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.

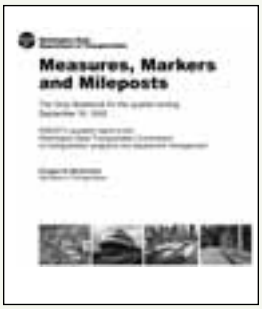
Telling the Story

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.