodecisions.com).

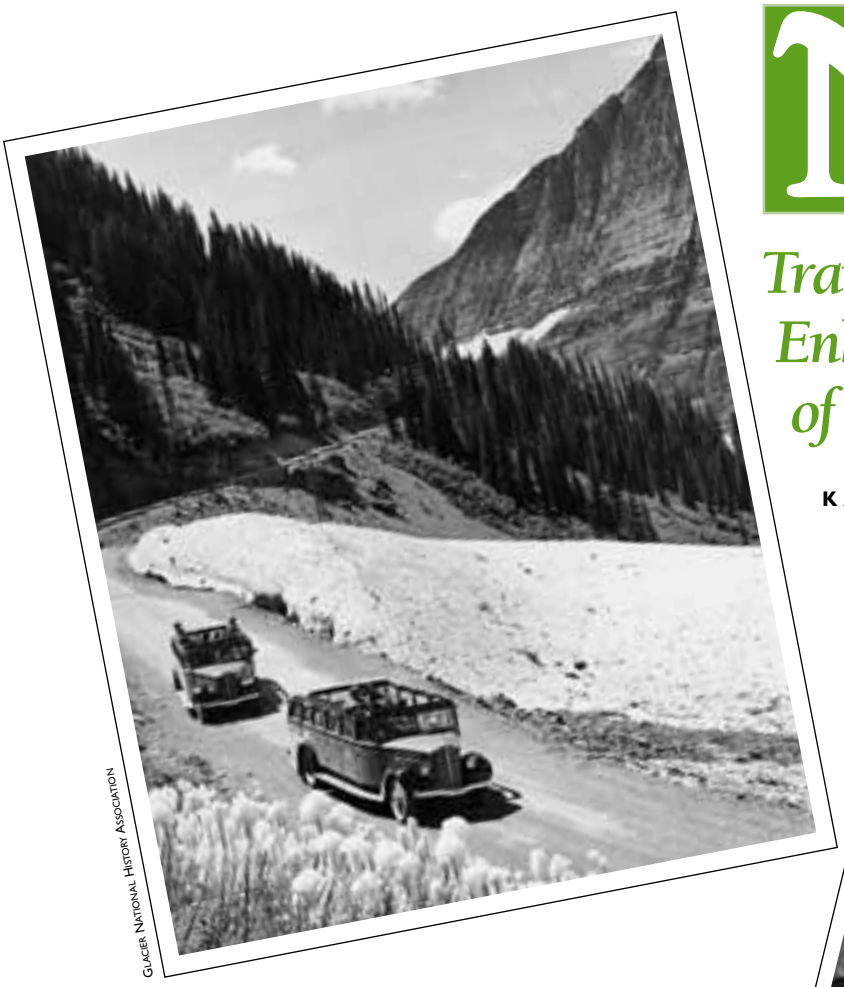
Websites

GeoDecisions
www.geodecisions.com
IRRIS Demo
www.geodecisions.com/IRRIS
Military Traffic Management Command Transportation Engineering Agency
www.tea.army.mil

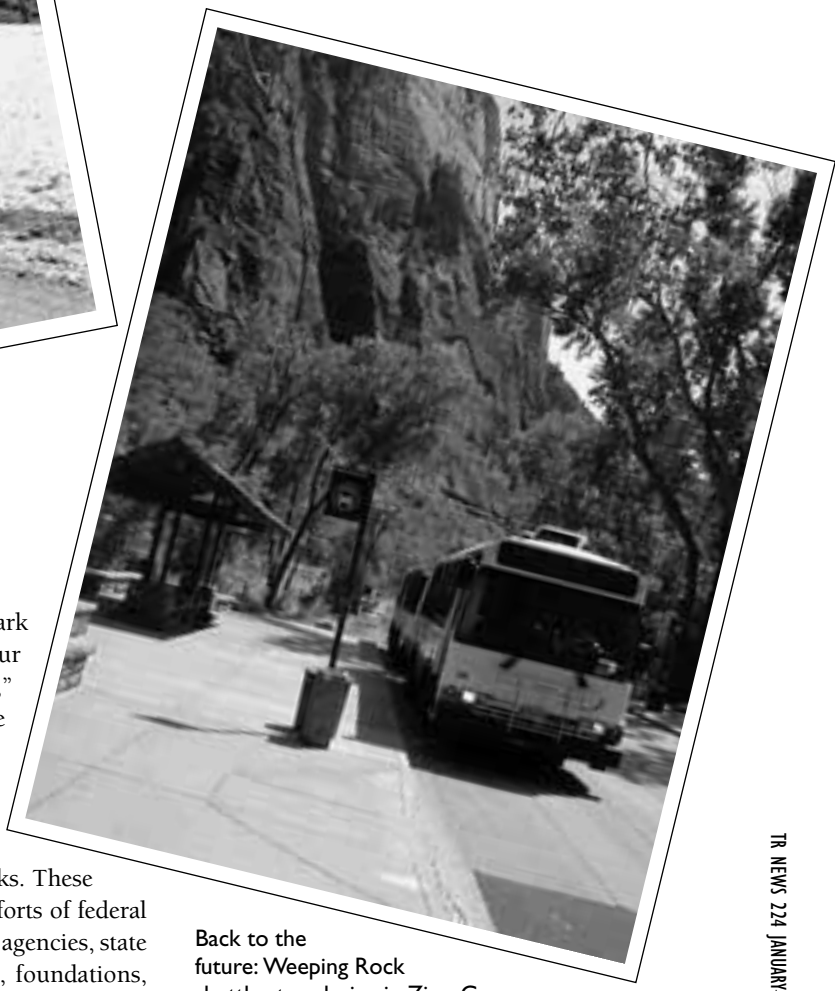
TRANSPORTS TO Nature

Transportation Strategies Enhancing Visitor Experience of National Parks

KATHERINE F. TURNBULL



GLACIER NATIONAL HISTORY ASSOCIATION



Back to the future: Weeping Rock shuttle stop design in Zion Canyon, Utah (*above*) complements Works Progress Administration street elements from the 1930s. The open-topped tour buses popular in Glacier Park in the 1930s (*above, left*) have been refurbished and are now back in service along Going-to-the-Sun Road.

The author is Associate Director, Texas Transportation Institute, Texas A&M University System, College Station, and serves TRB as Chair of Technical Activities Division Group 5: Intergroup Resources, as a member of the Task Force on the Transportation Needs for National Parks and Public Lands, and on several other standing committees.

In keeping with the National Park Service (NPS) theme, "Visit Your Parks: Experience America," record numbers of visitors are flocking to national parks and other federal lands. New shuttle bus systems, refurbished 1930s touring coaches, and other transportation options await the influx at many parks. These services represent the coordinated efforts of federal land management and transportation agencies, state governments, gateway communities, foundations, businesses, and other groups.

Transportation and the national parks are intrinsically linked—traveling to and within national parks is a major part of the visitor experience. The focal points of many visits are the park roads, scenic

Hikers and bicyclists use the shuttle at Bubble Pond at Acadia National Park, Maine.

overlooks, hiking trails, and related facilities—built by such diverse groups as the U.S. Cavalry, early pioneers, John D. Rockefeller and other wealthy industrialists, railroads, and the Civilian Conservation Corps of the Works Progress Administration. Railroads not only built park roadways, but also established hotels, organized motor coach tours, and promoted outdoor activities.

The numbers of visitors at national parks, historic sites, battlefields, monuments, memorials, recreation areas, seashores, rivers, trails, and parkways continue to increase. NPS received 300 million visitors at its 380 sites in 2000. The nature reserves, wildlife preserves, and recreation areas under the U.S. Fish and Wildlife Service (FWS) and the Bureau of Land Management (BLM) are also experiencing increases in visitors.

The concerns about traffic congestion, vehicle-generated noise and air pollution, deteriorating roadways, and wildlife degradation are well documented and publicized. The federal land management agencies, the U.S. Department of Transportation (DOT), state governments, local communities, foundations, regional organizations, businesses, and other groups are responding to these challenges.

Federal Directions

The Intermodal Transportation Efficiency Act (ISTEA), the Transportation Equity Act for the 21st Century (TEA-21), Presidential directives, and interagency agreements established new directions for transportation within national parks and other federal lands during the 1990s. The policies, programs, funding levels, and initiatives in these acts, directives, and agreements are responding to the increased visitor levels, traffic congestion, environmental concerns, and other issues at many national parks.

Studies and Strategies

Section 3039 of TEA-21 required that the Secretary of Transportation, in coordination with the Secretary of the Interior, conduct a comprehensive study of alternative transportation needs in national parks and related federal lands. The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), in association with NPS, BLM, and FWS, sponsored a study to examine the alternative transportation needs at 207 sites. The study identified system needs at 118 of 169 NPS sites, 6 of 15 BLM sites, and 13 of 23 FWS sites.

The needs ranged from enhanced services to new transit systems. Buses were the most common mode recommended, but some sites required water transportation systems.

The study also estimated the short- and long-term costs of the alternative transportation systems and the potential sources of funding. In addition, the study examined the transportation issues, visitation levels, and current transit systems at all 207 sites.

NPS then developed an Alternative Transportation Program Strategy Plan for 2002 through 2006. According to the mission statement, the plan will

> …preserve and protect resources while providing safe and enjoyable access to and within the national parks by using sustainable, appropriate, and integrated transportation solutions. The vision…is [that] all parks employ an integrated approach to visitor access and mobility using a combination of transportation technologies, facilities, and management strategies to provide a range of mode choices to best preserve and protect resources while providing a pleasant visitor experience appropriate to the park and the community.

Creating a Fleet

NPS sponsored a workshop to bring together representatives from federal land management and transportation agencies, vehicle manufacturers, and other groups. The workshop served as an initial step in creating a distinctive fleet of vehicles for visitor travel at national parks.

The concept of the Arrowhead Transportation Fleet is to use a common design or theme for large, medium, and small buses and trams in the parks. The workshop results also have been helpful in developing detailed specifications for vehicle proposals.

Successful Initiatives

Five parks—Acadia in Maine, Golden Gate and Yosemite in California, Grand Canyon in Arizona, and Zion in Utah—were selected for demonstration proj-

ects shortly after the 1997 signing of the Memorandum of Understanding between the Department of the Interior and U.S. DOT. The transit projects at Acadia and Zion have advanced faster than those at the three other parks. In addition, new shuttle bus systems have started at Rocky Mountain in Colorado and at Utah's Bryce Canyon, and historic motor coaches have been refurbished at Glacier in Montana.

Exploring the Islands

The Island Explorer transit system recently completed its fourth season serving visitors to Acadia National Park in Maine. The popularity of the system continues to increase, with more routes and buses added to keep up with demand. In 2002, 17 propane-powered buses traversed the seven routes serving towns and park destinations along the coast of Maine, Mount Desert Island, and other islands. From late June to early September, Island Explorer provides free service daily, from 7:30 a.m. until 11:00 p.m.

Ridership almost has doubled during the four-year period, from 142,000 passengers in 1999 to nearly 280,000 in 2002. Although visitors account for most of the increase, local residents also are riding the buses more often, including travel to and from work.

The results from annual on-board surveys show strong support for the service and high levels of satisfaction with driver friendliness and helpfulness, clean buses, and free fares. Most riders indicate that the Island Explorer improves the quality of their visit. The survey results also have helped to target service extensions and improvements.

The Island Explorer gained a new sponsor in 2002—the catalog sales company L. L. Bean. The 1999 agreement that established the system had included 22 signatories, representing the cooperation of NPS, Maine DOT, Mount Desert Island towns, Friends of Acadia, regional organizations, local businesses, and other groups. Funding for capital and operating expenses has come from a range of sources, including traditional and new NPS, FHWA, and FTA programs and funds from the state, Friends of Acadia, Mount Desert Island towns, and other groups and businesses.

L. L. Bean became the single corporate underwriter for the Island Explorer in 2002 with a four-year $1 million contribution. With close to 3 million annual visitors to its store in Freeport, L. L. Bean and Acadia share honors as Maine's most popular destinations. Announced as the company's 90th anniversary gift to the state, the sponsorship reflects L. L. Bean's values of promoting recreation and stewardship of the nation's natural resources, as well as helping to address local issues. The $250,000-a-year contribution will

- Extend Island Explorer service into mid-October instead of ending on Labor Day, possibly add routes, and increase hours of operation;
- Serve as a local match for federal funds; and
- Underwrite operating costs, to ensure sustainable service.

Other funding options are being explored. NPS may increase the park fee at Acadia under a demonstration program, dedicating the additional funds to the transit system.

Acadia also was selected as one of the federal Intelligent Transportation System Field Operational Test projects in 1999. The demonstration includes components for transit, traffic monitoring, and information dissemination. Transit elements feature an automatic vehicle location system, real-time bus status signs at major stops, automatic passenger counters, automated bus stop announcements, a website with real-time bus information, and a closed circuit television monitor at a major location.

All of the transit components were in operation or testing in 2002. In addition, Island Transit buses are equipped with radios and mobile data terminals, allowing drivers to communicate problems en route.

Traffic monitoring elements are in development and testing but should be in place this summer. These include automated parking lot monitors, automated classification counters for park entrances, real-time parking lot information accessible via the Internet and an interactive telephone system, and links to the tri-state 511 information system.

Shuttling Through Zion

For more than two years, a free shuttle bus system has been the only means of transportation for summer visitors to Zion Canyon—the main destination for the 2.5 million annual visitors to Zion National Park. Buses traverse the 6-mile, dead-end roadway from 6:30 a.m. to 9:30 p.m., providing access to hiking trails, scenic views, and Zion Lodge. Overnight guests at Zion Lodge are the only visitors allowed to drive private vehicles on the roadway.

Shuttle to lodge, Zion Canyon, Utah; another loop connects to the gateway community of Springdale.

Big Bend shuttle stop, Zion Canyon, Utah; with the decrease in vehicle traffic, sightings of several wildlife species have become less rare.

A second shuttle bus route, serving the gateway community of Springdale, includes stops at hotels and activity centers. The two routes connect at the Zion Canyon visitor center, allowing passengers to transfer. Propane-powered buses and trailers provide service every 6 minutes or less on both loops during peak times.

Ridership has increased in the past three years. In 2002, 2.71 million trips were made on the shuttles, up from 2.13 million in 2001. Approximately 20,527 trips were made each day during the three-day Memorial Day weekend in 2002. Visitors on the Canyon Loop average three to four daily trips on the shuttle.

Funding for the shuttle bus stops in Springdale and for related streetscape improvements represents the coordinated efforts of Springdale, Utah DOT, FHWA, NPS, Zion National History Association (ZNHA), local businesses, and other groups. Through Utah DOT, Springdale obtained federal Transportation Enhancement Program funds, matching city and ZNHA funds. The shuttle stop design complements the community's road and streetscape elements constructed by the Works Progress Administration in the late 1930s.

Acadia and Zion exemplify the success of new national park transit systems. Other parks are implementing new shuttle bus systems, and some parks and nature reserves are expanding and upgrading visitor transportation systems.

Jamming the Glaciers

Transportation played an important role in the development of Glacier, established as a national park in 1910 and known for spectacular glaciated landscape, lakes, forests, and alpine meadows. Located in northwest Montana, adjacent to the Canadian border, the park includes 1 million acres and receives 1.7 million visitors annually.

Early access to the park was by railroad and horseback. The Great Northern Railway built hotels and small lodges throughout the park to serve visitors arriving by rail. Going-to-the-Sun-Road, which traverses the park and links to Waterton Lakes National Park in Canada, opened in 1932 after 11 years of construction. Traveling the road by motor coach or automobile became a focal point for visitors.

During the 1930s red touring coaches operated in Glacier and other western parks. Known locally as "jammer" buses because the drivers jammed the gears going up and down the steep terrain, the canvas-topped 17-passenger vehicles served hotels and crossed the park along Going-to-the-Sun Road.

Glacier's fleet of 33 red buses was part of 500 vehicles built by the White Motor Company in the 1930s for the western national parks. The red buses provided visitors with a unique experience but had to be removed from service in 1999 because of structural and metal fatigue and other safety concerns.

Through the combined efforts of the Ford Motor Company, concession operator Glacier Park, Inc., and The National Park Foundation, the red buses returned to Glacier in 2002. Glacier Park donated the original red bus fleet to Ford, which coordinated the refurbishing with Transportation Design and Manufacturing in Michigan. The red buses received new chassis, rebuilt bodies and interiors, new dual propane–gasoline fuel systems, and new wiring, speakers, and bright red paint.

Hiking the Rockies

Established in 1915, Rocky Mountain National Park in north central Colorado encompasses 416 square miles of the Rocky Mountains and is home to elk, mule deer, big horn sheep, moose, coyotes, and other animals. Hiking, camping, and viewing wildlife are major visitor activities.

Trail Ridge Road (U.S. 34) traverses the park and the Continental Divide but is closed from late fall to Memorial Day because of snow. Access to the main area of the park is by road, but parking at many of the trailheads is limited. The high elevation of the park—8,000 to 14,000 feet—can affect hikers and even drivers.

A shuttle bus service started in 2001 to address the shortage of parking spaces at trailheads and to ease traffic congestion on the park roadways. Two routes provide access from the shuttle parking area to trailheads and other sites. Buses operate only dur-

ing the summer, from 7:00 a.m. to 7:30 p.m., every 8-to-10 minutes for most of the day.

Response to the shuttle bus system has been positive. The system averaged 3,000 riders daily in 2002, an increase of 7 percent from 2001. The system appears to be popular with hikers and with visitors who prefer to view the park without driving.

Breezing Through Bryce

South central Utah's Bryce Canyon was established as a national monument in 1923 and as a national park in 1924. The park encompasses 35,000 acres of canyons, plateaus, and forests and attracts 1.7 million visitors annually.

Union Pacific Railroad played a major role in developing Bryce Canyon, added to the Grand Circle Tour in the 1920s. Tourists came to Cedar City by rail and then traveled by motor coach to Cedar Breaks, Zion, the north rim of the Grand Canyon, and Bryce Canyon. Union Pacific built the Bryce Canyon Lodge to accommodate travelers and constructed other park buildings and roadways. The five-day loop tour cost $86.75 per person in 1924 for motor coach, meals, and lodging.

The eight major scenic destinations in the park are connected by an 18-mile roadway, which was not built for heavy year-round use. Parking in Bryce Canyon is limited—on peak days, only one in every four visitor cars can park.

An initial test of a shuttle bus system to address the traffic and parking problems averaged 10,000 visitors a month, at a fare of $4.00 per person. Building on this demonstration, a free shuttle bus system began in 2000. The voluntary system operates during the peak summer months, serving the major points of interest from a staging area just outside the park.

Service levels and months of operation have varied with available funding over the three years; as a result, shuttle use has ranged from 25,440 to115,640 passengers. The shuttle is an attractive option for visitors who have only a short time to spend in the park and for backpackers.

Developing Demos

Activities also are under way at the three other demonstration parks and at other parks and historic sites:

◆ Canyon View Information Plaza opened at Grand Canyon in 2000, and the park shuttle system was extended to year-round operation. Congressional action has placed the proposed light rail transit system on hold to explore other options.

◆ Shuttle buses began operating in Yosemite in 2000. Traveler information systems alert visitors to travel conditions and parking availability.

◆ Coordinated planning and alternative-fueled buses are on the agenda at Great Smoky Mountains National Park in Tennessee and North Carolina.

◆ Expansion of the historic trolley is under consideration at Lowell National Historic Park in Massachusetts.

Mounting Benefits

Alternative transportation modes, innovative strategies, and advanced technologies may provide many benefits to visitors, to the environment, and to gateway communities.

◆ *Improving air quality.* Reducing the number of automobiles operating in a national park or wildlife preserve translates into lower levels of vehicle emissions. Studies indicate that carbon monoxide emissions have been reduced by 33 percent in Acadia and by 46 percent in Zion with the introduction of park transit systems. Although the greatest air quality benefits occur at parks like Zion that limit private vehicle use, voluntary transit systems also reduce automobile-generated emissions.

◆ *Reducing noise levels.* Fewer vehicles on park roads also mean lower noise levels. The bus system at Zion has reduced noise near the park road by 9.6 decibels, and the Island Explorer accounts for a reduction of 6.3 decibels on roadways in Acadia. The change in noise levels with the bus system at Zion is probably one of the most noticeable—hiking on trails and experiencing the park are much quieter without the steady stream of automobiles.

◆ *Reappearing wildlife.* Animals and birds have become more visible in parks that have started or expanded transit services. Since the introduction of shuttle buses in Zion three years ago, animals not readily seen for years—such as wild turkeys and

Tunnel and parapet on east slope of Going-to-the-Sun Road, Glacier Park, Montana.

LANNY LUDING

Sperry Chalet in Glacier Park, built by Great Northern Railway.

Visitors orient themselves to the Grand Canyon—including routes and transportation services—at outdoor display panels in Canyon View Information Plaza.

Responding to Tourism and Recreation Travel Demands

Getting the Plans Together

In providing the framework for transportation planning, development, and implementation from 1991 through 1997, the Intermodal Surface Transportation Efficiency Act specified topics for metropolitan and state transportation planners to address. Metropolitan plans had to consider access to federal lands—such as national parks—as well as to tribal lands, recreation areas, monuments, and historic sites. State plans had to accommodate recreational travel and tourism.

Many metropolitan planning organizations (MPOs) and states developed procedures and techniques for identifying the needs of tourists and visitors. One way was to invite representatives from national parks and tourism organizations to participate in the planning process and then to incorporate the input into plans and project selection guidelines.

The Transportation Equity Act for the 21st Century revised the guidance, referring only indirectly to planning for the needs of visitors and tourists. Nonetheless, MPOs and states have continued to address visitor and tourist travel needs, and guidance is still needed for transportation and tourism professionals with federal agencies, MPOs, states, and consulting firms.

MPOs and states use many different methods to incorporate tourist, visitor, and recreation travel needs into the planning and decision-making process. Much has been learned about the advantages and limitations of the various approaches, but the information never has been collected.

National Cooperative Highway Research Program (NCHRP) Project 20-5, Synthesis of Highway Practice 33-11: Including Tourism and Recreation Travel in Metropolitan and Statewide Transportation Planning and Decision Making, is surveying MPOs, regional planning organizations, state departments of transportation, and federal land agencies to document the state of the practice. The synthesis project is also reviewing previous surveys, relevant transportation plans, and the literature, as well as interviewing selected experts, to explore such subjects as

- Technical analysis tools for forecasting tourist, visitor, and recreation travel demand;
- Effects of demand on transportation system performance and the economy;
- Institutional relationships and partnerships;
- Stakeholder involvement techniques;
- Integration of state, MPO, and federal plans, processes, programs, and decision making;
- Advantages, limitations, and effectiveness of alternative strategies, including techniques identified in *NCHRP Report 419: Tourism Travel and Transportation System Development* (1998);
- Innovative financing; and
- Best practices.

cougars—have been sighted. The Rocky Mountain National Park bus system has the distinction of being the only transit system in the world that offers views of elk rutting.

◆ *Accommodating increasing visitor demands.* The park transit systems can accommodate more visitors in fewer vehicles. However, restrooms, food facilities, interpretive centers, and other services also must be able to accommodate the larger numbers.

◆ *Balancing infrastructure needs.* Roadways, scenic overlooks, and viewing areas are key elements in many parks. Park transit services can help preserve historic roadways and reduce the need for more parking spaces inside the parks. Alternative transportation systems, however, require infrastructure, such as bus maintenance and service facilities, bus stops, and passenger waiting areas.

◆ *Enhancing the economy of gateway communities.* Although no major study has examined the effects of new park transit systems on the economy of gateway communities, the anecdotal evidence appears positive. The reaction of hotel and restaurant owners in Acadia and Zion has been primarily favorable, as has response from other local businesses. The Springdale Loop connecting to Zion appears to have changed customer shopping patterns, with some tradeoffs among businesses.

◆ *Enhancing the park experience.* Alternative transportation systems make visits to the parks more enjoyable and pleasant. Easing traffic congestion, reducing levels of noise and air pollution, and improving wildlife viewing opportunities enhance the experience for visitors to national parks and federal lands. As the survey results at Acadia indicate, transportation services that improve the quality of a visit are highly valued.

Learning from Experience

Although many of the new transit services have operated only a few years, characteristics of the more successful projects are emerging. These include partnerships, funding, combining old and new features, and patience.

◆ *Partnerships.* Partnerships have always been important to the national parks. Railroads, wealthy industrialists, and private concessionaires have played key roles in creating, developing, and operating the national parks. Partnerships are even more critical today—not only among federal, state, and local governments, but with local foundations, organizations, businesses, and corporations, as experience has demonstrated at Acadia, Glacier, Zion, and other parks.

◆ *Funding.* With budget constraints at all levels of government and a sluggish economy, innovative financing is critical in meeting the transportation needs in parks. Establishing strong partnerships with public- and private-sector groups builds a solid base for coordinated funding. Traditional federal, state, and NPS transportation programs will provide a significant

portion of the needed funds. New programs, foundation and corporate sponsorship, dedicated park fee increases, and other innovative approaches will play increasingly important roles.

◆ *Balancing old and new.* The historic elements of national parks, including roadways, motorcoaches, trolleys, lodges, and other structures, are key parts of visitor experience. Maintaining historic and cultural integrity may not always be easy as new technologies and modes address specific problems. Recent surveys at two national parks in California revealed that some visitors—one-quarter to one-third of respondents—considered the use of advanced technologies such as handheld computers, electronic message signs on roadways and in parking areas, and Internet terminals, "inappropriate" or "somewhat inappropriate." The use of advanced technologies, therefore, should be balanced with efforts to preserve historic and natural features.

◆ *Patience.* New transportation systems and other improvements do not occur overnight. Planning, designing, funding, and implementing shuttle services and other modes require time and effort. Federal and state agencies, gateway communities, foundations, environmental groups, local businesses, and other groups have vested interests in national parks. Establishing trust and building strong working relationships among these diverse groups takes time but is critical to the ongoing success of transportation enhancements in the parks.

Nurturing Research

The TRB Task Force on Transportation Needs for National Parks and Public Lands provides a forum for issues, opportunities, and research related to transportation to and within parks, recreation areas, and other federal lands. Established in 1998, the task force has sponsored TRB annual meeting sessions, developed research problem statements, assisted with national conferences, and facilitated intergroup coordination.

The National Cooperative Highway Research Program has selected a problem statement submitted by the task force as a synthesis topic (see box, page 20). A first draft of the synthesis, *Including Tourism and Recreation Travel in Metropolitan and Statewide Transportation Planning and Decision Making*, was completed in 2002, and the final report will be issued in 2003. The synthesis examines how state departments of transportation and metropolitan planning organizations are incorporating tourist, visitor, and recreation travel needs into transportation planning and decision making.

The task force has identified several other areas for research:

Accessibility trams driven by National Park Service personnel are available to help mobility-impaired visitors travel between Mather Point and Canyon View Information Plaza, Grand Canyon, Arizona.

◆ Examining the influence of shuttle bus systems on the economy of gateway communities,

◆ Developing performance measures and data needs for alternative transportation systems,

◆ Exploring advanced technologies to enhance pretrip and en route information,

◆ Developing more sophisticated planning models to estimate visitor travel needs,

◆ Examining innovative partnerships and funding for park transportation, and

◆ Monitoring projects under way and in planning.

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Resources

Cambridge Systematics, Inc., and BRW Group, Inc. *Federal Lands Alternative Transportation Systems Study: Summary of National ATS Needs*. Federal Highway Administration and Federal Transit Administration, Washington, D.C., 2001.

Turnbull, K. F. Visitor Transportation at U.S. National Parks: Increasing Accessibility but Preserving the Environment. *TR News*, September–October 2000, pp.3–8.

Websites

Island Explorer, Acadia
www.exploreacadia.com

The National Park Foundation
www.nationalparks.org

National Park Service
www.nps.gov

CALENDAR

TRB Meetings

2003

March

17–19 National Asphalt Pavement Conference: Superpave 2003*
Nashville, Tennessee
Frederick Hejl

April

6–10 9th Application of Transportation Planning Methods Conference
Baton Rouge, Louisiana
Kimberly Fisher

28–30 9th International Bridge Management Conference
Orlando, Florida
Frank Lisle

May

18–21 Statewide Transportation Planning Conference: Making Connections
Florida Keys, Florida
Kimberly Fisher

June

22–25 8th International Conference on Low-Volume Roads
Reno, Nevada
G. P. Jayaprakash

July

11 Data Analysis Working Group (DAWG) Forum on Pavement Performance Data Analysis
Guimarael, Portugal
A. Robert Raab

13–18 Joint Summer Meeting of the Planning, Economics, Finance, Freight, and Management Committees
Portland, Oregon
Kimberly Fisher

13–18 28th Annual Summer Ports, Waterways, Freight, and International Trade Conference
Portland, Oregon
Joedy Cambridge

15–17 10th AASHTO/TRB Maintenance Management Conference*
Duluth, Minnesota
Frank Lisle

20–23 42nd Annual Workshop on Transportation Law
New Orleans, Louisiana
James McDaniel

23–26 Highway Capacity and Quality of Service Committee Midyear Meeting and Conference
Buckhead, Georgia
Richard Cunard

27–30 2nd Urban Street Symposium
Anaheim, California
Richard Cunard

September

8–10 International Conference on Pavement Performance, Data Analysis, and Design Applications*
Columbus, Ohio
G. P. Jayaprakash, Stephen Maher, Frederick Hejl

November

16–18 9th National Light Rail Transit Conference*
Portland, Oregon
Peter Shaw

2004

January

11–15 TRB 83rd Annual Meeting
Washington, D.C.
Mark Norman

April

13–17 5th International Conference on Case Histories in Geotechnical Engineering*
New York, New York
G. P. Jayaprakash

May

5–8 5th International Conference on Cracking in Pavements: Risk Assessment and Prevention*
Limoges, France
Frank Lisle

23–26 10th International Conference on Mobility and Transport for Elderly and Disabled People
Hamamatsu, Japan
Claire Felbinger

July

21–24 Highway Capacity and Quality of Service Committee Midyear Meeting and Conference
State College, Pennsylvania
Richard Cunard

September

19–22 2nd International Conference on Accelerated Pavement Testing*
Minneapolis, Minnesota
Stephen Maher

October

19–24 6th International Conference on Managing Pavements*
Brisbane, Queensland, Australia
Stephen Maher

Additional information on TRB conferences and workshops, including calls for abstracts, registration and hotel information, lists of cosponsors, and links to conference websites, is available online (www.TRB.org/trb/calendar). Registration and hotel information usually is available 2 to 3 months in advance. For information, contact the individual listed at 202-334-2934, fax 202-334-2003, or e-mail lkarson@nas.edu/.

*TRB is cosponsor of the meeting.

States Work to Resolve Critical Issues in Transportation

Reports from TRB's 2002 Field Visit Program

In late 2001, the TRB Executive Committee published a report identifying and assessing the most critical issues in transportation.[1] The 2002 field visits by TRB Technical Activities Division staff confirmed the urgency of these issues for state DOTs. More important, the visits allowed TRB staff to see firsthand how state DOTs and other transportation organizations are answering the challenges. Following are summaries of the findings on activities addressing each critical issue, with capsule restatements of the issue in italics.

[1] Critical Issues in Transportation 2002. *TR News*, November–December 2001, pp. 3–11.

Specialists in the Transportation Research Board's Technical Activities Division identify current issues, collect and generate information on the issues, and disseminate the information throughout the transportation community. The TRB Annual Meeting, Board-sponsored conferences and workshops, standing committee meetings and communications, publications, and contact with thousands of organizations and individuals provide TRB staff with information from the public and private sectors on all modes of transportation.

A major source of this information is the annual field visit program. TRB staff meet on site with representatives of each state department of transportation (DOT) and also with representatives of universities, transit and other modal agencies, and industry. The objectives of the field visit program are to

- Identify problems and issues of importance to the department and other organizations visited,
- Provide assistance and information to help the organization in addressing the problems and issues,
- Identify problems and issues that TRB should address to assist transportation organizations, and
- Identify activities that TRB should continue or undertake, to provide the best service to sponsors and other customers.

Security

The transportation system is vulnerable to attacks by terrorists and saboteurs.

Since September 11, 2001, transportation agencies and users have had to concentrate on safety and security. General awareness has increased and many new protective measures are in place.

To accomplish this, governments and transportation providers, including state DOTs, have had to redirect substantial funds to safety and security. In some systems, for example, premiums for insurance covering property, workers compensation, and terrorism have quadrupled, especially for agencies with high-profile infrastructures.

In transportation operations, many of the essential players in safety and security have cultivated cooperative relationships for years. For example, most major urban areas have implemented regional traffic incident management programs that involve representatives of the agencies providing fire and emergency response, law enforcement, towing and recovery, and transportation operations. The institutional relationships have become a starting point for the multidisciplinary and interagency network operations and emergency services needed for increased levels of safety and security.

The U.S. Customs Service and other federal agencies are working to enhance national security through programs such as the Customs Trade Partnership Against Terrorism, the Container Security Initiative, and Operation Safe Commerce (OSC), designed to involve the private sector in supply-chain security. OSC pilot programs are under way in New England and the Pacific Northwest; however, much remains to be done in developing the technology and procedures to prevent the possible entry of weapons of mass destruction through the U.S. border.

Ferry systems—particularly with vessels carrying 500 or more passengers—are trying to formulate and implement procedures that enhance security but maintain the efficient movement of passengers and vehicles. The ferries of the Alaska Marine Highway System carry cars and trucks as well as people and serve 35 ports in the state. Each port has increased levels of security—for example, new procedures for handling unaccompanied vehicles and baggage. The U.S. Coast Guard, the Federal Bureau of Investigation, and state police have been involved in threat and vulnerability assessments of the system.

Port facilities throughout the nation similarly have undergone vulnerability and threat assessments. The security improvements that are needed far exceed available resources, making implementation difficult.

The U.S. Coast Guard participates in the Operation Safe Commerce pilot program in the New England area.

PHOTO: MIKE HVOZDA

Safety

Fatalities and injuries from transportation crashes are a major public health problem.

Statistics for fatal crashes have not changed dramatically. However, variations occur within different crash types—for example, pedestrian crashes have decreased, but alcohol-related fatalities have increased. Specific crash causes have become the subject of focused investigations.

The pros and cons of cell phone use by drivers are being debated, with much research focusing on the role of cell phones in traffic safety. In one example, the California Highway Patrol examined crashes on state highways and found that in the past year approximately 4,700 crashes—with 2,700 injuries and 31 fatalities—were attributable to driver cell phone use.

Aggressive Driving Measures

Many drivers apparently are becoming more aggressive in their driving behavior, usually by speeding and red-light running. Public agencies are implementing countermeasures including photo enforcement of speed limits and of red-light running, as well as roadway modifications designed to calm traffic.

The Milwaukee, Wisconsin, area reduced aggressive driving through a six-month "Aggression Suppression" program targeting traffic offenses associated with aggressive driving. The program included a series of public awareness campaigns, each three weeks long, and involved 20 area enforcement agencies using seven specific strategies to increase enforcement in the city and in 15 suburban areas, with a final program evaluation.

Enforcement strategies included in-car video cameras, unconventional patrol vehicles (e.g., a minivan, a Cadillac, and an older-model Toyota), enforcement at intersections, laser speed detection devices, technology to measure the distance between cars, magnetic vehicle signs announcing "Aggressive Driving Patrol," and electronic displays showing driver speeds. Crash data were used to target corridors with a history of crashes related to aggressive driving. The evaluation showed that red-light running decreased at the targeted intersections and that crashes declined by more than 12 percent in the targeted corridors and by more than 6 percent areawide.

Other communities have implemented photo enforcement primarily for red-light running. The technology can detect red-light running and speeding violations without a law enforcement officer present. Many citizen and safety groups regard the cameras as an effective deterrent to unsafe driving behavior and therefore an improvement to safety. However, recent court decisions, along with political and citizen opposition, have raised the issue that, in some cases, engineering solutions did not receive enough consideration before the cameras were installed.

Traffic calming, used in Europe and Australia, recently has become a hot topic in the United States as local agencies grapple with citizen demands to improve traffic control. Traffic calming strategies typically place speed humps, chicanes, chokers, small traffic circles, or other features within the roadway to reduce vehicle speeds and to encourage more acceptable driver behavior.

Advocates for traffic calming measures frequently cite the benefits of improved safety and quality of life in residential areas, but opponents are concerned about increased response times for emergency vehicles, obstacles to snow removal, and the potential for liability. State DOTs are trying to determine which locations and roadways are appropriate for traffic calming measures.

In Howard County, Maryland, cameras detect red-light running and speed violations.

Seat-Belt Use

"Click It or Ticket" campaigns have increased seat belt use, contributing to a 73 percent national use rate. An evaluation of the campaign in the eight states of the National Highway Traffic Safety Administration's Region IV—Alabama, Georgia, North Carolina, South Carolina, Florida, Kentucky, Mississippi, and Tennessee—again demonstrated the value of intensive publicity combined with vigorous enforcement.[2]

Front seat belt use increased from 65 percent at the beginning of the campaign to 74 percent at the end. In addition to the 119,805 seat belt citations and 9,495 child restraint citations, enforcement agencies made 8,478 driving-under-the-influence-of-alcohol arrests, recovered 254 stolen vehicles, and arrested 1,471 fugitives during the two-week enforcement period.

Colorado DOT used survey data to identify areas with the lowest rates of seat belt use. Market research then revealed specific high-risk groups within the areas. The DOT designed different types of seat belt campaigns for each group, working with the groups to tailor the campaigns. Several of these campaigns are undergoing formal evaluations. In one area, seat belt use increased 14 percent and the target audiences showed high retention and memory of the messages.

Research and Data Collection

More research is supporting the effectiveness of graduated driver licensing. For example, in Pennsylvania nighttime driving and passenger restrictions took effect in August 1999, with further reforms in December 1999. Since then, 16-year-old driver crash experience has changed dramatically, with 1,700 crashes in 2000—down 27 percent from 1999. Injuries dropped by almost one-third—6,200 in 1999 to fewer than 4,300 in 2000. Fatalities dropped from 60 to 25—a 58 percent reduction in one year.

Many states are investing in crash data systems to improve understanding of factors contributing to crashes and to assist in countermeasures. Some are using geographic information systems (GIS) and the Global Positioning System (GPS) to integrate diverse sources of information and to analyze relationships. Since the sources of crash data are diverse, DOTs often have to invest in improving the data collection and systems of other agencies.

[2] Cosgrove, L. *Traffic Tech,* NHTSA Technology Transfer Series, No. 270, March 2002.

The National Highway Traffic Safety Administration promotes increased seat-belt use with its "Click It or Ticket" campaign.

Colorado DOT also applies a sophisticated concept and model—Level of Service of Safety (LOSS)—developed by staffers Jake Kononov and Bryan Allery. The LOSS reflects how a roadway segment is performing in comparison with the expected accident frequency for an equivalent level of annual average daily traffic. The LOSS qualitatively describes the relative safety of the roadway segment.

To determine why a particular segment registers higher crash rates, analysts rely on direct diagnostics and pattern recognition techniques, reviews of construction plans, and site visits. The approach has enabled the Colorado DOT Safety Engineering and Analysis Group to make significant, timely, and efficient identifications of high-crash areas and state highway system segments.

Bryan Allery (*left*) and Jake Kononov, Colorado State Department of Transportation, developed the Level of Service of Safety data collection model.

The LOSS approach also has helped determine the factors contributing to the crashes. These developments suggest that several years of statistical research and development will make the model ready for use by other DOTs.

Work Zone Safety

The safety of motorists and workers in work zones remains a priority for state DOTs. The use of double fines and police patrols to deter speeding in work zones is the norm in many states, as is performing road work at night. State DOTs have found that portable message signs controlled by cell phones are effective in communicating with drivers in work zones, as are trailer displays that post an approaching vehicle's speed.

Many states are turning to the Internet to advise motorists of work zone conditions and of the approximate travel times through work zones. At least one state is considering variable speed limits in work zones.

Speed limits that change dynamically to reflect conditions are under consideration in some areas to improve speed management on freeways and in work zones. These variable speed limits inform motorists of reasonable and safe operating speeds based on real-time traffic speed and flow data, weather conditions, construction or maintenance activities, or other factors.

The system detects changes in traffic flow with sensors and displays the appropriate reduced speed limits on variable message signs. Other countries have used variable speed limits successfully to maintain traffic flow and to achieve safety benefits.

Other Safety Issues

Other safety issues and concerns gaining prominence at the state level include

- Roadside safety barriers and guardrails that meet the standards recommended in National Cooperative Highway Research Program Report 350[3] and accommodate a changing vehicle fleet, as well as motorcycles;
- The compatibility of increasing truck sizes and weights with geometric design and posted speeds;
- The increased demand from utility companies to use rights-of-way, and
- The safe mobility of pedestrians and bicycles in a mix with vehicular traffic.

In some states, the volume of rail freight traffic has increased but safety at crossings has not. Many states are having difficulty finding the resources to improve crossing safety.

Congestion

The demand for passenger travel and freight movement is straining the capacity of the U.S. transportation system.

Highways

Highway congestion occurs daily in all large metropolitan areas and is a constant source of frustration and agitation for millions of commuters and travelers. Once an urban problem, congestion now affects all areas of the country. In 1981, 25 percent of urban highways were classified as congested. By the mid-1990s, the proportion had risen above 45 percent, with more than 4 billion hours lost to traffic delays in the top 70 metropolitan areas. Rural travel is also growing at a rapid pace.

[3] *NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features*. TRB, National Research Council, Washington, D.C., 1993.

Tunnel and bridge agents and police officers from Port Authority of New York and New Jersey and firefighters from Jersey City respond to motor vehicle accident at entrance ramp to the New Jersey Turnpike, near the Holland Tunnel.

Traffic Incident Management

Traffic congestion resulting from crashes and vehicle breakdowns accounts for more than half of the delay on our nation's urban freeway system, according to some estimates. Traffic incident management response plans therefore are a valuable strategy—a planned and coordinated process to detect and remove highway traffic disruptions and restore capacity as safely and as quickly as possible.

Incident management programs are in place in more than 50 locations throughout the United States, and other regions are developing programs. Studies clearly prove that the programs are cost-effective in reducing traffic congestion, enhancing safety, and improving air quality.

Incidents also affect the safety of responders. In 1999, more than 50 percent of the police officers killed in the line of duty died in traffic crashes. Nearly 10,000 police cars, 2,000 fire trucks, and more than 3,000 other service vehicles were struck while responding to traffic incidents. Consequently, techniques for traffic incident management are under study in many states and urban areas.

The Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), the Intelligent Transportation Society of America, and TRB jointly sponsored a National Conference on Traffic Incident Management in March 2002 in Irvine, California, focusing on the incident management role of agencies responsible for emergency service, public safety, and transportation operations. The proceedings from the conference are available on the web.[4]

[4] Proceedings, National Conference on Traffic Incident Management, March 11–13, 2002. http://gulliver.trb.org/conferences/TIM/.

Minimizing Construction Delays

States also are exploring the use of high-performance concrete and steel, structural fiber-reinforced plastics, and precast elements to accomplish the "get in, get out, and stay out" ideal in bridge construction and maintenance. These materials may provide positive alternatives to conventional materials and construction methods and minimize disruptions that cause roadway congestion. Material and design specifications are under development, and use is increasing for appropriate projects and locations.

More states are including incentive and disincentive clauses in contracts to accelerate construction, and nighttime construction is becoming standard for high-volume highways. Indiana and Pennsylvania pilot-tested a new concept developed by a TRB task force for constructing a project or corridor with high speed, high quality, and high safety. The approach involves workshops and an accelerated construction technology team to identify, discuss, and evaluate options before design. The AASHTO Technology Implementation Group and FHWA have adopted the concept and will conduct several workshops in the next two years.

Transit

Transit solutions to roadway congestion received financial and technology boosts. In December 2001, President George W. Bush signed the Department of Transportation Appropriations bill for Fiscal Year 2002, with $6.7 billion for transit. On January 1, 2002, the maximum employee benefit under the transit commuter benefit program increased from $65 to $100 per month, as stipulated in the Transportation Equity Act for the 21st Century (TEA-21).

Buses transport spectators between park-and-ride lots and events at the 2002 Winter Olympics in Salt Lake City, Utah.

Many states offer incentives for nighttime construction, to accelerate work and minimize disruptions on high-volume roadways. FHWA has produced informational publications on the topic (*above*) and is developing workshops with AASHTO.

Many agencies have expanded services, introducing bus rapid transit systems and extended light rail and commuter rail service. The Salt Lake City, Utah, area transit agencies successfully met the challenge of carrying 3.8 million riders during the February Winter Olympics.

Equipment replacement programs continue for bus fleets updating propulsion, fuel, and maintenance technologies. Improved technologies such as "smart cards" are making fare media accepted more widely by agencies and users. In 2001, transit ridership nationwide increased by 2 percent.

Managed Lanes

High-occupancy vehicle (HOV) lanes have been in operation in the United States since the late 1960s. Early HOV treatments allowed buses or carpools of three or more and were characterized by a high bus-transit ridership. During the 1980s and 1990s, HOV lanes began to allow two-person carpools to promote ridesharing, meet growing demand, and utilize HOV lane capacity more effectively, as traffic volumes outpaced the expansion of adjacent general-purpose lanes.

The HOV concept continues to evolve with experience and technology. Recently, the term "managed lanes" was introduced to describe the strategies that relate to HOV lanes, high-occupancy toll lanes, value pricing, truck lanes, and other dedicated lane treatments. Managed HOV lanes provide preferential treatment for buses, carpools, and vanpools and employ other management strategies such as pricing, selected additional user groups, and controlled access to maintain free-flow speeds and promote full use of the facility.

The management strategies can be implemented individually or in combination, depending on the travel demand conditions throughout the day. Several states, including Arizona, are studying the possibility of dedicated truck lanes on major highways with heavy truck volumes.

The use of managed lanes—for example, high-occupancy vehicle lanes—is expanding as traffic volumes increase.

Aviation

Adequate capacity is the long-term concern for aviation, beyond the current difficulties with depressed air traffic and increased security demands. Technologies implemented under the Federal Aviation Administration's Operational Evolution Plan are expected to increase capacity by 1 to 8 percent. Over the next 5 years, 15 additional runways should enhance capacity by about 1 percent per annum. The depressed economy and reduced demand may have eased immediate concerns about adequate capacity in the national airspace system, but the long-term problem persists.

Railroads

The lack of capacity for rail freight traffic in the Northeast Corridor prompted five states and three railroads to conduct the Mid-Atlantic Rail Study. The goal of the study was to develop a long-term investment program to eliminate rail choke points in the mid-Atlantic corridor, increase rail freight and rail passenger service capacity, and relieve congestion in the highway and air systems.

The states of Virginia, Maryland, Delaware, Pennsylvania, and New Jersey have been involved, along with Amtrak and the CSX and Norfolk Southern freight railroads. The study has identified projects to eliminate bottlenecks throughout the mid-Atlantic rail corridor at a total cost of approximately $12 billion. The partnership advocates viewing and funding freight improvements by corridors, not by political boundaries.

Major questions for the states include the creation of mechanisms for funding corridor improvements that involve both public- and private-sector interests and assuring private-sector accountability for public investments.

The state of Delaware and Norfolk Southern railroad have entered into a unique agreement to repair a bridge near Wilmington. The bridge will allow the railroad to reopen a line and divert rail freight traffic from the Northeast Corridor, allowing more capacity for Amtrak and commuter trains. The state is providing the initial funding for the project, and Norfolk

Southern will repay half of the cost through fees for each freight car crossing the bridge.

To address issues of rail corridor capacity and public-sector plans to increase or initiate services on freight railroads, TRB sponsored a workshop at the 2002 Annual Meeting on "Railroad Capacity and Corridor Planning," which public-sector planners found helpful.[5]

Freight

Many states are working to incorporate the needs and demands of freight transportation into the planning processes. These states are recognizing the need to view the freight system—highway, rail, water, and air—strategically and to understand more clearly the relationship between freight transportation and state and regional economies.

Locomotive in Bush Terminal near New York City.

New York State DOT is looking for the best way to move freight and is trying to identify bottlenecks, particularly in the New York City area. The DOT would like to find alternatives to trucking, but moving freight into the city via the limited number of rail lines is difficult. Under consideration are such measures as adding rail capacity, scheduling nighttime movement of freight trains, and using tunnels. The department is partnering with railroads in some of these studies. The state is committed to spending $30 million to improve clearances along railroad lines around New York City, and intermodal facilities also are being planned.

Marine

Service and equipment innovations that can be implemented on the inland waterways have gained attention, as have domestic coastwise and short sea-shipping routes. The Coastwise Coalition is among the groups that have brought together states, ports, carriers, and shippers to promote a marine transportation alternative for freight movements in the coastal regions.

Most U.S. ports lag behind counterparts in Asia and Europe in employing the technological innovations necessary to keep pace with demand. The contentious negotiations between West Coast port operators and the longshoremen's union over technological innovations illustrate the challenge facing the U.S. port community.

As vessel sizes and cargo volumes increase, the technology to process the cargo at ports is essential, particularly in Southern California with the large volumes anticipated. Barcode scanners, GPS equipment, and networks can add efficiency and connect information on freight movements. Because many ports lack land area for expansion, facilities must find ways to handle more freight per acre, to avoid construction projects that can cost millions of dollars and raise public opposition.

Environment

Worthy environmental goals and values pose serious challenges to the operation and expansion of transportation facilities to meet growing demand.

Environmental Streamlining

On September 18, 2002, President Bush signed Executive Order 13274 to expedite the delivery of transportation projects, but with good stewardship of the environment. Although the two goals may seem conflicting, FHWA and state DOTs already had focused on working with resource agencies to strike a balance and have made progress in adjusting the planning and project delivery system to achieve both environmental protection and program delivery.

State DOT responses to the initiative vary but fall into two main categories:

- *Merging steps in the planning and environmental process*—Indiana DOT developed a procedure to incorporate the processes required under the National Environmental Protection Act into the early stages of transportation planning and decision making. Major planning corridor studies are designated as environmental assessments, which involve the resource agencies in the development of purpose and need statements and in the preliminary screening of alternatives.

[5] Harrison, J. A. Maximizing the Capacity of Shared-Use Rail Corridors. *TR News*, September–October 2002, pp. 18–19.

Measures to minimize emissions and improve air quality at the Port of Los Angeles, California, also must consider the port's continuing, rapid expansion.

■ *Developing memoranda of understanding (MOU) to guide planning and analysis*—Illinois DOT, the Illinois Historic Preservation Agency, the State Historic Preservation office, and FHWA developed an MOU outlining a programmatic approach to identify and treat historic bridges. The first step is to conduct a survey of historic bridges and develop a list of structures that are or could be included in the National Register of Historic Places. All other highway bridges then could be considered to have no historic value, allowing improvements to begin without further review.

Using GIS to make relevant environmental data rapidly available to both transportation and resource agencies is another way to accelerate decision making. Florida DOT works with other state and federal agencies to assure that the Florida Geographic Reference Library at the University of Florida readily provides current data layers for all users via the web, saving cost and collection time.

Many state DOTs, such as Pennsylvania, have converted historic preservation records into GIS-enabled computer files to support transportation project development. Arizona, Colorado, and Kentucky have taken the lead in addressing environmentally sensitive construction.

Context-Sensitive Design

Context-sensitive design is evolving into context-sensitive solutions and continues to hold the attention of the public, designers, traffic operations personnel, and researchers. Traffic calming measures are being implemented, although safety issues and liability concerns still challenge widespread adoption.

Emissions from Freight Movement

In Southern California, residential interests, trucking companies, labor unions, and environmental groups are attempting to find solutions to harmful diesel emissions from trucks and yard equipment at major port complexes such as the Ports of Los Angeles and Long Beach. Equitable solutions have become increasingly difficult as parties face legal challenges and legislative hurdles.

In Los Angeles, Mayor James Hahn announced that several of the largest shipping companies in Asia had agreed to work with the city to improve air quality at the port. Last year, the port received 2,200 cargo ship visits, each burning approximately 14 tons of heavy bunker fuel. Under the new plan, the ships will help to reduce pollution by shutting off engines while docked and plugging into the city's power system. The program would be the largest of its kind in the world. Some local activists, however, have predicted that the port's continuing expansion will undermine the project's benefits within one or two years.

Aging Infrastructure

The aging transportation infrastructure must be rebuilt, but the costs involved exceed revenues.

Construction

Highway construction activity in most states primarily involves resurfacing, reconstruction, and rehabilitation to increase the effective life of the infra-

Reconstruction of urban roadways—above, near Boston, Massachusetts—is often difficult, dangerous, and expensive.

Interstate-95 in Bridgeport, Connecticut, is undergoing reconstruction to repair aging infrastructure.

structure, improve safety, mitigate congestion, and increase mobility. New construction projects are the exception—for example, in Connecticut only about 10 percent of the work is new construction.

Connecticut has undertaken one of its last remaining major highway reconstruction projects, widening the roadway and replacing a bridge on Interstate 95 through Bridgeport. Arkansas is in the third year of a five-year program to rehabilitate a major part of its Interstate system.[6] South Carolina is in the midst of an ambitious program, scheduling 200 projects within seven years.

Pavements and Bridges

With the latest edition of AASHTO's *Pavement Design Guide* near completion, states are looking for advice on implementation and on incorporating the changes. Adoption of the guide is likely to follow a path similar to that of the Superpave® mix design implementation—several states will take the lead, with educational efforts to complement the findings.

States continue to implement, update, and upgrade pavement management systems. Many are using the data to justify the preventive maintenance and preservation of pavements to state administrators and legislators, by adding quantitative rationales to statements of needs. Coordinating the output from the pavement management data with the asset management principles now required of the states is the likely next step.

States are continuing to improve and redesign roadway inventory systems and are making the information accessible on the web. As additional Internet bandwidth becomes available, states have been able to improve web access to photolog data.

Implementation of the load and resistance factor design (LRFD) method for bridge structures is not yet uniform among the states. Variations range from no adoption of the method to application on certain bridge elements and on box culverts.

Several states have incorporated LRFD into approximately 20 to 30 percent of designs and are working toward full implementation. However, finding time to train engineers in the use of the new method is difficult. Full implementation of LRFD nationwide for superstructures and substructures probably will take some time.

All states are concerned about extending the durability of constructed infrastructure. Superpave, developed to improve the service life of asphalt pavements, now comprises approximately 65 percent of all hot-mix asphalt tonnage used by the states.

The moisture sensitivity of hot-mix asphalt paving mixtures continues to be a national issue.

[6] Wilson, F. Arkansas' Interstate Rehabilitation Program: Research, Planning, and a Healthy Dose of Innovation. *TR News*, March–April 2002, pp. 9–12.

California is sponsoring a seminar in 2003 to develop a strategic plan to address the problem. Early bridge deck cracking and alkali-silica reactivity (ASR) are issues for several states. New Hampshire, South Dakota, and Texas have ongoing research projects to mitigate ASR.

(a)

(b)

(c)

The "mix of fixes" approach to pavement preservation involves strategic use of many techniques, such as (*a*) dowel-bar retrofit to eliminate faulting in rigid pavements, allowing load transfer from one slab to another; (*b*) diamond grinding to improve ride quality of concrete surfaces; and (*c*) resealing joints on portland cement concrete pavement.

Maintenance

The maintenance community must contend with aging transportation infrastructure, dwindling numbers of employees, limited financial resources, and increased requirements to integrate environmental considerations into activities. Maintenance proponents are responding with new technologies and procedures and an emphasis on the basic engineering principles of infrastructure preservation.

According to several maintenance and chief engineers, preserving the infrastructure and optimizing the network level of service (LOS) will require a shift in the balance of funding, from capacity and alignment improvements to reconstruction and asset preservation. Agencies are developing new maintenance management systems that incorporate asset management concepts along with infrastructure needs. Some would like to integrate maintenance management into the systems for pavement and bridge management.

More agencies are implementing quality assurance (QA) programs that can serve as management tools to identify problem areas, prioritize maintenance projects and resources, and monitor agency and contractor performance. Several have had difficulties with contractor performance levels for reactive maintenance tasks and for emergency response.

The "mix of fixes" approach to pavement preservation—coordinating reconstruction, rehabilitation, and preventive maintenance activities—is paying dividends in several states.[7] The three-pronged approach improves network condition, optimizes funds, and balances the remaining life of the network pavements to ensure manageable workloads with the funds available. Challenges include determining the right time to apply treatments for the maximum benefits and maximum return on investment and then evaluating performance based on the "life-extending value imparted to the pavements" instead of on how long the treatments will last.

During tight financial times, a preservation program is critical to ensure financial and LOS benefits. Several agencies have requested guidelines, methodologies, and best management practices for the implementation of preventive maintenance treatments. Monitoring network pavement condition and coordinating maintenance and construction activities are key elements in implementation.

[7] Galehouse, L. Strategic Planning for Pavement Preventive Maintenance: Michigan Department of Transportation's "Mix of Fixes" Program. *TR News*, March–April 2002, pp. 3–8.

Several agencies have benefited by applying preservation programs to structures—changing assessments from structure sufficiency ratings to a health index. Experience has shown that delaying maintenance on bridges shortens the life of bridge elements.

One agency expressed the need for improved nondestructive tests to assess structural element conditions and to avoid expanding the scope of work and the associated costs under contract. Several states are developing specifications to address problems with pavement marking paints and to apply life-cycle costing and performance measures for pavement marking.

Inland Waterways

The U.S. commercial inland waterway system directly serves 38 states and is the optimal mode for shipping many bulk commodities. However, more than half of the operating locks on the system are more than 50 years old—well beyond their design life.

The aging infrastructure impedes the efficiency of barge transportation and could be a factor in influencing growth in the volumes of agricultural and energy commodities.

Institutional Constraints

Current institutional arrangements constrain the orderly development, operation, and coordination of U.S. transportation, including facilities, modes, and services.

Federal legislation established metropolitan planning organizations (MPOs) to ensure that transportation projects and programs follow a comprehensive, cooperative, and continuing planning process. MPOs are required in every urbanized area with a population of more than 50,000.

Representatives of local governments and transportation authorities work through the MPO to evaluate and approve transportation projects, develop regional transportation plans, develop programs for projects, track air quality conformity, and conduct technical studies. The MPO provides a forum and staff to support interagency cooperation and encourages public involvement throughout the planning process. MPO responsibilities increased with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) and TEA-21.

In response to population growth measured by the 2000 Census, more than 45 new MPOs will be added in the next few months. The formal designation caught some communities by surprise, while others already had begun organizing. The new MPOs bring the national total to approximately 400. Most will be in small but growing regions and will have small budgets, few staff (often also working for a local government), but the same responsibilities as the larger MPOs. State DOTs and local governments have 12 months to establish the agencies and three years to meet all of the planning requirements.

Waterborne commerce on Upper Mississippi River makes maximum use of locks that in some cases are more than 50 years old.

The new MPOs face administrative tasks such as hiring staff, deciding whether to share space in an agency, and determining the composition of the policy board—and also face a steep learning curve. The MPO designation changes a community's federal funding for transit and adds new responsibilities. The expansion also affects older MPOs, because the level of funding remains constant within each state, and the available funds now will have to be shared.

Institutional relationships between the public and private sectors continue to spur innovation. The St. Lawrence & Atlantic Railroad's intermodal hub facility at Auburn, Maine, is a good example of a private business working with local, state, and federal government agencies to create a successful business partnership. Built in 1994 under an agreement with the state of Maine and the city of Auburn, the facility expanded to 35 acres in 2001 and handles domestic shipments along with international container traffic from two major ocean carriers.

The U.S. Customs Service plans to designate the facility an official U.S. port of entry for international freight. With customs on-site, the railroad will be able to increase international business from the five deepwater ports served by the connecting Canadian National Railway, as well as shipments from Maine's paper and forest products industries.

FINANCE

The financing of publicly provided transportation infrastructure is not adequately matched to use or need.

Reauthorization

The most important finance issue for state DOTs is the upcoming reauthorization of the legislation supporting surface transportation, aviation, and Amtrak—the reauthorization trifecta. Expectation is that the programs will be maintained without drastic changes—no evidence suggests an alteration of the principles established in ISTEA and continued in TEA-21.

The gas tax continues to be an issue. Federal environmental policies that encourage the use of nonfossil fuels also reduce gas tax revenues. Transportation officials in states that generate large quantities of gasohol—such as Iowa and Nebraska—are trying to balance revenue-generating mechanisms with an awareness of environmental impacts—a difficult approach with the economic slowdown. The problem underscores the call for an alternative to reliance on gas tax revenues to fund transportation projects.

November 2002 Ballot Referenda

In the election of November 5, 2002, citizens in 17 states voted on transportation-related issues addressing more than 40 diverse questions. The results were mixed. Successful transportation ballot issues included the following:

- A one-half cent local sales tax increase to fund public transportation projects (Miami-Dade County, Florida);
- An infrastructure bond approval for light rail, streets, sidewalks, and intersections (Charlotte, North Carolina);
- A property tax increase for regional transportation and ambulance service (Kanawha County, West Virginia);
- The local funding of regional transportation needs (the Fair Share Funding Program, Las Vegas, Nevada);
- An increase in automobile taxes to fund a monorail (Seattle, Washington); and
- A three-tenths of one percent increase in local sales tax to replace state funding cuts (Pierce County, Washington).[8]

In California, voters approved measures to extend a half-cent sales tax for roads and transit (Riverside County); to collect a special tax to offset operator budget deficits (Contra Costa and Alameda counties); and to call on operators to pledge use of state and federal discretionary funds for roadway, bicycle, and pedestrian projects (Santa Clara County).

Some metropolitan plans, however, were put on hold. Nearly half of the ballot issues were rejected, including

- Initiatives to raise local sales taxes for road and transit improvements in Northern Virginia; in the Norfolk–Hampton Roads, Virginia, area; and in Fresno, California;
- Efforts to increase the statewide gas tax to fund highway and transit improvements in Washington State—but voters approved an initiative to reduce vehicle license fees, cutting the Seattle transit agency's budget by 20 percent; and
- Proposals to increase the sales tax to fund a $2.7 billion transportation plan, which promised a 60-mile light rail system, in Hamilton County (Cincinnati), Ohio.

Amtrak

During 2002, intercity passenger and commuter rail services across the country almost came to a halt. Amtrak was about to stop operations nationwide in July, but Congress provided short-term support.

If Amtrak had closed down, intercity passenger rail service would have halted, and commuter rail service contracted to Amtrak in Maryland, Massachusetts, California (Southern California, San Diego, the San Francisco Bay Area, and Sacramento), Virginia, and Washington State would have been affected. In addition, other commuter rail service on Amtrak-owned facilities and rights-of-way would have been curtailed.

States that fund Amtrak services are concerned about additional costs that may be imposed to resolve Amtrak's financial difficulties. Many states use their own funds to support Amtrak operations, and several also have funded capital improvements that benefit Amtrak operations.

Amtrak continues to operate after a near shutdown in July, although funding remains a concern.

[8] Approved in a February 5, 2002, ballot.

Rail and Other Freight Modes

Several states, including Delaware and Wisconsin, have raised the issue of funding for rail freight and passenger rail improvements. Of particular concern is how to gain a dedicated revenue source for rail and freight projects; some state officials have requested research on alternative funding sources.

Transportation Improvement Board

The Washington State Transportation Improvement Board (TIB) offers an example for improving efficiency in the use of available funds for transportation. The TIB invests state gas tax funds (3 cents per gallon from the state gas tax) in local communities through six grant programs serving cities, urban counties, and transportation benefit districts in Washington State.

Each year the TIB identifies and funds the highest-ranking transportation projects based on criteria established for each program. In 2004, 86 separate projects will share $80 million. The range of projects embraces pedestrian safety and mobility; paving and utility programs in communities with populations of less than 5,000; corridors in urban areas; and more.

The TIB program optimizes project delivery by pooling federal funds that otherwise would be distributed in small amounts to many individual projects. State funds then replace the federal funds, with fewer requirements and considerable savings for the communities—particularly small communities. For example, the small town of Mansfield was to receive $25,000 from U.S. DOT for a $500,000 project, but complying with the requirements for use of the federal funds would have cost the town $55,000 to $60,000.

The second critical improvement involves the leveraging of funds to complete projects at a systemwide or corridor-long level. Repaving all the roads or upgrading all the utilities in a small community or making all the necessary transportation improvements in a corridor saves money and allows consistency in design.

DEREGULATION

Consumer benefits from deregulation are threatened by industry consolidation.

Security, capacity, funding, and policy uncertainty are challenges for aviation at the state level. Often considered the nursery for the nation's aviation industry, general aviation has had to contend with the loss of many small, independent airports due to urbanization. Changing cultural and economic conditions, along with security concerns, present additional challenges to this fundamental and traditionally vibrant sector of aviation.

Addressing one of several challenges to the aviation industry, Phoenix Sky Harbor International Airport in Arizona undergoes construction in an effort to manage capacity problems.

The combination of a declining trust fund and the redirection of funding from infrastructure to security have made the past year difficult for most commercial air carriers, with no immediate indications of change. The industry was barely getting by before September 11, 2001, and now has been battered by declining demand, increasing costs, and changing dynamics in security, efficiency, and policy. Heightened security, the new air travel "hassle factor," increased insurance costs, and federal policies make aviation's future hard to divine.

Recovery could be prolonged if terrorist activities increase, or if conflict erupts in the Middle East. The fragile financial position of some large commercial air carriers may not survive such interrelated setbacks as heightened international tensions that boost oil prices, public perceptions that reduce demand, or further restrictions on capital investments.

Despite the major airlines' efforts to increase yields and reduce costs, low-fare airlines are expected to increase market share from levels of 15 percent a few years ago to as high as 30 percent. Several major carriers are experimenting with business models emulating those of the low-cost airlines.

During this period of depressed operations, resources and attention may be diverted from efforts to improve the air traffic control system, which in turn could have a dampening effect if activity returns to previous levels. Not long ago, inadequate capacity was the driving concern—and may be again with an economic and industry recovery.

Aviation forecasting is difficult under such uncertain conditions, and professional forecasters are exploring new tools to provide wider ranges of probability and to offer more flexibility for decision making. Air cargo is expected to increase at a rate faster than the overall economy but is vulnerable to competition from truck and seaborne alternatives.

The many qualitative issues that affect the demand for commercial aircraft have received much attention—including U.S. economic stability, airline prof-

itability, corporate policies and budgets, and security. Short-term inhibitors to aircraft deliveries include demand shocks, such as military conflict, as well as high interest rates and major increases in oil prices. Airline alliances and code-sharing also drive change, as do security measures and travel alternatives.

Business aviation could profit from the turmoil, especially if commercial travel hassles increase and some of the promised low-cost technologies are delivered. For example, small, comparatively inexpensive twin-engine business jets may be available by 2005, offering an alternative for business travelers and others. But questions will arise about security, policy, and the capacity of the air traffic control system to manage the potentially significant increase in flights.

Human Resources

Transportation organizations are having difficulty attracting and retaining the technically diverse personnel needed in the 21st century.

The recruitment and retention of engineers and transportation managers is a top human resources concern for states. The number of students entering civil engineering has been declining. In addition, public-sector pay scales have not kept pace, so that graduates with loan burdens are choosing private-sector employment. Many transportation professionals are retiring, and the pool of qualified candidates for the vacancies is not large.

With increasing workloads and diminishing numbers of in-house personnel, more states have hired consultants to handle engineering and inspection. Contractors are completing 50 to 80 percent of the highway designs in many states, as a result of reductions in the state work force and increases in the need for designs to meet the demands of construction programs.

The states would like to complement the expertise of in-house staff responsible for design with that of the outside contractors. Some are concerned that quality control and policy control can be less effective when outside forces complete the majority of the designs.

Design–build projects are increasing, and many states report favorable results. States are making progress in overcoming liability issues and are initiating pilot projects and monitoring the results of initiatives in neighboring states. Some maintain that design–build project delivery, along with value engineering initiatives, is encouraging innovations among contractors; design engineers can play a significant role in this dynamic.

Georgia performed in-house inspection on 95 percent of its construction projects but is cutting back to 60 percent of projects in 2003. One way to bolster the work force is by allowing former state employees to return as consultants. Arkansas has smoothed the transition from state employee to consultant with a deferred retirement option that allows employees to retire but continue working for the department for five more years. An employee can retire and then return to work as early as the following day under an on-call technical services contract.

The loss of in-house geotechnical expertise is a particular concern. Another concern is limited experience with contractors handling the geotechnical aspects of design–build projects.

States such as Wisconsin and others in the Midwest High-Speed Rail Coalition, planning for improved passenger rail services, would like more technical training for staff on signal systems, on the design of passenger equipment, and on how to make cost comparisons of alternative investments.

Impact of Telecommunications

Telecommunications and information technologies are likely to have significant but uncertain consequences.

State DOTs are adopting web-based systems to reach geographically dispersed employees, private-sector contractors, and the public. Electronic bidding is a common technique to save time and effort. Online accessibility has increased the demand to integrate diverse data sources for comparisons and for clarifying the complexity of relationships. Some initiatives are examining enterprise information flows, business processes, and data models.

Cooperative activities often extend beyond the DOT and its transportation partners. Many governors have established statewide information technology integration plans, often with unified web portals. These initiatives require DOTs to define their unique needs, funding sources, and business environment, as well as to communicate that uniqueness to the state chief information officer.

The U.S. and state DOTs are continuing with research and deployment of intelligent transportation systems (ITS). In addition, MPOs and regional operating organizations have been developing and implementing regional ITS that conform to the national ITS architecture.

PHOTO: SCOTT EKLUND/SEATTLE POST-INTELLIGENCER

Cell phones can be used to track bus schedules and routes.

ITS has gained acceptance within the transportation community. Good information is essential to the successful operation and management of the system and for efficient use by the public. However, the essential real-time transportation data often are not available, and only limited progress has been made in deploying the so-called "infostructure." According to recent studies, approximately 20 percent of the nation's urban freeways and less than 10 percent of urban arterial roadways are instrumented for real-time data collection, and less than 50 percent of the urban freeway system will be instrumented by 2010.

Dependably sharing information between ITS systems is a necessity, as is making information available to the managers and the users of the transportation system. The recently published "National ITS Program Plan: A 10-Year Vision" recommends the development of an integrated transportation information network for users, operators, and decision makers. U.S. DOT has suggested that a major first step should be the establishment of a road- and traffic-oriented national transportation information infrastructure.

TRB, ITS America, and the California DOT sponsored a three-day workshop in August 2002 to establish a foundation for the infostructure program and to create a clear understanding of the issues and approaches to policy, data needs, and implementation of a National Transportation Information Infrastructure.[9]

Barriers to Innovation

Transportation faces formidable barriers to innovation, which are compounded by growing constraints on research investments.

State DOTs continue to find ways to overcome barriers to innovation. Following are initiatives that promise breakthroughs in three different areas: communicating with the public and elected officials, adjusting to severe weather conditions, and refining the use of geotechnical data.

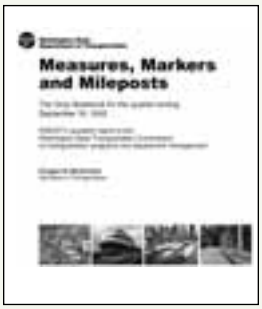
Telling the Story

State DOTs and other transportation professionals are making progress in "telling the story" of transportation to the general public and to decision makers. Understanding transportation system successes, how transportation research improves service, and how transportation agencies are evolving to respond to new public expectations—such as environmental stewardship, air quality, and quality-of-life issues—is critical to financial and public support for transportation.

Telling the story so that the transportation user community grasps the subtleties and trade-offs of each decision is difficult, but anything less prevents the public from making informed decisions. Limited data and a general resistance to funding data collection and analysis often make the task harder. The story itself may vary with the audience and the medium:

- Describing a problem and alternative improvements at public meetings and through various media—for example, for a small portion of the I-69 corridor between Evansville, Indiana, and Henderson, Kentucky, Indiana State DOT presented 9 major alternative routes, with several variations. Each route presented unique environmental, economic, and social impacts, as well as transportation service characteristics.
- Using high-tech tools—GIS and remote sensing imagery are proving to be effective in communicating complex ideas to diverse audiences.
- Educating leaders—after each election, state DOT staff work to educate decision and policy makers about funding sources, transportation programs, and the status of the system.
- Informing voters—transportation budgets may be augmented as a result of funding initiatives on the ballot. Transportation professionals can work to inform voters but must be aware of conflicts of interest.
- Sharing data—other state and local government agencies can use correctly packaged transportation data. For example, Washington State DOT's Transportation Data Office prepares a vehicle speed report, which the State Patrol also uses in speed reduction efforts.

Notable successes have emerged. The Washington State DOT publishes the Gray Notebook,[10] a



Washington State Department of Transportation's Gray Notebook—*Measures, Markers, and Mileposts*—is a quarterly report that keeps the state DOT accountable to the Transportation Commission and the public.

[9] Workshop materials and white papers are available at http://gulliver.trb.org/conferences/INFOstructure/.

[10] Measures, Markers, and Mileposts: The Gray Notebook. www.wsdot.wa.gov/accountability/.

comprehensive quarterly performance report with the premise, "What gets measured, gets managed." The Notebook's "performance journalism" tells both the good and the bad of the transportation story, has a wide distribution, and has generated interest within the state and from other state DOTs.

"Getting information out to the public is a critical issue for all state DOTs," Daniela Bremmer, Washington State DOT's Director of Strategic Assessment, said. "We continue to learn from the public and from our peers as we publish and refine the Gray Notebook."

Adjusting to Weather

Several state and local agencies are participating in AASHTO's Snow and Ice Cooperative Program to develop self-paced, interactive, stand-alone, computer-based training for equipment operators, first-line supervisors, and middle managers on the effective use of road weather information systems and anti-icing procedures.

High-tech winter road services, including road weather information systems and anti-icing technologies, are in development.

Several agencies are participating in a pooled-fund study on the Maintenance Decision Support System (MDSS) for snow and ice control. The MDSS will allow viewing of predicted weather conditions, the effects on road conditions, and the identification of appropriate treatment scenarios with available resources. Several agencies have noted an increase in contractor support for winter services, including the use of GPS on trucks to track plowing and the placement of chemicals, the evaluation of bridge spraying systems to support anti-icing, and the posting of winter roadway condition information for the public on the Internet.

Innovations Below the Surface

Geotechnical engineers routinely collect large quantities of data, for example, in subsurface investigations and in the installation of structural piles. Databases are in development to store the information and to assist in analyzing data, making appropriate recommendations, and providing future reference. Interactive GIS databases and GPS location systems also are of interest to practitioners.

The use of instrumentation for determining in situ soil properties is on the rise. A mechanical stiffness device, Geo-gauge, has attracted attention.

Hazard assessment systems for rock falls continue to develop and improve. Some states have several years of experience with systems designed to address specific concerns, and other states have initiated similar projects. These efforts should produce inventory systems that aid in determining appropriate measures to mitigate rock falls.

Scour prediction, particularly when the foundation soils are cohesive or transitional materials, is also receiving increased attention. Some states are conducting laboratory and field studies to predict scour rates using newly developed equipment. The scour rates estimated with current equipment and equations have not proved accurate.

Taking the Lead

As the many examples in this overview demonstrate, state DOTs and other transportation organizations are taking the lead in addressing today's critical issues in transportation. Challenges abound, but thousands of transportation professionals across the country are working to meet the challenges directly and effectively, to provide a transportation system that is safe, secure, efficient, and sustainable.

NEW TRB SPECIAL REPORT

The Relative Risks of School Travel

A National Perspective and Guidance for Local Community Risk Assessment

PAUL S. FISCHBECK AND BEVERLY M. HUEY

Fischbeck is Associate Professor, Department of Engineering and Public Policy and Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, Pennsylvania. Huey is Senior Program Officer, TRB Division of Studies and Information Services, and was study director for this project.

School transportation safety is often synonymous with school bus safety—when people think about school transportation, they immediately think about school buses. Yet other travel modes—walking, bicycling, parents driving, teenagers driving, and public transit—account for more than half of all school trips.

Each travel mode has its risks, which vary from community to community and from school to school. However, school officials, parents, and students often do not consider the associated risks and choose or encourage the use of school travel modes for reasons apart from maximizing safety or minimizing risk—for example, for convenience, flexibility, or cost savings. But this is changing.

Recent congressional testimony has heightened interest in school transportation safety issues, as have reports and recommendations issued by the National Highway Traffic Safety Administration, the National Transportation Safety Board, and others. The 1996 U.S. Senate hearings on school transportation safety, for example, raised the question of the safety of children who use public transit to and from school. The focus of interest soon expanded to include other modes for transporting students.

The Transportation Equity Act for the 21st Century mandated that the Secretary of Transportation commission the Transportation Research Board (TRB) to examine the safety issues related to the transportation of school children to and from school and school-related activities by various modes. Through the National Research Council of the National Academies, TRB convened a Committee on School Transportation Safety (see box, page 42) to

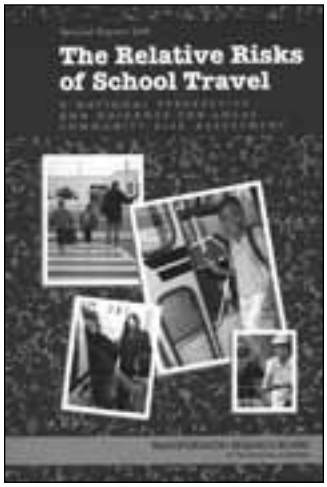
- Review available injury, fatality, and exposure data; and
- Examine other related factors, including operating characteristics, vehicle design, and driver and passenger training.

The committee also was asked to assess the efficacy of drawing conclusions from the available data and—if the data were not available or were insufficient—to recommend a new data collection regimen and guidelines for implementation. *Special Report 269: The Relative Risks of School Travel: A National Perspective and Guidance for Local Community Risk Assessment*, released in June 2002, presents an assessment of the relative risks of each major mode for school travel and provides insights on how changes in the distribution of school trips by mode may affect safety. This is the first study to present clearly the relative risks of the various modes, so that school officials, parents, and students can make informed decisions about how to get to and from school.

Goals and Approaches

The study committee's goal was to produce findings and recommendations that would have practical application to decision making about school travel safety. The committee adopted a two-part approach: a national-level statistical risk assessment of each travel mode and a set of risk mitigation checklists built from the peer-reviewed literature and accepted best practices. This framework allows communities to evaluate school travel alternatives systematically.

Because specific data for comparing the relative safety of narrowly defined individual travel modes are unavailable, insufficient, or inadequate, the committee grouped the modes for school travel into six categories with sufficient data to support the analyses:



Special Report 269, *The Relative Risks of School Travel: A National Perspective and Guidance for Local Community Risk Assessment,* is available from TRB (see Publications Order Form in this issue).

- School buses, including regular and special education pupil transportation services;
- All other buses—transit, paratransit, and motorcoach service;
- Passenger vehicles—motor vehicles excluding school buses and other buses—with drivers at least 19 years old;
- Passenger vehicles with drivers less than 19 years old;
- Bicycles; and
- Walking.

Because data on trip purpose were not available for all modes, the analysis focused on deaths and injuries that occurred during normal school travel hours—6 a.m. to 8:59 a.m. and 2 p.m. to 4:59 p.m., weekdays, September 1 through June 30.

Data Sources

The data used in the analyses were extracted from three main sources:

- Nationwide Personal Transportation Survey (NPTS). Travel information was used to estimate the number of trips taken and the miles traveled by school-age children for all modes.
- Fatality Analysis Reporting System (FARS). Data on all police-reported fatal traffic crashes on public roadways in the United States were used to analyze student fatalities.
- General Estimates System (GES) of the National Automotive Sampling System. A nationally representative, stratified sample of data from police-reported traffic crashes on public roadways, involving property damage, injury, or death, was used to analyze student injuries. The data came from 60 geographic sites across the United States

Exposure to Risk

The NPTS dataset provided estimates of the total trips and distances traveled via each of the modes. The 1995 NPTS survey data show that school bus services accounted for 25 percent of trips and 28 percent of student-miles traveled during normal school travel hours. Other buses—typically but not exclusively transit buses—accounted for another 2 to 3 percent of school trips and of student miles during the same time periods. Trips by passenger vehicles, whether the driver was an adult or a teenager, represented about 60 percent of trips and two-thirds of student miles.

The distance traveled per trip varied by mode. For example, student pedestrian travel accounted for 12 percent of trips but represented only 1 percent of student-miles traveled. These differences are important in analyzing risk measures.

Injuries and Fatalities

Injuries and fatalities to children traveling to or from school are infrequent enough that a single year of data can be misleading. Therefore data from 9 years were combined.

Each year approximately 800 school-age children are killed in motor vehicle crashes during normal school travel hours. This represents about 14 percent of the 5,600 child deaths that occur annually on U.S. roadways and 2 percent of the nation's annual total of 40,000 motor vehicle deaths.

Of these 800 deaths, only about 20 (2 percent)—5 school bus passengers and 15 pedestrians—were school bus–related. Approximately 75 percent of the deaths in crashes occurred in the two passenger-vehicle categories. A disproportionate share of the passenger vehicle–related deaths (approximately 450 of the 800 deaths, or 55 percent) occurred with a teenage driver.

Finally, bicyclists and pedestrians accounted for 22 percent of student fatalities in crashes. Because of the limitations of the source databases, the statistics on student bicyclist and pedestrian crashes represent only accidents in which a motor vehicle was involved.

Approximately 152,000 school-age children are injured nonfatally during normal school travel hours each year. More than 80 percent (about 130,000) of these nonfatal injuries occur in passenger vehicles; only 4 percent (about 6,000) are school bus–related (about 5,500 school bus passengers and 500 pedestrians), 11 percent (about 16,500) occur to pedestrians and bicyclists, and fewer than 1 percent (500) are to passengers in other buses.

The injury estimates and fatality counts for school buses, other buses, and passenger vehicles with adult drivers fall below what would be expected from the exposure to risk implied in the number of trips taken or student-miles traveled. Conversely, injury estimates and fatality counts for passenger vehicles with teenage drivers, for bicycling, and for walking are disproportionately greater than expected. For example, passenger vehicles with teenage drivers accounted for more than half of the injuries and fatalities, a much greater proportion than the 14 to 16 percent that would be expected from the amount of student miles and number of trips.

Injury and Fatality Rates

By combining the estimated number of trips and student-miles traveled by mode with the injury and fatality data by mode, measures of risk can be developed to permit high-level comparisons of relative safety among modes. The highest rate of student injuries and fatalities per trip during normal school travel hours occurred for passenger vehicles with teenage drivers; the next highest rate was for student

cyclists. On a per-student-mile basis, however, school-age bicyclists have the highest injury and fatality rates, with school-age pedestrians next, and then students who travel in passenger vehicles with teenage drivers.

The fatality rates for passenger vehicles driven by teenagers were roughly 8 times higher than the rate for passenger vehicles driven by adults. School buses and other buses have the lowest injury and fatality rates. Figure 1 shows how uncertainty in the underlying data affects the estimates of risk for each mode.

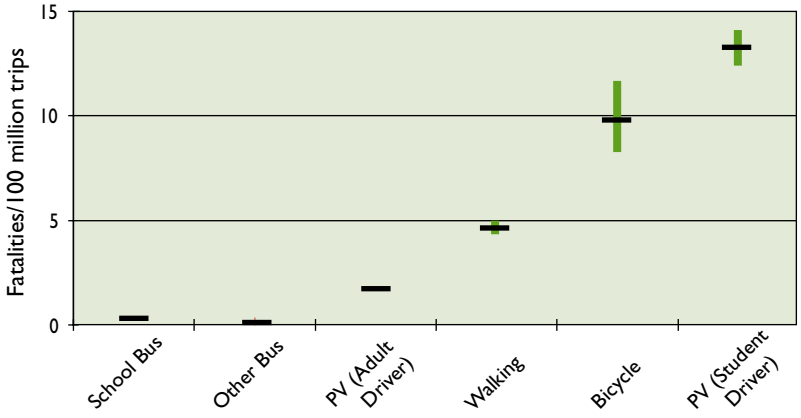


FIGURE 1 Student fatality rates per 100 million trips, by mode, during normal school travel hours, with 90 percent confidence intervals. (Note: Horizontal bars represent best estimates; PV = passenger vehicle.)

Managing Risk

Assessments of the comparative safety of school travel modes and of the options to enhance safety must consider a range of factors: human, vehicular, operational, environmental, infrastructure-related, and societal. Policies at the local, state, and federal levels can control some of these factors; but others—such as age and gender—also must be considered when making policy decisions.

The large differences in risks to school-age children across travel modes suggest that some modes, in general, are safer than others. One approach to lowering the risks, therefore, would be to shift students from modes overrepresented in crashes (bicycling, walking, and passenger vehicles with teenage drivers) to modes that are underrepresented (school buses, other buses, and passenger vehicles with adult drivers).

Results from communities that have implemented specific risk mitigation programs, however, suggest that more can be done to reduce the risks of each of the travel modes. Programs designed to enhance the safety of particular modes—such as new passenger pick-up and drop-off locations at or near the school, enforcing bicycle helmet laws, and implementing and enforcing graduated driver licensing programs—also must be considered.

The risk assessment process developed by the committee combines quantitative estimates of travel mode risk with local student demographics and travel mode distributions to calculate the risk estimates for a school or region. Combining these quantitative risk assessment measures with the safety checklists creates a risk-management framework that can guide decision making on school travel safety.

The framework highlights the effects of changing the relative safety of a particular mode or of shifting students among modes. This can inform local decisions on such matters as school siting, student parking policies, and changes in the minimum walking distance, as well as allocation of available funds for infrastructure improvements.

The framework also can indicate instances in which policy changes to improve one aspect of safety inadvertently increase risks in other areas. However, because the committee's findings are based on national averages and current modal experience, the risk reductions for a local school district implementing a specific risk-mitigation program cannot be determined precisely.

School transportation planners and policy makers at all levels should analyze transportation risks comprehensively in making decisions about school travel.

Application of the results of risk analyses reveals how decisions affecting one mode of school travel influence the risks to users of other modes. These decisions can affect overall risk significantly in ways that may not be obvious. The risk-management framework can highlight the importance and the implications of such choices.

The framework, however, should not stand alone. School transportation planners and policy makers also should take into account budget constraints, local conditions and values, local data, and judgments about the relative safety and cost-effectiveness of alternative policies.

Using a systematic risk-management framework, school districts should identify the most salient risk factors for the modes of school travel used by children in the community and identify approaches to manage and reduce those risks, including shifts to safer modes and safety improvements within each mode.

Each school district, and even schools within a district, will have different conditions and requirements that affect school travel risks and the choices that officials and parents make to reduce the risks. When resources permit, districts should support strategies that promote safety, as appropriate for the school or

Committee on School Transportation Safety

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district. Districts also can adopt policies designed to support walking and bicycling to school to promote healthy lifestyles, after carefully assessing the adequacy of sidewalks, bicycle paths, crosswalks, and other infrastructure and safety measures, and making any necessary improvements.

The U.S. Department of Transportation (DOT) should disseminate information on the relative risks of using various modes of travel for school and school-related activities and on possible ways to mitigate the risks. U.S. DOT also should use this information to assess what role, if any, federal policy makers should have in efforts to improve the transportation safety of school children and the cost-effectiveness of specific safety measures.

State and local legislators, school boards, parent-teacher associations, private and religious schools, parents, students, and the media all play a role in decisions about school transportation. The national-level data presented in the report provide a starting point for decision making by highlighting the considerable differences in risk across modes of travel.

Local risk estimates will differ from these national estimates, however. School officials, state and local officials responsible for transportation facilities and operations, parents, and others need information on how to assess the adequacy of school transportation systems, the relative risks and cost-effectiveness of various safety measures, and how to promote safety cost-effectively across and within modes.

Developing Databases

Many databases contain information related to transportation safety. Most of these databases, however, do not allow comparisons across modes for analyzing exposure to risk. Current data are illuminating, but incomplete.

Obtaining more thorough and complete data, however, can be costly. Of the large number of fatalities and injuries on highways in the United States, the proportion involving school-age children during normal school travel hours is relatively small. Therefore the benefits of additional data collection focusing on school travel should be carefully considered.

U.S. DOT and other agencies should examine and improve the compatibility and completeness of existing databases, to allow development of better risk estimates. To the extent possible, critical data elements—such as vehicle and roadway classifications—should be included and defined consistently in all the datasets.

The NPTS, FARS, and GES are the best available data sources but are not fully compatible because of differing variables, definitions, and classifications. U.S. DOT and other agencies should explore making the definitions and classifications consistent. This would enable development of more precise risk estimates.

U.S. DOT and appropriate agencies, in consultation with outside experts, should analyze the advisability and cost-effectiveness of establishing and maintaining any new database related to school transportation.

The committee encountered difficulties in estimating risk by mode for school travel. Moreover, estimating the risk of travel for school-related activities was not possible, because relevant data were lacking. However, the magnitude of the school transportation safety problem does not warrant major expenditures for new data collection—instead, cost-effective ways to collect new data with current structures should be explored and identified.

Improving Safety

Risk measures can be applied to analyze policy alternatives at state and local levels, and options can be implemented to reduce the risks to students who use the different modes. The goal is to improve safety for all children traveling to and from school and school-related activities and to provide communities with the information to make appropriate choices that balance needs and resources.

TR News Rolls the Odometer —And Keeps Up to Speed

With this issue, *TR News* reaches its 40th anniversary as the chronicle of TRB activities and interests. After two earlier, interrupted launches—first as a monthly from October 1925 until March 1927 and then as a "mimeographed newsletter" from May 1928 until 1933—the magazine series debuted in February 1963 as *Highway Research News*, became *Transportation Research News* in 1974, and then *TR News* on its 20th anniversary in 1983.

The first issue, in the 6.75- x 9.75-in. trim size that was the standard for the next 11 years, promised publication "at irregular intervals," featuring "articles of current or passing interest, notes on research techniques or problems, committee reports, research progress reports, and other such materials." The first masthead page placed the magazine at the mainstream of TRB history, listing leaders later commemorated as namesakes of TRB awards: Fred Burggraf, W. N. Carey, Jr., Pyke Johnson, and K. B. Woods. A paper by another TRB award namesake, Thomas B. Deen (TRB Executive Director, 1980–1994), was cited in the first issue's Urban Transportation Research Digest, and yet another, D. Grant Mickle, appears as editorial staff—and executive director—one year later, in No. 11, March 1964.

Originally set in a reduced-size typewriter font, the *News* was typeset by the third issue, with photographs for an article on "Sign Maintenance in California"—which included "Mr. Clean liquid detergent" among the agents tested. Three editions were published in May 1963, including a forerunner of the theme issue that featured "Five Papers on Thin Bituminous Surfacing."

The publication became a quarterly and underwent its first redesign in June 1965 (No. 19), replacing the table of contents on the cover with the Highway Research Board (HRB) logo—which remained the standard cover design until the Board's name change in 1974. According to an editorial by Mickle, the magazine had "proved somewhat unpopular, primarily… because it lacked a central theme," necessitating a revision of contents. The new formula introduced several departments that remain the core of the magazine: feature articles, News Briefs, Profiles, and Bookshelf, as well as listings of meetings and a section covering National Cooperative Highway Research Program (NCHRP) news.

Design milestones (*left to right*): Issue No. 1, February 1963, with table of contents on the cover; first redesign, which lasted nine years, June 1965 (No. 19); change to new title and to 8.5- x 11-in. size in Summer 1974 (No. 55); and finally as *TR News*, January–February 1983 (No. 104).

1963

1965

1974

1983

The March–April 1981 issue (No. 93) was the first to include the TRB Annual Report (for 1980). From 1977 to 1982, *TR News* also included the Annual Meeting Preliminary Program, until the insert became too unwieldy at 52 pages.

May–June 1982 centenary issue (No. 100) celebrated with yellow type on the cover.

First full-color cover, July–August 1992 (No. 161), signified the importance of ISTEA.

Other *News* mainstays also have a long history. The first photographic coverage of the TRB Annual Meeting Highlights dates to February 1966. The "Research Pays Off" column, which reached its 100th installment in 2001, began in January–February 1983 with "Kansas DOT Saves Its Bridges—and $1 Million Besides." Later that year, the first annual field visit report by the Technical Activities Division staff appeared in the November–December issue.

Feature articles, however, were not the magazine's emphasis until the 1970s—the focus was on news reports, with active departments covering Industrial Research News and Foreign Research News, and back pages devoted to abstracts of published research. Intriguing headlines from 1965, for example, include "West Virginia's Cy Hamill Is Credited with Developing the Dashed Centerstripe" (August) and "Computer Named 'Kathy' May Soon Boss Drivers Using Detroit's Six-Lane John C. Lodge Freeway" (November).

Feature articles moved to the front of the book in Summer 1974 and began to gain distinction with theme issues, histories, future outlooks, policy statements, and explorations of research theory and practice. "The Ten Critical Issues in Transportation," a seminal statement by the TRB Executive Committee on trends that should influence policy and research, appeared in November–December 1976, followed by eight succeeding versions appearing at three-to-four year intervals. As the introduction to the 1981 compilation states, "the usefulness of such a list [is] governed by its periodic updating."

Other feature articles examining research include "Considerations and Guidelines for Research Management" (Winter 1968), an update of a 1951 HRB survey on "how highway departments organized and administered their research programs," by staffer Kenneth E. Cook, discussing such questions as "Why do we need research?" and "How do you select and control research projects?" The September–October 1994 issue presented "A Paradigm for Addressing Change in the Transportation Environment," by Deen and his successor as TRB Executive Director, Robert E. Skinner, Jr., examining the insufficiency of either "technological breakthroughs" or "incremental changes" to produce "a sustainable transportation system."

Skinner also authored "Ten Theses About Transportation Research" in the March–April 1997 issue, citing the "13-year-old series of Research Pays Off articles" to illustrate the first thesis, "research matters." The TRB Executive Director, who first wrote for the *News* in March–April 1984 on the "TRB Study for Geometric Design Standards for Highway Improvements," also has contributed to special issues, including "Transportation–Land Use Interaction" (November–December 1996) and "Research Implications of TEA-21" (November– December 1998).

Feature articles on transportation history have attempted to illuminate current practice. Early examples are "Asphalt Pavements from the Ancient East to the Modern West," by F. N. Hveem (Winter 1971) and "Early American Tunnels," by Robert S. Mayo (September–October 1977). In a January–February 1985 feature, "Welcome Back, McAdam," Damian Kulash, then head of the TRB Special Projects Division, saw the history of macadam roads as an example for the new Strategic Highway Research Program (SHRP) to "focus renewed energy, boldness, and conviction on solving the nation's highway problems." Kulash later became head of SHRP and currently is president and chief executive officer of the Eno Transportation Foundation.

The *News* also has ventured future forecasts. Some early news items may have missed the mark—for example, "Designing the 100 mph Expressway" (Winter 1969), which predicted that "highway transportation systems geared to sustained speeds of 100 mph are possible…for intercity travel by…2000," or the "proposed [pneumatic] tube train, [which] would travel at speeds as high as 300 mph…rapidly, silently, and without pollution" (Winter 1975). Feature articles, however, maintained sobriety: "A Forecast of Bridge Engineering, 1980–2000" (November–December 1979), "Microcomputers and Transportation Team Up: What's Ahead?" (March–April 1983), "Transportation 2020: Developing a Nationwide Surface Transportation Program for the Future" (March–April 1988), "Intelligent Vehicle–Highway Systems: A Vision and a Plan" (January–February 1991), and a special issue on "Transportation in the New Millennium" (November–December 1999).

A series of full-page, full-color covers started in July–August 2000 (No.209).

The January–February 1996 issue (No. 182)—still a showpiece—was dedicated to coverage of TRB's 75th anniversary, and featured a fold-out, wraparound cover, a historic photo of attendees at TRB's 2nd Annual Meeting.

Special issues devoted to a single feature topic became a staple with the January–February 1989 Transportation Safety Issue, which established the model with six diverse features and a related Research Pays Off, and which inspired a two-part follow-up in 1999, covering highways (March–April) and then air, marine, transit, and rail (July–August). Special issues—often produced by standing technical committees—have examined such topics as "Transportation and Air Quality" (May–June 1990), the ramifications of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) (July–August 1992 and 1994), high-occupancy vehicle lanes (January–February 1994 and May–June 2001), SHRP (January–February 1997), transportation information (March–April 1998), the transportation workforce (January–February 1999), geotechnical engineering (March–April 2000), and inland waterways (July– August 2002), among many others.

Two recent issues are notable. Articles in the November– December 2000 issue on Transportation Security: Protecting the System from Attack and Theft became the core content for the website assembled by TRB immediately after the September 11, 2001, terrorist attacks, and were cited in TRB Special Report 270, *Deterrence, Protection, and Preparation: The New Transportation Security Imperative*. A special historical feature on "Frank Turner: Father of the U.S. Interstate Highway System" (March–April 2001), by Bruce E. Seely with contributions by noted transportation leaders Alan E. Pisarski, Kulash, Peter G. Koltnow, and Francis B. Francois, also found a home on TRB's website, which now hosts complete issues on a four-month delay.

Other milestones of the magazine's first 40 years include

◆ Format changes. The News changed to the standard 8.5 x 11 in. size in summer 1974 and adopted a theme color for each year. The first full-color cover distinguished the July–August 1992 special issue on the advent of ISTEA, and full-color covers became the norm in 2000.

◆ The 100th issue (May–June 1982). Featuring articles on high-speed rail in Japan and on research needs of the motor carrier industry, the issue listed the first *News* editorial board—including Robert J. Reilly, now Director of Cooperative Research Programs. Neil F. Hawks, now Director of Special Programs and chair of the editorial board, joined one year later.

◆ The spectacular January–February 1996 edition, commemorating TRB's 75th anniversary. The full-color collector's issue, edited and produced by current Director of Publications, Nancy A. Ackerman, featured a foldout, wraparound vintage cover photograph of participants at the 2nd annual meeting in 1922, as well as memoirs, histories, predictions, interviews, and timelines. L. G. (Gary) Byrd, a past member of the TRB Executive Committee and onetime interim director of SHRP, authored the main feature.

The *News* has served as a vehicle for delivering other related TRB publications, such as the Annual Report (since 1980), the Annual Meeting preliminary program (1977–1982), and research abstracts (1963–1986). The original *News* also listed the first 14 contracts awarded under NCHRP, and NCHRP's Progress Report One appeared in the July 1963 issue.

Finally, in tribute to the "good old days" of the *News*, following are some memorable items from the archive:

◆ A news article in Spring 1975, "Spiral Auto Jump Entertains Moviegoers, May Result in Safer Highways," described the design of a stunt for the James Bond movie, "Man with the Golden Gun."

◆ In July–August 1976, then-editor Hugh Gillespie reported on a supersonic flight from Bahrain to London. He noted that "14 minutes after leaving the runway, the Mach meter registered 1.00…the speed of sound, the barrier that only a few decades ago was considered impenetrable, and I had conquered it with a glass of champagne on one hand and a pencil in the other!"

Champagne and a pencil for *TR News*' 40th anniversary!

—Javy H. Awan
Managing Editor, TR News

Connecticut's Bridge Monitoring Program

Making Important Connections Last

ROBERT G. LAUZON AND JOHN T. DEWOLF

Through a cooperative research program, the Connecticut Department of Transportation and the University of Connecticut are utilizing several monitoring systems to continuously monitor the behavior of in-service highway bridges in both temporary and continuous applications. Response data collected in the past with temporary systems have been used successfully to guide bridge repair decisions, reduce project scopes, and save money. Response data collected with permanently installed systems will be used to define healthy behavior for in-service bridges and to serve as the basis for determining bridge integrity on a continuous basis.

Lauzon is Supervising Materials Testing Engineer, Office of Research and Materials Testing, Connecticut Department of Transportation, Rocky Hill; and DeWolf is Professor, Department of Civil and Environmental Engineering, University of Connecticut, Storrs.

Problem

Transportation authorities are continually challenged to provide and maintain a safe and efficient highway network. Not only are bridges an integral part of the network, they also represent a multibillion dollar investment. To meet this challenge and safeguard this investment, transportation authorities need to understand completely the condition and behavior of the bridge structures, so that the bridges can remain open to traffic, be resistant to the elements, and be undaunted by the millions of loading cycles per year—all with minimal maintenance expense.

Realistically, the high cost of maintenance—often exacerbated by the budget-driven policies of bridge owners—frequently leads to the deferment of routine bridge repairs and preservation measures. These policies can contribute to an occasional bridge failure, which is completely unacceptable and forces more costly actions.

To manage bridges effectively, more needs to be done to assess the day-to-day and long-term condition and behavior of in-service bridges, so that preventive measures can be taken, and deterioration rates can be better understood.

Solution

The Federal Highway Administration and the Connecticut Department of Transportation (DOT) are sponsoring research on the use of state-of-the-art monitoring systems to determine the behavior and condition of in-service highway bridges and to promote a proactive response to maintenance and inspection needs. Two objectives of this research are to provide a reliable supplement to current inspection procedures and to improve the understanding of the behavior of bridges. The scope of this ongoing study includes

- The application of temporary instrumentation to determine in-service behavior and to justify rehabilitation and repair plans, and
- The installation of continuous monitoring systems on bridges of various type, size, and vintage, to record long-term behavior and to develop global condition assessment guidelines.

Application

A monitoring system can determine stress levels in steel members or bridge components and can identify the cause of cracking or fatigue categories applicable to the structure. Temporary monitoring on several large steel bridges has addressed such problems as fatigue cracking in diaphragm connections, cracked secondary connections, main-girder cracking, counterweight support capacity, load rating, overload influence, drive mechanism stresses, and movable bridge member stresses.

In general, the findings have shown that the ability to monitor an in-service bridge on a temporary basis is invaluable for determining specific, economical, and effective repair and rehabilitation plans. Accordingly, continuous monitoring would have a positive influence on the design and management of the entire bridge network.

Continuous monitoring systems have been installed on

- A curved, three-span, continuous cast-in-place concrete multibox-girder bridge;
- A ten-span, continuous precast concrete single-cell girder bridge; and

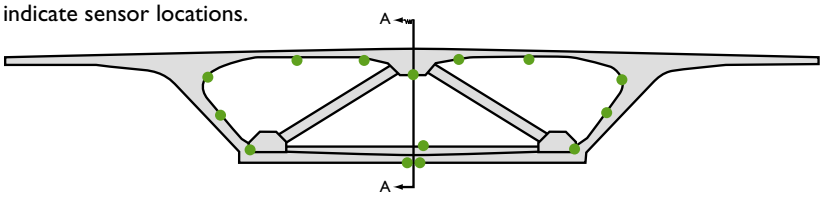

FIGURE 1 Cross-section of bridge being monitored continuously for temperature. Circles indicate sensor locations.

◆ A curved, three-span, continuous steel dual-box girder bridge.

Each system has unique features conducive to monitoring the aspects of each bridge. Sensors—which include tiltmeters, accelerometers, strain gauges, and thermocouples—measure tilt, vibration, strain, and temperature at various locations throughout the structures. The maximum number of sensors on any one bridge is 52—which includes all of the previously mentioned types—and the minimum number is 14 thermocouples. The sensor configuration is based on the needs of the particular bridge.

Bridges scheduled to have continuous monitoring systems installed in 2002–2003 include typical rolled-beam concrete-deck bridges, a multispan continuous bridge, a simple span bridge regularly subjected to heavy loads, a typical precast concrete girder bridge, and a large-deck truss bridge with a suspended span. Additional sensor types planned for these and other bridges include a linear variable-distance transducer to measure the movement of expansion bearings and state-of-the-art strain-monitoring sensors.

Benefits

The benefits of portable monitoring are numerous and quantifiable. Connecticut DOT has decided on rehabilitation options for several bridges from the data collected with the portable monitoring systems (see Table 1).

Through revised rehabilitation plans and in-house data collection, the temporary monitoring has saved more than $3 million since 1997. For example, field data were collected from a steel girder bridge that had cracks in connection angles. Preliminary plans had called for the replacement of approximately 900 angles; however, monitoring showed that was not necessary. The duration of the project was decreased by one year, and the revised plan saved $250,000. On another steel bridge, the number of diaphragms to be replaced was reduced by two-thirds, saving close to $2 million.

Safety benefits were demonstrated by a study of a counterweight hanger on a movable bridge. The analysis of field measurements showed that the hanger was inadequate and strengthening was required. Repairs were made in time to maintain the functionality of the bridge without compromising the safety of the public.

More benefits of continuous monitoring are forthcoming. A system will be installed on a new, major bridge on the historic Merritt Parkway in southwestern Connecticut. The bridge will be the first in the state—and one of the few in the country—with a monitoring system included in the original construction documents. The system will monitor continuously strain, tilt, vibration, and expansion.

TABLE 1 Portable Monitoring System Applications

Town	*Bridge type*	*Problem/Concern*	*Outcome*	*Benefit ($)*
Bridgeport	Steel bridge on I-95	Cracked connections	Fewer repairs	$2,000,000
Wethersfield	Steel bridge	Cracked connections	Repair not required	$250,000
New Haven	Steel moveable	Counterweight hanger	Immediate repair verified	Safety
Norwalk	Steel bridge on Rt. 7	Fatigue cracking	Repair not required	$50,000
Westport	Steel bridge on Parkway	Fatigue cracking	Repair not required	$50,000
Trumbull	Steel bridge	Girder strength	Repair not required	$25,000
Seymour	Steel bridge	Cracked connections	Repair not required	$250,000*
North Haven	Steel bridge	Cracked girders	Repair not required	$10,000
South Norwalk	Bascule bridge	Drive mechanism study	Outside consultant not required	$10,000
Mystic	Bascule bridge	Member forces	Continuing	$25,000
East Haddam	Swing bridge	Member forces	Outside consultant not required	$40,000

**Length of project was reduced by one year.*

Ultimately, continuous monitoring will indicate a bridge's health or integrity. This type of monitoring has the potential to save human life and a tremendous amount of money, considering the number of people who use bridges every day and the volume of commerce that relies on the highway network. Other long-term benefits will be the refinement of design criteria from actual behavior, the development of more accurate deterioration rates, and the availability of more realistic data for bridge management decisions.

For more information contact Robert G. Lauzon, Office of Research and Materials Testing, Connecticut Department of Transportation, 280 West Street, Rocky Hill, Connecticut 06067-3502 (telephone 860-258-0327, e-mail Robert.Lauzon@po.state.ct.us) or John T. DeWolf, Department of Civil and Environmental Engineering, University of Connecticut, 261 Glenbrook Road, U-2037, Storrs, Connecticut 06269-2037 (e-mail John.Dewolf@uconn. edu).

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Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayapra@nas. edu).

Sue McNeil

University of Illinois at Chicago

"My interests in transportation research are very broad, as there is no shortage of interesting transportation problems," says Sue McNeil, Director of the Urban Transportation Center and Professor in the College of Urban Planning and Public Affairs, University of Illinois at Chicago (UIC). Like her graduate students, McNeil must balance "the demands of the formal academic program and research projects" as she covers interests in transportation infrastructure management and applications of advanced technologies, economic analysis, analytical methods, computer applications, and brownfield development.

"I am particularly interested in asset management and improvement of physical infrastructure rather than the planning, design, or construction of new facilities," she notes. "I use the same basic principles and tools for different types of infrastructure. I have developed geographic information systems tools for the Chicago Transit Authority's fixed assets, explored tools to support bridge inspection and assessment for the Illinois Department of Transportation, and performed case studies of asset management in the private sector, funded by the Midwest Regional University Transportation Center."

"…[D]espite the effort involved, [interdisciplinary research] solutions are more likely to be workable, and the approach provides…some personally enriching experiences."

McNeil sees the "close working relationships with the local, regional, and state agencies involved in transportation" as vital to university-based research: "These links are critical to ensuring that academia stays relevant and addresses real problems."

McNeil is energized by teaching, which she defines as "not just classroom instruction, but guiding student research, advising, and mentoring." She has taught "at all levels" in her career, focusing now on graduate education at UIC: "The opportunity to develop close working relationships with talented graduate students is one of the real perks of academia," she observes.

Another perk is the opportunity for collegial teamwork: "Most transportation problems require an interdisciplinary solution. Much of our research is collaborative, and effectively working in teams, managing these teams, and structuring the research to recognize the contributions of a variety of disciplines is a challenge," she states. "However, despite the effort involved, the solutions are more likely to be workable, and the approach provides each of us with some personally enriching experiences."

McNeil's long list of publications, presentations, and reports shows a variety of coauthors and of subjects—at the recent TRB Annual Meeting, for example, she coauthored three papers for presentation, working with a total of nine colleagues. A variety of agencies and institutions have awarded grants and contracts to her team projects, including the National Institute for Occupational Safety and Health, the Illinois Transportation Research Center, the Federal Transit Administration, the U.S. Environmental Protection Agency, and the National Science Foundation.

McNeil's dedication to her students earned the Benjamin Teare Teaching Award in 1994, and she was named Outstanding Civil Engineering Professor of the Year by the American Society of Civil Engineering (ASCE) Pittsburgh Chapter in 1992. She sets a model of professional accomplishment for her students—she was a National Science Foundation Presidential Young Investigator (1987–1992) and received a doctoral dissertation fellowship from the American Association of University Women.

Before her appointment as director of the Urban Transportation Center in 2000, McNeil was Professor in the Departments of Civil and Environmental Engineering and of Engineering and Public Policy at Carnegie Mellon University, Pittsburgh, Pennsylvania, where she earned her M.S. and Ph.D. degrees in civil engineering. She also was Braun Intertec Visiting Professor in the Department of Civil Engineering at the University of Minnesota for 1999–2000, and has taught at Princeton University and at Massachusetts Institute of Technology. She earned bachelor's degrees in mathematics and in civil engineering at the University of Newcastle, New South Wales, Australia.

McNeil's professional involvement and leadership extends to ASCE, initiating and chairing the Committee on Transportation Facilities Management (1988–1993), and serving as Associate Editor for the *Journal of Infrastructure Systems*. She has been a member of the TRB Task Force on Transportation Asset Management, the standing committees on Vehicle–Highway Automation, Conduct of Research, and Applications of Emerging Technology—among several others—and is a member of two National Cooperative Highway Research Program project panels on asset management.

With her personal and professional investment in research, teaching, and volunteer leadership, McNeil has identified an additional outreach project: "introducing kindergarten through 12th grade students—particularly girls and young women—to engineering. I look forward to doing more of this in the future."

Thomas E. Bryer

Pennsylvania Department of Transportation (retired)

Thomas E. Bryer, who retired in April 2002 after almost 40 years with the Pennsylvania Department of Transportation (DOT)—the last 18 as Director of Highway Safety—continues as an active proponent of highway safety research. "Targeted and quality research is essential to give us the knowledge and insight to identify new, effective safety strategies and countermeasures that can reduce deaths and injuries dramatically," he says.

Bryer currently serves as Chair of the National Cooperative Highway Research Program (NCHRP) Project Panel 17-18(3), Guidance for Implementation of the American Association of State Highway and Transportation Officials' (AASHTO) Strategic Highway Safety Plan. Participants in the NCHRP 17-18 initiative are consolidating knowledge and information gained from previous research on the most effective safety strategies for 18 emphasis areas (for example, run-off-the-road crashes, aggressive driving, pedestrian-related accidents, rural emergency management, and signalized intersections) and are developing guidance documents.

"Targeted and quality research is essential to give us the knowledge and insight to identify new, more effective safety strategies and countermeasures that can dramatically reduce deaths and injuries."

According to Bryer, the guidance documents, combined with an integrated management process and a technology transfer delivery plan, will provide state and local governments with the tools needed to improve safety substantially.

"I am convinced that these 'low-hanging fruit' are sufficient to realistically and cost-effectively reach AASHTO's goal of reducing the annual death rate by 5,000 to 7,000. However, products and tools alone will not get us there," states Bryer.

"At the national, state, and local level, in addition to a determined commitment to safety, we need to be receptive to innovative solutions and to deploying cost-effective countermeasures systematically," Bryer adds. "With only a modest commitment of human and financial resources, the strategies can be deployed for substantive statewide gains. The benefits are tremendous—large numbers of men, women, and children continuing to walk this good earth who otherwise would have perished."

From a long-range perspective as cochair of the National Research and Technology Partnership's Safety Working Group, Bryer also spearheads activities to develop and implement a National Safety Research Agenda. He and his colleagues have gathered researchers, managers, and practitioners from federal, state, and local governments, universities, and private-sector research organizations and are laying the foundation for an integrated safety research process that has the potential to increase substantially the effectiveness of future safety research.

He advocates a four-point approach:

- Gain consensus among researchers, managers, and practitioners to identify key knowledge gaps;
- Promote collaboration among universities; federal, state, and local governments; and private-sector research organizations to close the knowledge gaps more quickly and more effectively;
- Strive to improve the quality of research: establish protocols, provide more effective training for researchers, set realistic scopes of work for the available funds, select appropriate performance measures, and preserve the integrity of data in research efforts; and
- Develop a better delivery system from the practitioner's viewpoint. "Practitioners need to receive important new safety information generated from research that relates to their job function. They should not have to wade through countless research documents to find the needle in the haystack," Bryer observes. "Also, a more concerted technology transfer effort needs to be launched to better ensure that important research findings are being implemented."

From 1984 to 2002, Bryer was director of Pennsylvania DOT's Bureau of Highway Safety and Traffic Engineering program; he also served as coordinator for the Highway Safety Program. Previously he was manager of program development at the Center for Program Development, where he was responsible for development and management of the statewide, federally funded transportation plan. He was assistant director of the Bureau of Traffic Engineering from 1969 to 1982.

In addition to his role as Chair of the NCHRP Project Panel on the AASHTO Strategic Highway Safety Plan Implementation Support, Bryer participates on other TRB project panels and committees, including the NCHRP Project Panels on a Strategic Plan for Improving Roadside Safety and on Detailed Planning for Research on Making a Significant Improvement in Highway Safety; and the standing committees on Traffic Signal Systems and Traffic Records and Accident Analysis.

He received a bachelor's degree in civil engineering and a master's degree in engineering from Pennsylvania State University.

NEWS BRIEFS

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Highway departments that use the Maintenance Decision Support System—a weather information tool—can deploy snowplows and improve road conditions with increased effectiveness and reduced costs.

Data Plow Before Snow Plows

The U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) has produced a sophisticated weather information tool, the Maintenance Decision Support System (MDSS), to assist winter road maintenance managers in predicting the impact of adverse weather conditions and in planning treatments. With assistance from the U.S. DOT's intelligent transportation systems program, FHWA built on various approaches now in use in the winter maintenance community to develop MDSS.

The system combines standards of practice with the latest weather models and forecasting techniques. Advanced winter prediction capabilities can present recommended courses of action. The system displays maintenance alternatives and the resulting benefits, allowing highway departments to deploy snowplows and improve road conditions effectively while reducing response costs. The system also will lead to more efficient use of chemicals, reducing the impact on the environment.

INTERNATIONAL NEWS

Securing Borders, Moving Freight

Shenzhen Customs of Shenzhen, China, is implementing a new intelligent border-crossing application—part of a multimillion-dollar automatic vehicle and driver detection and identification system—to facilitate the flow of low-risk traffic and goods while assisting customs agents in combating smuggling between Hong Kong and mainland China.

The system will assign unique electronic identity numbers—encoded in tamper-resistant wireless communication windshield tags—to drivers and vehicles. One tag is mounted permanently on the windshield and one tag is assigned to the driver. The driver inserts the driver tag in a hanger mounted on the windshield. As the driver and vehicle approach the customs lane, the reader reads both tags, and a match is made.

Using the lane-mounted readers to scan all vehicles automatically, the system allows identification and screening of low-risk, compliant vehicles and drivers, who can pass quickly through the border checkpoint. Customs personnel can screen out rapidly any noncompliant, high-risk vehicles for further inspection.

Information provided by the International Bridge, Tunnel, and Turnpike Association.

TRB HIGHLIGHTS

National Academies Announces 2002 Associates

The National Associates of the National Academies program recognizes extraordinary contributions to the National Academies through pro bono service to National Research Council and Institute of Medicine programs.

Individuals recognized have served with distinction on committees of the National Academies. Membership in the Associates is for life, and new designations are made annually.

The following TRB veterans were recognized in the 2002 class of National Associates:

Donald S. Berry (*deceased*)
Peter F. Bontadelli, Jr.
Michael S. Bronzini
Forrest M. Council
Frank L. Danchetz
Mortimer L. Downey
William L. Garrison
Genevieve Giuliano
Jose A. Gómez-Ibáñez
David L. Greene
Robert N. Hunter
Peter G. Koltnow
A. Scheffer Lang (*deceased*)
Herbert S. Levinson
Ysela Llort
Craig Marks
John R. Meyer
M. Granger Morgan
Michael M. Ryan
Thomas B. Sheridan
Alison Smiley
Alan M. Voorhees

IN MEMORIAM

Donald S. Berry
1911–2002

Donald S. Berry, a member of the National Academy of Engineering and a 2002 inductee into the National Associates of the National Academies, devoted his professional life to education and research in traffic and transportation engineering. During World War II, he was selected by the Federal Bureau of Investigation to teach courses in major cities throughout the country on how to manage transportation and traffic control in case of damage from wartime blackouts and air raids. Berry spent 12 years as a transportation engineer and later was Director of the Traffic Division at the National Safety Council in Chicago, Illinois, before beginning a career in academia.

As a professor, he helped organize graduate programs in transportation engineering at the University of California–Berkeley, at Purdue University, and at Northwestern University, where he taught for 22 years. While at Northwestern, he served as Chair of the Department of Civil Engineering.

Berry's activity in TRB extends back to the days of the Highway Research Board. A member of several TRB technical committees, he served on the Executive Committee from 1962 to 1967 and was Chair in 1965.

Northwestern University has established the Donald S. Berry Memorial Fund to assist transportation engineering students to attend the TRB Annual Meeting.

A. Scheffer Lang
1927–2003

An expert in railroad economics, technology, and policy, A. Scheffer Lang pioneered the use of computers in railroad operations. As a professor, he was an advocate for research and innovation in transportation and was a founding member of the Massachusetts Institute of Technology Center for Transportation Studies (now known as the Center for Transportation and Logistics).

Lang worked for the Denver and Rio Grande Railroads, the U.S. Army Corps of Engineers, and the New York Central Railroad. As director of data systems for New York Central, he conceived, designed, and implemented the first real-time operating data systems in the rail industry.

He was deputy undersecretary of commerce for transportation research from 1965 to 1967. When the U.S. Department of Transportation was established, Lang became the nation's first federal railroad administrator. He later served as senior researcher at the Association of American Railroads.

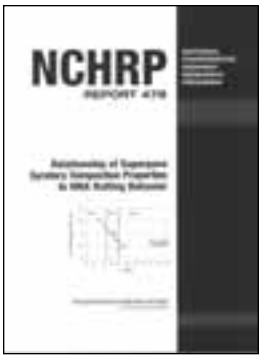
From 1978 to 1979, Lang chaired the TRB Executive Committee and then served as an ex officio member from 1979 to 1981. He also was a member of TRB's Committee on the Identification of Transportation Data Needs and Measures for the Facilitation of Data Flows.

Bryant Mather
1916–2002

Bryant Mather, one of the nation's foremost experts on concrete, specialized in concrete research. His distinguished career included such honors as induction into the National Academy of Engineering, presenting the second TRB Distinguished Lecture (on "Concrete in Transportation: Desired Performance and Specifications"), and Honorary Life Membership in the American Museum of Natural History. Mather was a successful amateur entomologist and seven species of insects have been named "matheri" in his honor.

In 2000, Mather retired as director of the Structures Laboratory at the U.S. Army Engineer Research and Development Center's Waterways Experiment Station in Vicksburg, Mississippi; he had worked for the U.S. Army Corps of Engineers since 1941, first as a geologist and later as an engineer. After retirement, he remained director emeritus of the Structures Laboratory, continuing to write technical papers and to participate in technical societies.

Active in TRB since the early 1950s, Mather served on many TRB committees and panels. He also was a member of the Strategic Highway Research Program's Concrete and Structures Advisory Committee.



Recommended Performance-Related Specification for Hot-Mix Asphalt Construction: Results of the WesTrack Project
NCHRP Report 455
WesTrack—an experimental test road facility at the Nevada Automotive Test Center—was constructed under an FHWA project for accelerated field-testing of hot-mix asphalt (HMA) performance-related specifications. The Report presents an overview of the WesTrack experiment; a detailed description of the experiment's principal product, an HMA performance-related specification; and a summary of observations. The WesTrack team—a consortium of seven public- and private-sector organizations—conducted the project.

2002; 496 pp.; TRB affiliates, $26.25; nonaffiliates, $35. Subscriber categories: pavement design, management, and performance (IIB); materials and construction (IIIB).

Guidelines for Design and Operation of Nighttime Traffic Control for Highway Maintenance and Construction
NCHRP Report 476
The Report presents guidelines to assist highway agencies in developing night work plans that provide for public and worker safety and satisfy the community, while minimizing waste and other problems associated with the supply of materials and capable workers. The guidelines contain innovative procedures suggested by state departments of transportation (DOT) to respond to special nighttime problems such as glare control, visibility of workers, and the conspicuity of traffic control devices.

2002; 120 pp.; TRB affiliates, $13.50; nonaffiliates, $18. Subscriber category: maintenance (IIIC).

Relationship of Superpave Gyratory Compaction Properties to HMA Rutting Behavior
NCHRP Report 478
The Report relays findings from an investigation into the relationship between any property of HMA measurable with the Superpave gyratory compactor and the rutting behavior of HMA pavements in service. The main finding is that the parameter $N\text{-}SR_{max}$, the number of gyrations at maximum stress ratio, may be used within certain limits to identify mix designs likely to show gross instability under the shear stress produced by traffic.

2002; 59 pp.; TRB affiliates, $11.25; nonaffiliates, $15. Subscriber category: materials and construction (IIIB).

A Guide to Best Practices for Achieving Context-Sensitive Solutions
NCHRP Report 480
Discussion focuses on how state DOTs and other transportation agencies can incorporate context-sensitive solutions into transportation project development. The guide is applicable to the variety of projects that transportation agencies routinely encounter. Example project documents are included on the accompanying CD-ROM, CRP-CD-23.

2002; 138 pp. + CD-ROM; TRB affiliates, $15.75; nonaffiliates, $21. Subscriber category: highway and facility design (IIA).

Guidelines for Selecting Compensatory Wetlands Mitigation Options
NCHRP Report 482
Guidance is offered on selecting the best compensatory strategies to mitigate the effects of transportation projects on wetland habitats. Case studies illustrate the process used by state DOTs to mitigate unavoidable wetland losses. The steps needed to develop a wetland banking program are outlined, with examples of banking agreements used across the United States.

2002; 47 pp.; TRB affiliates, $11.25; nonaffiliates, $15. Subscriber categories: planning and administration (IA); energy and environment (IB); highway and facility design (IIA).

Strategies for Improving Public Transportation Access to Large Airports
TCRP Report 83
Presented are the results of the second phase of a two-phase research effort. First-phase results were published as *TCRP Report 62: Improving Public Transportation Access to Large Airports*. Report 83 identifies strategies to improve public transportation access to large airports through market-based planning and improved management of ground access. A six-step process for a market-based strategy is outlined in the final chapter.

2002; 141 pp.; TRB affiliates, $15.75; nonaffiliates, $21. Subscriber categories: planning and administration (IA); public transit (VI); aviation (V).

e-Transit: Electronic Business Strategies for Public Transportation—Volume 1: Supply Chain: Parts and Inventory Management
TCRP Report 84
TCRP Report 84 comprises a series, documenting techniques used in electronic business strategies for public transportation. Volume 1 examines the supply-chain concept, clarifies terms, and identifies strate-

gies used by nontransit fleets to reduce investments in parts and inventory while increasing fleet availability. Discussed are the impact of asset-management decisions on parts and inventory management and strategies for streamlining the supply chain. Nontransit fleets with practices recommended for emulation are identified.

2002; 31 pp.; TRB affiliates, $12.75; nonaffiliates, $17. Subscriber category: public transit (VI).

e-Transit: Electronic Business Strategies for Public Transportation—Volume 2: Application Service Provider Implementation Guidelines
TCRP Report 84
This volume presents the results of an investigation into transit agency use of application service providers (ASPs)—enterprises that host, manage, upgrade, operate, and provide network access to applications—and of thin client computing technologies—software architectures that concentrate business and processing applications on a central server, limiting the client to user interface displays. The characteristics, market position, and strengths and weaknesses of ASPs and thin client computing are examined.

2002; 34 pp.; TRB affiliates, $11.25; nonaffiliates, $15. Subscriber category: public transit (VI).

Public Transit Board Governance Guidebook
TCRP Report 85
A reference tool on transit board organization and composition, the guidebook reviews the structure and practices of transit boards; offers information on board-selection methods and board size, length of service, and composition; and includes information on the primary role and activities of the board and the role of the chair. There are guidelines for determining the responsibilities of board members, along with a description of the characteristics of effective boards. A companion piece, *TCRP Web Document 21* (available online), focuses on the research findings.

2002; 30 pp.; TRB affiliates, $11.25; nonaffiliates, $15. Subscriber category: public transit (VI).

Assessment and Rehabilitation of Existing Culverts
NCHRP Synthesis 303
The deterioration of pipes and culverts is a growing problem for transportation agencies. As transportation drainage infrastructures age, the need for repair or rehabilitation has become critical, and the number of pipes and culverts needing repair or rehabilitation has increased. This Synthesis was initiated to determine the state of the practice in pipe condition assessment, selection of appropriate repair and rehabilitation methods, the management systems used with an agency's assessment program, the storage of inspection and maintenance records, prediction of the service life of pipes, and material specifications for repairs. In addition, the study provides information on how agencies have incorporated assessment and corrective work into the larger transportation management system.

2002; 74 pp.; TRB affiliates, $11.25; nonaffiliates, $15. Subscriber categories: bridges, other structures, hydraulics and hydrology (IIC); materials and construction (IIIB); maintenance (IIIC).

Driveway Regulation Practices
NCHRP Synthesis 304
Most state transportation agencies have some form of driveway regulations to regulate construction within the rights-of-way of state highways. Driveway regulation practices, however, vary. This Synthesis surveys driveway regulations and summarizes state and local permitting practices, identifies the impacts of driveway regulation, and defines issues in current practice and the lessons learned. Case examples illustrate state and local driveway regulation programs.

2002; 77 pp.; TRB affiliates, $12; nonaffiliates, $16. Subscriber categories: highway operations, capacity and traffic control (IVA); safety and human performance (IVB).

Interaction Between Roadways and Wildlife Ecology
NCHRP Synthesis 305
Transportation development creates challenges for wildlife conservation. The industry must provide safe and efficient transportation in an environmentally sound manner. This Synthesis reviews the interactions of the construction, operation, and maintenance of roadways with ecological systems and wildlife. Qualitative information about processes, effects, analytical tools, conservation and mitigation measures, maintenance, and funding is provided. The regulatory context and the planning and development processes addressing the regulations are discussed.

2002; 78 pp.; TRB affiliates, $12.00; nonaffiliates $16. Subscriber categories: energy and environment (IB); safety and human performance (IVB).

Customer-Focused Transit
TCRP Synthesis 45
Some public transportation stakeholders perceive that customer-service strategies of public transportation agencies lag behind those of other public and private service providers. This Synthesis reviews what public transportation agencies believe are the most customer-focused strategies and assembles the experiences of

selected agencies in attempting to develop and implement agencywide, results-oriented, customer-focused programs. The report examines and documents the effectiveness of customer-focused activities in four categories: general interaction between the customer and the public transportation systems, obtaining and using customer input, involving employees in customer-focused public transportation, and achieving customer satisfaction.

2002; 100 pp.; TRB affiliates, $12.75; nonaffiliates, $17. Subscriber category: public transit (VI).

High-Occupancy Vehicle Systems and Demand Management 2002
Transportation Research Record 1781
This volume introduces and describes the conceptual framework of PAMELA, a parking analysis model for local areas. Other traffic-based tools presented include the commuter choice benefits calculator (a web-based tool for estimating costs and benefits of commuter programs) and the toll network capacity calculator (an operations management and assessment tool for toll network operators).

2002; 55 pp.; TRB affiliates, $20.25; nonaffiliates, $27. Subscriber category: highway operations, capacity, and traffic control (IVA).

Marine Transportation and Port Operations
Transportation Research Record 1782
Safety, marine traffic management, port redesign, and innovative shipment technologies are discussed. Specific case studies examine relevant research on the Port of Pittsburgh Practicum Project, the feasibility of a container-on-barge network along the Texas Gulf Coast, the expansion of the Port of Rotterdam, and issues related to fast vehicle ferries in the Alaska Marine Highway System.

2002; 122 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: marine transportation (IX).

Transportation Network Modeling 2002
Transportation Research Record 1783
The performance, designs, and risks and rewards of a variety of transportation network models are examined. These include the multiclass continuous-time equilibrium model for departure time choice on a single-bottleneck network, the combined model for time-dependent trip distribution and traffic assignment, function models for real-time dynamic traffic assignment operations, and the analytical dynamic traffic assignment model with probabilistic travel times and perceptions, among others.

2002; 196 pp.; TRB affiliates, $37.50; nonaffiliates, $50. Subscriber category: planning and administration (IA).

Statistical Methodology: Applications to Design, Data Analysis, and Evaluation
Transportation Research Record 1784
Research results are reported on an analysis of crash precursors on instrumented freeways, methodologies for analyzing collision experiences associated with speed limit changes on selected California highways, simulations to predict the safety and operational impacts of increasing traffic signal density, and other related topics.

2002; 158 pp.; TRB affiliates, $36; nonaffiliates, $48. Subscriber category: safety and human performance (IVB)

Railroads: Intercity Rail Passenger Transport; Track Design and Maintenance
Transportation Research Record 1785
This volume tracks studies on financially internalizing passenger rail–generated nonuser benefits, improved spiral geometry for high speed-speed rail and predicted vehicle response, simulations to evaluate rail sleeper replacement alternatives, and opportunities and challenges in regionalizing the Northeast Corridor.

2002; 70 pp.; TRB affiliates, $23.25; nonaffiliates, $31. Subscriber category: rail (VII).

Geology and Properties of Earth Materials 2002
Transportation Research Record 1786
Part 1 addresses the quality control of improved soils, including an analysis of the amperage and treatment time monitoring to evaluate stone column effectiveness and a case study on the resilient modulus of the Minnesota Road Research project subgrade soil. Part 2 examines landslide risk and hazard assessment; case studies include linking New Hampshire's rock cut management system with a geographic information system and the development of New York State Department of Transportation's rock slope procedures and rockfall assessment tools. Part 3 presents research on corrosive soil conditions, frost effects, and soil suction.

2002; 128 pp.; TRB affiliates, $31.50; nonaffiliates, $42. Subscriber category: soils, geology, and foundations (IIIA).

Geomaterials 2002
Transportation Research Record 1787
Papers focus on the performance evaluation of cementitious stabilized soils, chemical and mechanical stabilization, and base materials and performance and aggregate shape characterization. Specific studies include cold in-place recycling and full-depth strengthening of clay-till subgrade soils, the feasibil-

ity of geosynthetic inclusion for reducing swelling of expansive soils, and the quantification of coarse aggregate angularity based on image analysis.

2002; 124 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: soils, geology, and foundations (IIIA).

Aviation: Airport and Air Traffic Economic and Operational Issues; 2002 TRB Distinguished Lecture
Transportation Research Record 1788
Part 1 features "Perspective on Our National Air Transportation System: Past, Present, and Future," the 2002 TRB Distinguished Lecture by Francis X. McKelvey. Part 2 explores airport and air traffic economic and operational issues, including the parking requirements for relocated airports, an analysis of factors affecting the occurrence and severity of air traffic control operational errors, restricting the use of reverse thrust as an emissions reduction strategy, and how airport context and service are related to general aviation aircraft operations.

2002; 137 pp.; TRB affiliates, $31.50; nonaffiliates, $42. Subscriber category: aviation (V).

Bituminous Paving Mixtures 2002
Transportation Research Record 1789
A comparative study of laboratory and field performance of several applications of crumb rubber–modified hot-mix asphalt in Louisiana is the first topic addressed in this volume on materials and construction. Other research focuses on a historical overview (covering 1939–2001) of the challenges of gyratory compaction, a comparison of fundamental and simulative test methods for evaluating permanent deformation of hot-mix asphalt, and the application of digital image correlation method to mechanical testing of asphalt–aggregate mixtures.

2002; 224 pp.; TRB affiliates, $49.50; nonaffiliates, $66. Subscriber category: materials and construction (IIIB).

Freight Transportation 2002
Transportation Research Record 1790
Papers cover international comparisons of e-business challenges for intermodal freight, the integration of freight transportation with intelligent transportation systems, the long-term availability of railroad service for U.S. agriculture, and more.

2002; 109 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: freight transportation (VIII).

Transit: Buses, Paratransit, Rural Public Buses, and Intercity Transit; New Transportation Systems and Technology; Capacity and Quality of Service
Transportation Research Record 1791
Research reports cover the effect of computer-assisted scheduling and dispatching systems on paratransit service quality, the planning and design of flex-route transit services, new intelligent transport systems applications in Europe to improve bus services, and transit user perceptions of the benefits of automatic vehicle location, with several case studies.

2002; 133 pp.; TRB affiliates, $31.50; nonaffiliates, $42. Subscriber category: public transit (VI).

Sustainability and Environmental Concerns in Transportation 2002
Transportation Research Record 1792
Topics include U.S. dilemmas and European experiences involving sustainable transportation, trials and successes of covered bridge engineering and construction, a comparison of measured and modeled sound levels in the vicinity of traffic noise barriers, and a comparison of transverse-tined and longitudinal diamond-ground texturing for newly constructed concrete pavement.

2002; 128 pp.; TRB affiliates, $31.50; nonaffiliates, $42. Subscriber category: planning and administration (IA).

Transit: Intermodal Facilities, Rail Transit, Commuter Rail, Light Rail Transit, Maintenance, and Ferry Transportation
Transportation Research Record 1793
Papers present information on encouraging kiss-and-ride at commuter railroad stations, the need for a new commuter car entranceway design for mixed high- and low-level platforms, a heuristic analysis of impacts of commuter rail station consolidation on pedestrian access, and the tram-train.

2002; 118 pp.; TRB affiliates, $27; nonaffiliates, $36. Subscriber category: public transit (VI).

Safety and Maintenance Services
Transportation Research Record 1794
This four-part volume addresses work zone safety, signing and marking materials, winter services, and roadside management. Among the specific issues cited are the distribution and characteristics of crashes at different work zone locations in Virginia, an evaluation of snow removal service in four Japanese cities and residents' willingness to pay, and a benefit-cost analysis case study on soil bioengineering as an alternative for roadside management.

2002; 104 pp.; TRB affiliates, $25.50; nonaffiliates, $34. Subscriber category: maintenance (III).

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 to 4,000 words (12 to 16 double-spaced, typewritten pages), summarized briefly but thoroughly by an abstract of approximately 60 words. Authors should also provide appropriate and professionally drawn line drawings, charts, or tables, and glossy, black-and-white, high-quality photographs with corresponding captions. Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may help readers better understand the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographic or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information is used. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing. Readers are also invited to submit comments on published points of view.

CALENDAR covers (*a*) TRB-sponsored conferences, workshops, and symposia, and (*b*) functions sponsored by other agencies of interest to readers. Because of the lead time required for publication and the 2-month interval between issues, notices of meetings should be submitted at least 4 to 6 months before the event. Due to space limitations, these notices will only appear once.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, and price. Publishers are invited to submit copies of new publications for announcement, and, on occasion, guest reviews or discussions will be invited.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

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