

Managing Change in TRANSPORTATION

THE TRANSPORTATION RESEARCH BOARD'S 2000 FIELD VISIT PROGRAM

Specialists in the Transportation Research Board's (TRB's) Technical Activities Division identify current concerns and learn about activities in 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

- ◆ Learn about the problems organizations are facing and supply pertinent information from states, industry, or educational institutions to help solve these problems;
- ◆ Learn about research in progress or in planning and exchange information on similar efforts, preventing duplication;
- ◆ Identify new methods and procedures that also might apply elsewhere;
- ◆ Identify innovative or experimental work not widely published but deserving attention;
- ◆ Describe TRB's range of services to new staff at the transportation agencies that support TRB; and
- ◆ Identify potential candidates for TRB committees.

Through the 2000 field visits and information from other sources, the TRB Technical Activities Division staff identified issues, concerns, and recent program changes in transportation.

At the transition to the new century, state DOTs and other transportation organizations are in a transition from trying to understand and cope with change to managing change. This is a theme that emerged in field visits by TRB staff in 2000, after a decade of change started by the Intermodal Surface Transportation Efficiency Act (ISTEA) and continued by the Transportation Equity Act for the 21st Century (TEA-21), now at midpoint.

Managing Systems

Applying research from TRB and others, transportation departments are adopting business management techniques to manage and operate transportation resources as integrated systems. Transportation at all levels is focusing not only on facilities but also on dealing with policy issues, system management and preservation, operation, performance, customer needs and issues, financial and fiscal efficiency, the environment, and livability. The systems management approach is evident in many areas:

- ◆ Many states are developing and implementing maintenance management systems that incorporate customer input, record the condition of assets, and forecast workloads in the context of outcomes.
- ◆ Transportation officials at all levels are applying new management techniques to a range of transportation assets in response to public, agency, and legislative expectations. These assets include the physical infrastructure (e.g., pavements, bridges, and airports) and also an agency's financial capacity, human resources, equipment and materials, real estate, and corporate data and information.
- ◆ Several state DOTs are evaluating and implementing fleet management systems to monitor maintenance operations and to support decision making with information on equipment downtime costs and cost-avoidance analyses.
- ◆ Several state DOTs are developing total storm management techniques for winter services, effectively and efficiently integrating and coordinating workforce activities in response to changes in storm and traffic conditions.
- ◆ Intelligent transportation system (ITS) technologies for transit are improving customer information systems and the management of equipment and operations.
- ◆ State-of-the-art cargo-handling equipment and communications technology are maximizing throughput and minimizing transloading times and costs for intermodal freight.

- ◆ With freight railroads at near capacity in many corridors, companies are seeking operational and technological solutions to facilitate joint operations.

- ◆ A national dialogue has begun on transportation operations, “to manage and operate the transportation system so that its performance meets or exceeds customer expectations.” Led by the Federal Highway Administration (FHWA) and the Institute of Transportation Engineers (ITE), the dialogue has involved TRB, transportation agencies, universities, and the private sector.

Connecting with Customers

These new management systems also rely on performance measures. As DOTs focus on continuous delivery of services in addition to the implementation of individual projects, effective performance measures are necessary for decision making. A November 2000 TRB conference sounded a key point—performance measures must be understandable not only to DOTs but also to customers.

State DOTs are increasing emphasis on connecting with customers—the traveling public, the private sector, and elected officials. Some DOTs have hired public relations firms to improve communication with customers. Several states are using market research to monitor progress and to inform and educate the public.

Increased customer involvement has expanded transportation department objectives beyond the improvement of mobility and safety to consider livability and environmental issues. Some examples follow:

- ◆ Transportation planning now comprises land-use planning, economic development, and social equity.

- ◆ The federal government and many states are identifying ways to improve efficiency and reduce delays in project development while ensuring environmental protection.

- ◆ More states are interested in context-sensitive design and are balancing flexible approaches with the objectives of safety and efficiency.

- ◆ A new federal aviation law has increased funding for noise abatement projects, created a new environmental streamlining program similar to TEA-21, and is funding a program to encourage airports to use low-emission vehicles.

- ◆ The U.S. Army Corps of Engineers has requested the TRB Marine Board to explore the process for determining “environmental windows”—the time during which the ecological impacts of dredging will be minimal.

Applying Research Results

States are applying research results to improve performance of traditional functions:

- ◆ By 2001, more than 80 percent of hot mix asphalt tonnage on state DOT projects will be Superpave, a product of the Strategic Highway Research Program (SHRP).

- ◆ Another major SHRP product, High Performance Concrete (HPC), is gaining acceptance.

TRB has joined with state DOTs and other partners to lay the groundwork for research programs to help transportation departments address emerging issues such as:

- ◆ Strains on the capacity and safety of the transportation system due to demographic and economic trends;

- ◆ Workforce retention and recruitment;

- ◆ Outsourcing and contracting, including design-build projects and other innovative approaches; and

- ◆ Partnering with city and county governments.

On the highway side, TRB’s research-guiding efforts include the development of the Future Strategic Highway Research Program (F-SHRP) and the National Research and Technology Partnership Forum.¹ These efforts will generate information valuable to Congress and other decision makers setting the agenda for highway research. The TRB field visit program has played an important role in developing proposals and in helping to set the research agenda for transit, rail, aviation, marine, freight, and other transportation modes.

Addressing Institutional Issues

Key institutional issues raised in field visits and related activities involved management and administration, education, finance, environmental concerns, and planning.

Management and Administration

The 2000 field visits included interviews with the chief executives of state DOTs. A frequent topic was the environment of unprecedented change and the need to adapt ways of doing business.

In June 2000, TRB conducted a workshop in Minneapolis, Minnesota, on Managing Change in State Departments of Transportation. Sponsored by

¹For more information on the status and activities of F-SHRP and the partnership forum, see TRB’s website (www.national-academies.org).



State CEOs and other senior managers of state DOTs participate in TRB workshop in Minneapolis, Minnesota, June 2000. AASHTO President Thomas R. Warne told the group, “There is no question that change is upon us. However, we have to make a choice . . . it can happen to us or we can lead it.”

TRB, AASHTO, FHWA, and the Minnesota DOT, the workshop offered a peer-to-peer exchange among senior management from 30 state DOTs. Three principal themes emerged: strategic planning, workforce and reorganization, and process and program delivery.

Strategic Planning

Participants agreed on the importance of connecting strategic planning to the needs and expectations of the customers—the traveling public, the private sector, and elected officials. Several DOTs are employing public relations firms to improve communication with customers.

In addition, strategic planning must include performance measurements linked to budget, work program design, and resource allocation. For example, if performance indicators show that maintenance is falling behind and that customers are unhappy, resources might be moved from new construction to maintenance.

Workforce Issues

Workforce issues are a concern at most DOTs, with several contributing causes: increased resources and work as a result of TEA-21, shortages of qualified specialists, downsizing, retirements, competition for staff from the private sector, and legislative caps on staffing. Many DOTs have increased their outsourcing, raising questions about what should be contracted out and what core competencies should be retained. Attracting and retaining employees might involve raising salaries or establishing other incentives.

As DOTs adopt new technologies and ways of doing business, training becomes a priority; but training sometimes enables departures for better paying jobs.

“Some ask, ‘Why are we training people who are just going to leave?’” Tom Warne of Utah DOT

observed at the workshop. “We should also ask, ‘What if we don’t train them and they stay?’”

Some DOTs have adopted succession-planning programs to cope with the pending retirements of large numbers of key employees.

Innovative Practices

Workshop participants agreed that DOTs must find new ways of doing business. Many are evolving into contracting organizations and must create innovative contracting procedures, partnering practices, and incentives to ensure successful outcomes and the best use of public funds. Others are gaining operating efficiencies by partnering with city and county governments to share work and extend workforces.

Consequently, participants stressed that the quest for quality and performance in a rapidly changing environment required receptivity to change and also experimenting with new practices and organizational concepts.

In a special session of the workshop, DOT chief executive officers (CEOs) identified five areas for continued cooperation:

1. Knowledge,
2. Research,
3. Training,



Workforce retention and recruitment are major concerns for DOTs at all levels.

4. Scans (i.e., site visits to view best practices and innovations) and twinning (i.e., partnering for mutual education), and

5. Coping with federal, state, and local regulatory and statutory changes.

After the CEO session, staff from the states and FHWA, along with TRB committee members, drafted 22 priority research statements to assist states in managing change. Of these, eight have been selected for immediate implementation, and AASHTO—through the National Cooperative Highway Research Program (NCHRP)—has hired contractors to produce scans for AASHTO's Annual Meeting in December 2000.

Finance

The dramatic increases in motor fuel prices in 2000 were a major source of financial concerns for state DOTs. Governors and legislators provided citizens relief by cutting the state and federal fuel taxes that provide the bulk of revenues to support the management, development, and operation of the transportation system. In Connecticut, for example, the state fuel tax was cut by 12 cents, although the money was restored to the DOT from the state's general fund.

The volatility in fuel prices probably will continue, with additional impacts on the motor fuel tax. Several state DOTs are exploring alternative means of financing their programs.

An Environmental Protection Agency requirement prohibiting use of a fuel additive, MTBE, may have worsened the matter. The most likely replacement for this additive, ethanol, receives special tax treatment that could reduce the revenues from fuel taxes substantially.

To study these emerging issues, TRB sponsored the Second National Conference on Transportation Finance in Scottsdale, Arizona, in August 2000, with FHWA, the Federal Railroad Administration (FRA), and the Federal Transit Administration (FTA) as cosponsors, along with six other cooperating sponsors. More than 500 public and private sector transportation finance experts met to hear presentations on innovative practices and emerging issues and to propose and discuss financing solutions. A conference proceedings will be available in March 2001.

Education

A shortage of qualified engineers—a problem raised in the CEO workshop—reechoed at many of the universities visited by TRB; civil engineering professors and department heads report difficulty in attracting students—especially Americans—into graduate-level transportation engineering pro-

grams. One explanation is the attractiveness of careers in information technology, particularly the high salaries paid to entry-level professionals compared with engineers.

William A. Wulf, president of the National Academy of Engineering, presented another perspective in a recent interview (*Science and Government Report*, September 15, 2000). Dr. Wulf noted that the total number of students enrolled in university engineering programs today is 20 percent less than in 1985; at the same time, the number of information technology professionals is “falling behind by 200,000 per year.” According to Wulf, students decide at an early age to forgo core math and science skills, precluding technical careers.

Wulf also noted that the percentage of women in engineering leveled off at just below 20 percent five years ago. In addition, he pointed to “a double-digit drop in the number of African Americans in engineering since 1993.”

These trends suggest that the engineering profession in general—and transportation in particular—must undertake an organized effort to expose primary and secondary school students to the attractions and rewards of a technical career.

Planning

At the state level, transportation planning is changing focus from facilities to policy issues, system management and preservation, systems operation, system performance, customer needs and issues, financial and fiscal efficiency, the environment, and livability. Planning has expanded to include land use, economic development, and social equity, and the scope embraces rural areas, substate areas, multistate initiatives, international corridors, and multipurpose planning (see sidebar, page 23).

Environmental Concerns

Many state DOT environmental offices have observed scant progress on the TEA-21 requirements for streamlining environmental review. In response, NCHRP has started a project, “Monitoring, Analyzing, and Reporting on the Environmental Streamlining Pilot Projects,” to evaluate 10 state DOT efforts. The study will identify ways to improve efficiency and reduce delays in project development while ensuring environmental protection.

State DOT concerns about environmental requirements coalesced during the comment period on the planning and National Environmental Policy Act (NEPA) regulations issued by FHWA and FTA in May 2000. AASHTO criticized the proposed rules for intertwining the requirements of Title VI of the Civil Rights Act and the Executive Order on

Trends in Statewide Transportation Planning

1. Land-use considerations.

States are adopting many different approaches in considering the impact of land-use development, and state DOTs have different roles in these efforts. Common to all, however, is an increase in the dialogue among transportation agencies, land-use agencies at the state and local levels, and the private sector. The two central questions are how do transportation and land use interact and how can they interact?

2. Integrating environmental concerns into the planning process.

National Environmental Policy Act (NEPA) considerations sometimes enter into planning and resource agencies must be involved. Developing a process that offers permitting agencies specific time frames for input and that provides a mechanism for conflict resolution has been helpful in projects that must meet multiple objectives; this also has reduced project development schedules. Sharing, loaning, and hiring staff in resource agencies has expedited product review.

3. Goods movement and intermodal issues.

Although states have made progress in dealing with goods movement, pressure continues for a better understanding of the changing dimensions and impacts of freight demand and supply. However, the private sector also must understand federal and state policies, programs, and procedures. There is a critical need for improved tools for freight data and analysis.

4. Planning at different levels.

Planning in rural areas, integration with metropolitan planning organizations (MPOs), substate planning in MPO areas, tribal national planning, multistate planning, international border and corridor planning, and access to parks and public lands represent different levels or contexts for many statewide planning programs. Because these planning efforts are expected to continue

and increase, the integration and coordination of these efforts are a concern.

5. Integration of management and operations into statewide planning.

States have made progress in framing the issues—identifying the barriers and coordination points; however, this continues to be a challenge; institutional issues are the most difficult to reconcile.

6. Performance-based planning.

NCHRP Research Project 8-32(2)A, “Multimodal Transportation Development on a Performance Based-Planning Process,” has helped agencies move toward performance-based planning. The issues continue to be outputs versus outcomes, measuring multimodal outputs, and outcomes for facilities not responsible to the DOT.

7. Safety issues.

TEA-21 requires statewide planning to consider safety issues. Several states are integrating safety considerations into planning; some states are developing safety management systems. New concepts are emerging, such as inherent safety, sustainable safety, and safety-conscious planning.

8. Environmental justice and related issues.

The federal regulation on environmental justice has raised concern at the state and metropolitan levels for its effects on transportation planning. Several test cases regarding environmental justice are being closely monitored.

9. Measuring the impacts of changing demographics.

Many states are concerned about how to measure the impacts of changing demographics—such as immigration, aging of the population, leisure travel, and temporal distribution—on travel demand and integrate the results into statewide planning.

Environmental Justice. According to AASHTO, the result would “present major conceptual, practical, and legal problems that are likely to escalate dramatically.”

Other comments claimed that the proposed new rule for air quality conformity would make the process “less flexible and more bureaucratic.” Moreover, critics stated that the provisions for streamlining the NEPA process would increase the size and complexity of the environmental impact statements for major projects.

AASHTO recommended temporarily retaining the current planning, NEPA, and 4(f) regulations; calling on Congress for oversight hearings; and requesting U.S. DOT to make comprehensive revisions and issue a revised notice of proposed rule-making.

Highways

Design

More states are interested in context-sensitive design. Introduced in a 1997 FHWA document, “Flexibility in Highway Design,” the concept focuses on designing a facility with sensitivity to the context of the surrounding community and requires the early and continuous involvement of stakeholders.

Some states are seeking the relaxation of strict standards in the AASHTO “Green Book,” especially for lower volume roadways. The states are questioning whether the standards in the “Green Book” are valid, tested, and required, or if there is flexibility—a reasonable and safe basis for narrower pavements, shorter sight distances, and steeper grades. However, many states prefer to adhere to the recognized “Green Book” values, especially for legal accountability.

Pavement design has emphasized rehabilitation. Rapid, automated, and nondestructive testing of pavement surface condition, structural support, and thickness is essential. The profession is moving toward designing pavements through mechanistic principles, calibrated with local empirical data.

The long-term pavement performance database from SHRP and information from state pavement management systems are providing data not only for calibrating analytical tools, but also for improving predictions of pavement performance. States are looking forward to the revised 2002 AASHTO guide for pavement design (NCHRP Project 1-37).

In bridge design, states are slowly adopting the load and resistance factor design (LRFD) specifications, developed under an NCHRP project and adopted by AASHTO’s Highway Subcommittee on Bridges and Structures. Training has been ongoing but often is not followed by LRFD projects, de-

creasing its effectiveness. In addition, states need improved computer programs to facilitate LRFD design—for example, to provide 3-D visualization. Most states have completed investigations of scour susceptibility and have adopted mitigation techniques at bridge piers and foundations.

The trend of outsourcing design work to the private sector often is accompanied by—or results from—staff reductions at the agencies. States report concern about the quality control of consultant work. Design-build projects are gaining prominence in states that do not have laws restricting the practice; many states have achieved successful results.

States generally are using criteria in NCHRP Report 350, “Recommended Procedures for the Safety Performance Evaluation of Highway Features,” in selecting roadside safety appurtenances. However, there is concern about the magnitude of the effort to upgrade the hardware as well as about legal aspects and future revisions. FHWA is working toward the international harmonization of testing and evaluation for roadside safety features. The way of the future in certifying roadside safety hardware probably involves computer simulation of impacts, which is attracting widespread interest.

More states are changing from metric units back to U.S. customary units of measure. Some state legislatures have passed laws directing agencies to continue to use U.S. customary units; often this is in response to contractors’ and suppliers’ resistance to metric units. A few states, however, are proceeding with metric units in construction plans and specifications.

Materials and Construction

Highway construction is surging in many states due to TEA-21 and state bond issues. South Carolina, for example, has launched one of the most aggressive state construction programs, compressing 200 projects—which normally would take 27 years to complete—into 7 years at a cost of \$5 billion. The U.S. House of Representatives recently passed an appropriations measure recommending a 7 percent increase in federal highway funding for 2001 (\$30.7 billion).

Many states do not have adequate staff to handle the increased workload and most cannot hire new employees. As a result, states increasingly are contracting with consultants for construction inspection and with private laboratories for testing; reducing the frequency of sampling and testing; shifting quality control to contractors; increasing the use of materials certification; and hiring temporary employees. To avoid hiring several hundred employees for a seven-year period, South Carolina

DOT contracted with two construction management firms to oversee its ambitious program.

Design-build road and bridge projects are gaining acceptance, particularly among states represented in the Western Association of State Highway and Transportation Officials. Colorado's \$1.6 billion Southeast Corridor Project involving Interstates 25 and 225 in Denver is one of the latest to use design-build.

Most states comply with FHWA's Code of Federal Regulations 637, which requires that all quality control and quality assurance personnel on National Highway System projects be trained and qualified. All but six states completed the technician qualification requirements by the June 29, 2000, target date. All but a handful of states saw the need for reciprocity, forming five regional training and certification groups: the Western Alliance for Quality Transportation Construction, the Multi-state Training and Certification Group, the New England Transportation Technician Certification Program, the Mid-Atlantic Region Technician Certification Program, and the Southeast Task Force for Technician Training and Certification.

Speeding Up Construction

Practically all states, whether urbanized or rural, are concerned with rapid construction, since delay to motorists is related to local traffic volumes. States look to pertinent NCHRP projects for guidance and assistance.

◆ NCHRP Project 10-49, nearing completion, is drafting technical provisions for improved contracting methods—such as cost-plus-time bidding, lane rental, warranties, incentive and disincentive provisions, and nighttime construction—for states to consider for use in their bidding documents.

◆ A recently initiated NCHRP 20-24 project is studying ways to avoid delays during the construction phase of highway projects.

◆ A follow-up project to NCHRP Reports 390 and 391, "Constructibility Review Process for Transportation Facilities," is developing a procedure for states to determine the costs and benefits of constructibility reviews. This project could provide incentive for more states to use constructibility reviews—only about 25 percent now do.

SHRP Products

The implementation of Superpave is on schedule. All but four states had implemented the binder specification by the end of 2000, and most states had adopted the mixture specifications by 2000 or shortly after. The Superpave lead states project that by 2001 more than 80 percent of the hot-mix asphalt tonnage on state DOT projects will be



TRB field visit representatives viewed the Interstate 85 project through the center of Salt Lake City, Utah. The project involves research to test concrete structures as they are torn down for replacement.



Superpave. Several NCHRP projects are working to bring Superpave research to a close by 2005.

Another major SHRP product, HPC, is gaining state acceptance, particularly for bridge projects. Many states now use either conventional-strength HPC with improved durability for bridge decks or high-strength HPC for girders. A few use HPC for both superstructures and substructures. Approximately one-third of the states are engaged in HPC bridge projects sponsored by FHWA; however, only eight states have FHWA-sponsored projects involving HPC in pavements.

Soils, Geology, and Foundations

Monitoring and repair of landslides along major transportation corridors is a major task for many state DOTs. Excessive water in the embankment and cut slope material is the cause of the majority of these landslides. An innovative approach to alleviate the pore water pressure uses wick drains as horizontal drains; the results are promising.

Other materials under investigation for stabilizing slopes and controlling surface erosion are quick lime, kiln dust, portland cement, fly ash, and posts made of recycled plastic. Another emerging technique uses time domain reflectometry to quantify the depth and magnitude of slope movements.

To reinforce and strengthen the ground, closely spaced steel bars are installed into slopes or excavations during construction. This technique, known as soil nailing, has gained interest among state DOTs. Most states have completed or are in the process of designing and constructing at least one soil nailing project. Although a temporary measure, soil nailing in recent years has become a cost-effective, long-term solution for unstable slopes. In such cases, shotcrete generally is used as facing.

State DOTs have worked hard to meet the federal requirement for qualified technicians to conduct soil and aggregate sampling and testing. Regional state DOT organizations have developed technician training and certification programs.

Several state DOTs are evaluating in situ test devices—such as the dynamic cone penetrometer, the falling weight deflectometer, and the stiffness gauge—to determine the modulus of subgrade materials. The objective is to use the modulus as a control for compaction of embankment fills, determine the density of subsurface material, and specify in-place quality control of cement or fly-ash treated base material. FHWA has support from more than 20 states for a pooled-fund study to evaluate the stiffness gauge. If it proves satisfactory, this gauge could become an alternative to the nuclear gauge for measuring density.

Databases that support geotechnical activities are gaining favor. For example, there are efforts to create such databases as a geographic information system landslide inventory, a storage of information from boreholes and cone penetrometer tests, bridge scour data, and more. FHWA is developing a comprehensive database on deep foundations load tests.

Maintenance

Maintenance of the transportation infrastructure has gained importance in the new millennium, with emphases on work zone safety, maintenance and fleet management, recruitment and retention of maintenance workers, outsourcing, performance measures, bridge management, pavement preservation, and total storm management for winter services.

The safety of the traveling public and roadway workers remains the highest priority. Several states are using quality initiatives to improve work zone safety, increasing enforcement of speed limits, using raised pavement markers to improve guidance, communicating with drivers through variable message signs, and evaluating “smart road” technologies that improve safety. Many states have enacted legislation to double fines for speeding in work zones; excessive speed and aggressive behavior are significant factors in high accident rates.

Many states are developing and implementing maintenance management systems that incorporate customer input, record the condition of assets, and forecast workloads within the context of outcomes and asset management. To support these activities, agencies are updating their inventories of infrastructure features and implementing quality assurance statistical sampling to evaluate maintenance statewide.

Several state DOTs are implementing new fleet management systems to monitor operations and support decision making with such information as the total cost of equipment downtime as well as cost-avoidance analyses. Agencies are reporting savings through engine oil analysis programs.

Recruiting and retaining maintenance employees are problems for state DOTs and contribute to the outsourcing of work. In other countries, the outsourcing of maintenance work through long-term contracts has offered the potential to achieve consistent funding, to develop and apply advanced engineering systems and tools, and to employ business management techniques in the transition from a reactionary to a preventive maintenance program.

State DOTs are working together to develop common performance measures for roadway main-

tenance, primarily for roadway surface, signing and pavement marking, shoulders and roadsides, safety features and appurtenances, snow and ice control, and roadside drainage. The results will provide a benchmark for continuous quality improvements in maintenance activities. Several states are using market research to monitor progress and to inform and educate the public.

State DOTs are implementing bridge management systems; PONTIS is the preferred software. Several DOTs have computerized bridge inspection procedures and have numbers of inspection cycles sufficient to develop deterioration models. Several states are digitizing design and construction drawings for placement in a computer database and are investigating the use of management software to access and manipulate bridge data.

Fiber-reinforced plastic (FRP) wrap is being evaluated for concrete bridge elements; FRP might provide lightweight replacements for elements. Several DOTs implemented scour countermeasures after detecting problems in their bridge evaluation programs. Bridge health assessments; evaluation of bridge deck replacement alternatives; and installation of sensors to gather, display, and analyze real-time bridge performance measures also were noted.

Many states are developing and implementing pavement preservation programs to reduce the inventory of deficient pavements, extend the pavement life cycle, and gain consistent and adequate funding. One state DOT's preservation program has a goal of resurfacing 10 percent of its pavements each year, following the basic philosophy that excellent pavements are products of periodic maintenance even before signs of distress. To minimize disruptions to the traveling public, much of the pavement and shoulder maintenance is performed at night and during off-peak hours.

Several state DOTs have developed total storm management techniques for winter services, integrating and coordinating workforce activities in response to changing storms and traffic conditions. Snow Belt states expend 20 to 30 percent of their maintenance budget on winter services. Improved techniques, materials, equipment, and management can provide savings in lives, property, and expenses, and minimize impacts on the environment. Road weather information systems are a key to total storm management, providing real-time information about driving surface conditions.

Several DOTs are experimenting with devices to measure the coefficient of friction on driving surfaces. The impact of winter maintenance chemicals on the environment is a major issue, and many state DOTs are working with other agencies to develop emergency response procedures and programs.



Field visits in 2000 took TRB staff far into the U.S. hinterland—for example, to Alaska's Dalton Highway (*above*), the “haul road” or “ice road” between Fairbanks and Prudhoe Bay. Built as the access and service road for the Alaska Pipeline (*below*), the compacted gravel road freezes solid in winter—and the speed limit remains frozen for hundreds of miles (*left*).



Safety

Reducing Fatalities

After slight declines in crash fatalities on the highways for 1997 and 1998, the nation recorded another relatively small change. With traffic volume ever increasing, the fatality rate fell to another low—1.5 fatalities per 100 million miles driven. However, the costs of injury and death, as well as of congestion and associated conditions, remain dismayingly high—totaling more than \$175 billion per year.

Several states are implementing the AASHTO Highway Safety Strategic Plan, which has a goal of reducing the number of deaths by 4,000 to 7,000 by 2004. An NCHRP project and a pooled fund provide support for guidance to states in several safety areas. Several interested states are pilot-testing the guidelines.

The AASHTO plan also identified several mainly short-term research needs. With that as a base, the Safety Working Group of the National Research and Technology Partnership Forum developed a draft agenda for short- and long-term safety research. If funded, the National Safety Research Agenda would produce information, ideas, techniques, and methods that would reduce precipitously the numbers of highway crashes, injuries, and fatalities.²

Pavement Marking

Removal of pavement markings, particularly in work zones, has been a safety concern for many years, but successful removal techniques have been elusive. Research conducted by the University of Florida for the Florida DOT evaluated three promising methods. Ultrahigh-pressure water blasting efficiently removed even the most durable thermoplastic markings without significant scarring of the pavement surface. Operator skill was crucial for these results, but training provided the needed proficiency.

Preventing Drunk Driving

Legislative solutions to traffic safety problems are often controversial and opportunities to evaluate the solutions together are rare. Several states and the federal government passed laws to address driving while intoxicated (DWI).

After the signing of the transportation appropriations bill for FY 2001, U.S. DOT Secretary Rodney E. Slater emphasized the provision requiring states to adopt a standard of .08 blood alcohol content (BAC) to determine driver intoxication. States have until October 1, 2003, to pass a .08 BAC “per se” law to meet the provisions for a federal incentive grant; otherwise, 2 percent of their federal highway

construction funds will be withheld. States that do not pass a .08 BAC law by October 1, 2004, will lose 4 percent of their federal highway construction funds; 6 percent after October 1, 2005, and 8 percent per year after October 1, 2006. States that lose funding in 2003 can regain it if they pass the .08 BAC law by 2007.³

According to the National Highway Traffic Safety Administration, a 170-pound man can consume approximately four drinks in an hour on an empty stomach before reaching a .08 BAC. A 137-pound woman could drink three drinks in one hour on an empty stomach before reaching a .08 level. Studies show that the fatal crash risk at .08 BAC is at least 11 times that of a sober driver and that at .10 BAC the risk rises sharply to at least 29 times that of a nondrinking driver.

New Mexico passed an omnibus bill to strengthen its DWI laws and create a stronger anti-DWI environment. The bill included a lower BAC level (from .10 to .08) and zero tolerance (.02 BAC) for those under 21 years of age; created a new aggravated DWI offense (more than .15 BAC); increased penalties for driving on a revoked license; increased taxes on alcoholic beverages; increased penalties for service to minors; implemented statewide sobriety checkpoint blitzes; and created a DWI program fund.

An interrupted time series analysis of the effect of the omnibus bill found a 19.25 percent decrease in drunk-driving fatal crashes. Five surrounding states concurrently experienced a 3.52 percent increase, lending support to the hypothesis that the New Mexico reduction was due in part to the new legislation and enforcement programs.

Ohio passed laws for both administrative license suspension and vehicle sanction (i.e., immobilizing the vehicle for up to 90 days). Evaluation suggests that both laws are effective in reducing the occurrence of driving under the influence (DUI). For example, 99 percent of first- and second-time DUI offenders received license suspensions; recidivism rates dropped from 12.28 to 5.9 percent; DUI offenses declined 60 percent for offenders during vehicle impoundment and 56 percent afterward.

Licensing

An evaluation of the Nova Scotia graduated driver licensing (GDL) program, started in 1994, found a

²The draft agenda is available on the Internet at <http://gulliver.nationalacademies.org/~R&T>

³To date, 18 states and the District of Columbia have enacted .08 BAC laws (Alabama, California, Florida, Hawaii, Idaho, Illinois, Kansas, Kentucky, Maine, New Hampshire, New Mexico, North Carolina, Oregon, Texas, Utah, Vermont, Virginia, and Washington); 31 states define intoxicated driving as .10 BAC; and Massachusetts does not have an illegal per se law.

37 percent drop in crashes involving 16 year olds; currently 24 U.S. states and 6 Canadian provinces are implementing GDL programs. In Nova Scotia, the effect was consistent for each of the three years; at the same time, the crash rate for all novice drivers declined by 19 percent. GDL is a two-stage program (6-month learner and 24-month newly licensed driver phases), with several driving restrictions during both phases—for example, supervision by an experienced driver during the learning phase and a night-driving restriction from midnight to 5 a.m.

Documenting Crashes

Crash scene data collectors are under pressure to work quickly to reopen roads or lanes but still collect accurate, comprehensive data. The Maryland State Police have tested an electronic station system to document crashes. The device is a standard survey instrument that measures vertical and horizontal distances and angles; the physical evidence and roadway design information are stored for downloading and analysis.

The six-month pilot project improved the speed and efficiency of the crash investigation; reduced related congestion; increased accuracy (from 0.5 to 0.01 inch); decreased diagramming time (from 8 or 10 hours to about 2 hours per forensic map); and improved measures for collision reconstruction. The technology appears to have the potential to improve crash data collection and reduce time for both on-site collection and report preparation.

Although many safety countermeasures and techniques require long periods for evaluation, the results are often worth the investment. Negative results can curtail ineffective programs; positive results can guide decision makers and program managers to focus on proven safety efforts. Adopting and implementing techniques with known value promises significant decreases in crashes, injuries, and fatalities.

Operations

Highway Congestion

In the United States highway congestion occurs daily in large metropolitan areas and is a constant source of frustration 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 number had risen above 45 percent, with more than 4 billion hours lost to delay in the top 70 metropolitan areas. Rural travel is growing almost as rapidly.

Highway congestion is becoming a burden to the U.S. economy, productivity, and quality of life. Since the mid-1960s, the total of urban Interstate



Demographic and economic trends are straining capacity and safety of entire transportation system.

vehicle-miles traveled has increased three times faster than the construction of highway miles. A 50 percent growth in vehicle miles of travel is expected for urban areas by 2020.

However, environmental concerns, land use, and budget constraints make building new roads difficult. Many transportation leaders are encouraging agencies to emphasize management of roadway capacity, and many transportation departments are focusing on ways to operate networks of streets and highways more efficiently, maximizing the safe movement of people and goods.

Although the United States has invested significantly in capital improvements to the transportation infrastructure, the processes, personnel, and equipment for the operation of the system have not received the necessary funding. Inadequate numbers of personnel, deficient training, and insufficient equipment to manage and operate the highway system have been the results.

To provide leadership and support for a new focus on operations, FHWA recently implemented a major reorganization, establishing a core business unit on operations. TRB, U.S. DOT, AASHTO, ITE, and other highway-related organizations and constituencies are cooperating in a national research and technical partnership to identify research issues critical to the success of the operations initiative. A TRB working group is developing a strategic national research agenda for operations and mobility. Although still under way, this effort has identified the major research theme areas:

- ◆ Customers, customer expectations, and customer needs;

- ◆ Maximizing efficiency and minimizing congestion;
- ◆ Information needs and requirements;
- ◆ Transportation safety;
- ◆ Environmental impacts;
- ◆ Intermodal interfaces and efficiency; and
- ◆ Cross-cutting issues.

Interest in the development and use of performance measures to quantify the results of operations activities and improve communication with decision makers and the public is increasing dramatically. Performance measures provide a means of focusing programs, comparing projects, communicating results, and improving customer understanding and awareness of the role of operations.

Incident Management

Incident management is one of the tools available for efficient and effective management of roadway capacity, providing 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 nationwide. These programs have shown that improving the management of incidents benefits motorists by reducing vehicle delays and enhancing safety. These delay savings and the resultant decreased travel times also can reduce vehicle emissions.

A comprehensive incident management effort, with service patrols and major incident response teams, can yield benefit-cost ratios as high as 17 to 1. Some agencies are installing portable video surveillance systems in work zones to monitor congestion and identify incidents for more rapid clearance.

Calming Traffic

Road rage and aggressive driving are new terms that describe driver dissatisfaction with congestion and delays. Reports of aggressive driving accidents or a road rage altercation are commonly in the news. To remedy the problem, public agencies are implementing countermeasures such as enforcement targeted at aggressive drivers and roadway design modifications that “calm” the traffic.

Several European countries and Australia have used photo enforcement of red-light runners and speeders for many years. The technology detects traffic violations without a law enforcement officer present. Some U.S. communities recently have implemented photo enforcement, primarily for red-light running. Red-light cameras are gaining in use as evaluations show their effectiveness in deterring violations at locations with cameras, and many cit-

izen and safety groups see them as an effective deterrent to red-light running.

A similar technology, photo enforcement of speeding violations, has met with citizen opposition. A few communities, however, are planning trial implementations.

Traffic calming is gaining popularity in the United States, typically by placing a variety of physical features within the roadway to slow drivers and encourage acceptable behavior. Common measures include speed humps, chicanes, chokers, small traffic circles, and others. Advocates of traffic calming measures cite the benefits of improving the safety and quality of life in residential areas, but opponents are concerned about increased response times for emergency vehicles, snow removal problems, and potential liability.

Used extensively in other countries, roundabouts are receiving considerable interest in the United States. The modern roundabout successfully has replaced signalized intersections and diamond interchanges in several areas of the United States. When selected and designed properly, roundabouts have proved effective in reducing delay and improving safety.

Traffic Control

Light emitting diode (LED) devices are gaining rapid introduction in traffic control products as semiconductor technology makes LEDs technically and financially feasible for public agencies seeking alternative illumination and reduced life-cycle costs. Although relatively new, LED technology already appears in traffic signal lamps and changeable message signs. The principal benefits are reduced power consumption and improved durability with solid-state design.

The flexibility of LEDs has allowed alternative designs for traffic control devices—for example, some communities are implementing pedestrian signals with a “countdown” timer to show pedestrians the time for crossing; the countdown timers are gaining public support. However, since the LED technology is relatively new, there are gaps of knowledge regarding long-term durability and conformance to color and intensity standards.

The Internet has provided a means for traffic engineers to supply a range of services to the public. For example, many agencies now feed the video from their surveillance cameras directly to their website to provide “real time” travel information to the public. Other Internet applications by highway agencies include maps and information on construction projects, warnings on road and weather conditions, bridge clearance information for trucks, contact information for reporting problems, accident records, and analysis systems.

Traffic control at highway–rail grade crossings is receiving attention, with high-profile accidents and



the advent of high-speed passenger rail. Some major issues relate to interconnecting highway and rail signals, preempting signals, storing vehicles between rail and highway intersections, and providing adequate clearance. FHWA has issued recommendations for traffic operations that include the development of consistent terminology and definitions for the rail and highway industries; a new traffic signal warrant based on railroad preemption; and guidelines for evaluating and designing safe preemption and interconnection of highway–rail warning devices and signals.

Some agencies are installing video surveillance at highway–rail grade crossings to detect vehicles and trains. The surveillance identifies potential vehicle–train conflicts and facilitates the use of special timing plans to manage traffic so that the tracks are clear for the approaching train.

Some areas are changing speed limits to reflect conditions and improve speed management. Variable speed limits inform motorists of reasonable and safe operating speeds based on the weather and visibility, construction or maintenance activities, or real-time traffic speed and flow. Transportation authorities in several European countries have used variable speed limits successfully to achieve considerable traffic flow and safety benefits.

Capacity Analysis

In December 2000, TRB released a new edition of the *Highway Capacity Manual*—HCM 2000—in separate metric and U.S. customary unit versions; the CD-ROM versions are scheduled for release early this year (see sidebar, page 32). HCM 2000 is the result of a multiyear, multimillion dollar investment by NCHRP, FHWA, the Transit Cooperative Research

Program, and TRB. TRB's Committee on Highway Capacity and Quality of Service oversaw the development of the new edition of the manual.

Although the methodologies are identical for the metric and U.S. customary unit versions, all parameters, level-of-service thresholds, and other values were converted from the metric of the original research into U.S. customary unit measures. Because of approximations in conversion, analysis results calculated using the metric version of HCM 2000 may differ slightly from calculations based on the U.S. customary version. Transportation agencies, therefore, should specify a measurement system for exclusive use by their employees and consultants in conjunction with HCM 2000.

Transit

A strong national economy, job growth, low inflation, new technology and more public investment have affected and benefited transit. Ridership rose 4.8 percent in the first quarter of 2000 compared with the same period in 1999. The overall increase of 4.5 percent for 1999 helped account for the highest number of transit trips—9 billion—since 1960. All modes recorded higher ridership, especially bus systems serving urban areas of 50,000 to 100,000 (up 12.1 percent).

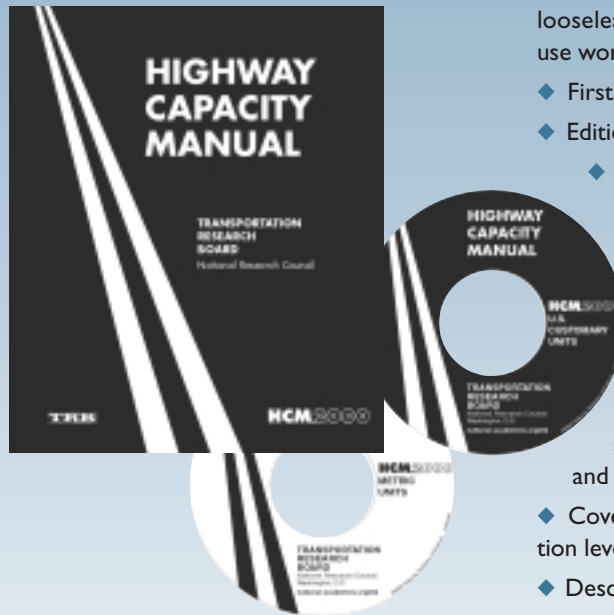
Rail Transit

Many cities are considering light rail transit system start-ups or expansions. Proposed full-funding federal grant agreements would support projects in Baltimore, Maryland (LRT); Chicago, Illinois (Chicago Transit Authority Blue Line; METRA);

The National Transportation Research Center, Knoxville, Tennessee, opened in 2000; construction was still in progress when TRB staff visited in spring. A public–private partnership of Oak Ridge National Laboratory and the University of Tennessee, the center will develop “technologies for cost-effective, advanced transportation systems.”

HCM 2000 Highlights

Presenting state-of-the-art improvements in capacity analysis methods, the newest *Highway Capacity Manual* (HCM 2000)—released in December—has added chapters on interchange ramp terminals and on the appropriate use of simulation models; it also has expanded several chapters with instructions on the planning applications of the information.



The HCM 2000 CD-ROMs include not only the text and exhibits in the print editions, but also interactive tutorials, narrated sample problems, explanatory videos, navigation tools, and hyperlinks from section to section.

Other highlights of the HCM 2000 print and electronic products include

- ◆ More than 1,100 pages of information in a looseleaf binder, including ready-to-copy-and-use worksheets for analyzing field data;
- ◆ First edition with analyses in metric units;
- ◆ Edition in U.S. customary units also available;
- ◆ Multimedia CD-ROM in both metric and U.S. customary versions in a single, two-disc package;
- ◆ CD-ROM compatibility with user-installed capacity analysis software from independent vendors;
- ◆ Extended scope of content beyond individual points (signals) and segments (freeways) to facility, corridor, and areawide analyses;
- ◆ Coverage of more facility types and congestion levels; and
- ◆ Description of the role of simulation models.

See order form on page 56 for further information on HCM 2000.

Denver, Colorado (Southeast Corridor LRT); Memphis, Tennessee (LRT); Minneapolis–St. Paul, Minnesota (LRT); North New Jersey (Hudson-Bergen LRT); Pittsburgh, Pennsylvania (LRT); Portland, Oregon (LRT); Salt Lake City, Utah (LRT); Seattle, Washington (Central Link LRT); and Washington, D.C. (Metrorail).

Other cities recently have expanded rail service; these include the Los Angeles–Hollywood extension, Seattle Sounder, and the Dallas–Ft. Worth Trinity Railway Express. Yet others are studying the possibility of expansion, like Anchorage, Alaska; Charlotte, North Carolina; Houston, Texas; Juneau, Alaska; Nashville, Tennessee; Omaha, Nebraska; Phoenix, Arizona; and Portland, Maine.

Federal TEA-21 funds seed much of this activity; some cities have voted to support new rail transit (e.g., Denver, Colorado; and Phoenix, Arizona) but voters were hesitant in other areas (e.g., Miami, Florida; Kansas City, Missouri; Norfolk, Virginia;

Columbus, Ohio; and San Antonio, Texas). In one instance, the Village of Rosemont, Illinois, discontinued a project, the Personal Rapid Transit System funded by the Chicago Regional Transportation Authority.

Bus Transit

Bus systems are replacing aging rolling stock with low-floor, high-tech vehicles and are enhancing customer information systems. Energy issues are taking on a higher profile with changes in the petroleum and natural gas markets. Oil now costs about \$30 a barrel and shortages of natural gas are predicted for this winter. In addition, operators are attempting to shift to alternative fuels, improved technology, and hybrid propulsion systems to meet environmental goals—all of which should lead to substantial energy savings.

Promising developments for buses include the new express-bus service, or bus rapid transit (BRT),

under study in major cities; Los Angeles has initiated a modified BRT system. The national parks have become a significant potential customer for transit service, with record-breaking numbers of visitors each summer at Yosemite, Grand Canyon, Yellowstone, and Zion national parks. Large-scale bus and LRT systems will ameliorate park access as well as internal circulation.

Agenda for Transit

ITS technologies are improving customer information systems and the management of equipment and operations. A new national traveler information system would consolidate 300 local numbers into one number, allowing a customer to dial 511 to receive multimodal information for the area.

Transit is working to address several concerns that require proactive management, funds, and public official support. For example, the lease, purchase, or shared use of freight track by commuter rail or LRT—as in Atlanta, Georgia; Orlando, Florida; and Seattle, Washington—may create conflicts with local rail freight operators. Aging transit infrastructure (structures, rolling stock, escalators, and electrical systems) requires \$16 billion annually for maintenance and upgrades. Transit human resources must cope with retirements and private-sector competition for employees. Moreover, transit customers are aging and may require different services; transit systems will have to fill the special needs of the baby-boom generation of senior citizens.

Conditions are favorable for improving transit, preserving transit investments, and meeting new requirements.

Freight Intermodalism

Assessing Readiness

In February 2000, TRB hosted a national conference in Long Beach, California, on *Global Intermodal Freight: State of Readiness for the 21st Century*. Participants assessed how the nation has addressed the findings and recommendations of the National Commission on Intermodal Transportation.

The U.S. DOT highlighted the work of its agencies in improving intermodal connections. Shippers presented their needs and requirements, and carriers discussed service and facility advances. State and local agencies showcased projects and initiatives, focusing on public-private partnerships and financing options. The proceedings of the conference will be published later this year.

Intermodal Projects

Intermodal connections for freight range from road and rail access routes to state-of-the-art cargo-handling equipment and communications tech-

nology that maximize throughput and minimize transloading time and costs. Landside infrastructure planning and investments must ensure that freight and passengers have sufficient access to ports, waterways, and airports to sustain current and projected traffic and operations.

State and local agencies have undertaken numerous intermodal projects, some in partnership with the private sector. In July 2000, New Jersey broke ground on the “Portway International-Intermodal Corridor” designed to improve freight movement at the airport-seaport complex in Newark and Elizabeth.

In Houston, Burlington Northern Santa Fe has introduced direct intermodal container service to Barbours Cut Terminal. With support from the Houston-Galveston Area Council and the Texas DOT, the Houston Port Authority used matching funds to build the facility, which will reduce truck emissions and congestion in the region.

In Pennsylvania, Norfolk Southern opened the new Rutherford Intermodal Terminal near Harrisburg. Originally a Reading Railroad switching yard, the new terminal is at the junction of six routes and will serve intermodal traffic to and from the north and south (primarily domestic freight) and from the east and west (primarily imports from Asia on the landbridge route across the United States).

In Illinois, a portion of the Joliet Arsenal was transferred from the ownership of the U.S. Army to a development authority for the Deer Run Industrial Park. Burlington Northern and Santa Fe Railway Co. will build a full-service intermodal terminal, container railyard, and automotive facility adjacent to the industrial park. Illinois DOT will provide an estimated \$50 million to upgrade area roads, bridges, and other project components.

Another former military facility, Rickenbacker International Airport in Columbus, Ohio, is adding two new cargo terminals, with hopes of an expanded role as an international distribution center. In Denver, Colorado, backers are promoting the Transport project at Front Range Airport, where access to Union Pacific rail lines and interstate truck routes offers the potential for a multimodal project similar to the Alliance project near Dallas, Texas.

Many state and local officials are seeking shared responsibility—cooperation, coordination, timely decision making, and action—to ensure an integrated multimodal transportation system that can meet the current and future needs of users and the expectations of the public.

E-Commerce

E-commerce is challenging public-sector planners and decision makers at all levels as well as military

transportation and logistics personnel and the commercial freight transportation and logistics. Demand is increasing for fast, reliable tracking of freight shipments across all transport modes. Real-time information on shipments from origin to destination, both domestically and internationally, is essential for the new logistics processes and for market competitiveness.

The impact of e-commerce on personal travel is also an issue for public-sector planners.

Aviation

Demand and Capacity

Demand encroaches on—and at times exceeds—capacity in many critical areas, with government and industry under pressure to reconcile the two forces. The typical airline passenger perceives that overall service has deteriorated, despite industry efforts to respond to last year's record delays and cancellations and to the ensuing congressional attention and criticism.

Several factors may change or impede projected levels of demand for the U.S. aviation infrastructure, including

- ◆ The constraints on airfield capacity;
- ◆ The effects of compliance with noise, air quality, and other environmental complications;
- ◆ The role of regional jet service; and
- ◆ The effect of changes such as code sharing, mergers, and new large aircraft; the spread of fractional ownership beyond business aviation; the demise of privately owned airports; and restrictions on access to major hubs.

Airline Mergers

A year ago, mergers seemed likely to continue. Today, some of the proposed mergers between major carriers (e.g., United–US Airways and American–Northwest) are coming under scrutiny. Regardless of the business advantages or disadvantages of mergers, real or perceived problems of quality and dependability of service are making the public, and its congressional representatives, cautious about mergers. Add the potentially monopolistic results of the mergers to concerns about quality of service and to the difficulties engendered by weather, air traffic control, airport capacity, and airline labor difficulties, and both Congress and the public are wary.

Regional airlines have been growing at faster rates than the major airlines and this is expected to continue. The mergers of regional airlines with major airlines have been less problematic than mergers between majors. This growth, plus the increased costs of pilot recruiting and training, has kept regional airline personnel departments busy. Region-

als have been expanding rapidly and also supplying pilots to major airlines. Expansion at all levels, along with revised crew rest regulations, has raised concern about the future availability of qualified pilots.

Aircraft: Large or Small?

Commercial aviation presents some seemingly contradictory trends that some have termed complementary. The capacity of individual airliners (e.g., the Airbus A3XX and Boeing supersized 747) is increasing, yet simultaneously the industry is moving to smaller aircraft with higher frequencies of service (e.g., smaller regional jets). Both trends meet changing demands, and both present major challenges to the infrastructure.

Other Pressures

The rapid growth of the air cargo industry in recent years continues unabated—with implications for demand on aircraft, airspace, and terminals.

Environmental policy can have major impacts on the aviation industry. Increased restrictions on aircraft and equipment noise and emissions can affect operating and business costs. Restrictions could have an impact on all aspects of commercial and general aviation, such as air carriers, cargo carriers, and business aircraft.

The enactment of the Wendell Ford Aviation Investment and Reform Act of the 21st Century (FAIR-21) was welcome, but the ultimate impact remains to be seen (see sidebar, page 35).

Business Aviation

Business aviation has been booming along with the U.S. economy and the boom is expected to continue. This optimistic forecast, however, stipulates no dramatic regulatory changes but continued product improvement and a positive impact from the availability of fractional ownership options.

Business aviation and general aviation are likely to benefit from the new advanced aircraft, some of which are already available; others are in the pipeline. The new aircraft promise major advances in speed, efficiency, ease of operation, and safety—as well as lower initial and operating costs for given levels of performance.

Rail

U.S. railroads had a record-breaking 1999, with four measures of traffic higher than ever before in the modern era. Class I revenue ton-miles rose to 1.43 trillion, a 4.1 percent increase from 1998. Tons originated also rose 4.1 percent, to 1.72 billion, and carloads originated rose 5.4 percent to 27.1 million. Intermodal volume rose to 9.04 million trailers and containers in 1999, a 3.1 percent increase over 1998.

Interpreting Aviation Investment Reforms

According to a Congressional staff interpretation, the Wendell Ford Aviation Investment and Reform Act of the 21st Century (FAIR-21) offers the following benefits:

◆ Safety

- Provides more money for runways and equipment that will enhance safety;
- Ensures Federal Aviation Administration (FAA) funding to hire and retain air traffic controllers, maintenance technicians, and safety inspectors;
- Increases FAA facilities and equipment funding to modernize the air traffic control system;
- Authorizes funding to improve the training of airport screeners;
- Designates wind-shear detection and runway incursion prevention devices as eligible for Airport Improvement Program (AIP) funding;
- Requires cargo aircraft to install collision avoidance devices;
- Provides whistleblower protection for FAA and airline employees who reveal safety problems; and
- Ensures funding to raise safety standards at small airports.

◆ Competition

- Provides substantially more funding to build terminals, gates, and other infrastructure to allow additional competition;
- Abolishes slots at Chicago and New York to enhance competition; and

- Requires medium and large hub airports to file a plan for the use of resources to spur competition.

◆ Environment

- Increases the money available for noise abatement projects;
- Creates a new environmental streamlining program similar to TEA-21;
- Establishes a regulatory regime to quiet air tours over national parks; and
- Funds a program to encourage airports to use low-emission vehicles.

◆ Small Airports

- Triples the amount of the minimum entitlement for nonhub airports to \$1.5 million;
- For the first time, provides entitlement money for general aviation airports;
- Triples the small airport fund;
- Authorizes a contract tower cost sharing program so that small airports can receive the benefits of air traffic control services;
- Creates a loan guarantee program to help airlines buy regional jets to serve small airports; and
- Creates a new funding program to help small underserved airports market and promote services.

◆ Large Airports

- Triples the amount of annual passenger entitlement for primary airports;

- Lifts the \$22 million cap on the amount of annual entitlement money that a large airport can receive;
- More than doubles the amount of entitlement money for cargo airports;
- Increases the discretionary fund so that FAA can fund high-priority airport improvement projects;
- Protects funding for letters of intent (LOIs) and makes clear that it is not necessary for an airport to assess a passenger facility charge (PFC) to qualify for an LOI; and
- Raises the cap on PFCs so that airports may proceed with improvement projects that cannot be funded through the federal AIP.

◆ Pilots and Passengers

- Reforms the management of FAA's air traffic control system, creating an oversight board similar to the one established in the recent reform of the Internal Revenue Service;
- Strengthens the provisions of the Aviation Disaster Family Assistance Act, created after the ValuJet and TWA 800 accidents;
- For the first time, explicitly prohibits racial discrimination in air travel;
- Allows pilots to appeal an emergency license revocations to the safety board; and
- Ensures that taxes paid by pilots and passengers will fund needed safety, security, and infrastructure.



Freight rail drawing oil tank cars past Denali National Park, Alaska. For U.S. railroads, 1999 was a record-breaking year. The extremely competitive environment in which railroads operate, however, prevented rail revenue growth from keeping pace with growth in traffic.

Financial Overview

The extremely competitive environment, however, prevented rail revenues from keeping pace with traffic. In 1999, Class I operating revenue rose 1.1 percent, but operating expenses rose 0.3 percent. Despite an increase in net income to \$3.0 billion in 1999 from \$2.8 billion in 1998, the industry's rate of return on net investment fell from 7.0 percent in 1998 to 6.9 percent in 1999. Meanwhile, the industry's cost of capital rose in 1999 from 10.7 percent to 10.8 percent.

With the slightly greater gap between return on investment and cost of capital in 1999, the rail industry took a small step away from its long-sought goal of achieving revenue adequacy. Revenue per ton-mile, a useful surrogate for railroad rates, continued a steady, nearly 20-year decline in 1999, falling to 2.28 cents—a 28 percent decline since 1981, the equivalent of a 57 percent decline when adjusted for inflation.

Railroads invested heavily in equipment, roadway, and structures in 1999, with capital investments totaling \$6.6 billion—the second highest ever, since totaling \$7.2 billion in 1998. Railroads are investing more revenue in capital expenditures than any other major industrial sector.

Rail Mergers

In recent years, mergers and acquisitions to enhance productivity and service among the dwindling number of North American Class 1 railroads have attracted attention and raised questions about how far the trend would reach. In 1999, CSX Corporation and Norfolk Southern completed acquisition of Conrail, approved by the Surface Transportation Board (STB) in 1998. The two carriers took over most of Conrail's operations on June 1, 1999, while Conrail continues to operate three "shared asset areas." In addition, Canadian National Railway (CN) com-

pleted its acquisition of Illinois Central (IC) as of July 1, 1999.

However, noting the service disruptions that have followed all recent mergers (except for CN-IC), STB chose not to approve a proposed merger of Burlington Northern Santa Fe and CN. Instead, in March 2000, STB issued a 15-month moratorium on major railroad merger proposals. The moratorium allows the STB to reexamine and revise its rail merger policies and procedures in the context of current industry conditions. A formal rulemaking on modifications to the regulations is scheduled for completion by June 11, 2001.

Local Rail Freight

The number of common-carrier freight railroads in the United States remained relatively steady in 1999 at approximately 560. Many communities depend on regional and shortline railroads, some of which receive state support.

States sponsoring programs to maintain shortline railroads base the investments on the benefits to local and state economies from the industries and businesses that rely on freight service. Many states fund infrastructure improvements—and in some cases, rail line purchases—through grants and loans, but many have difficulty keeping up with the needs for improvements, particularly in providing capacity for 286,000-lb cars.

Rail Passenger Developments

Thirty-two states are investing in improvements to intercity rail passenger services. In partnership with Amtrak, states are investing in the infrastructure and equipment for incremental high-speed services. For example, since 1998, the state of California has committed a total of \$466 million for capital improvements to railroad infrastructure to improve service, add capacity, and reduce trip times for passenger services. Other states making significant investments include Washington, New York, Pennsylvania, North Carolina, Virginia, and the states supporting the Midwest Regional Rail Initiative.

However, joint operations with the freight railroads at or near capacity in many of these corridors require both operational and technological solutions. Several demonstrations of new train control technology may help to improve capacity utilization.

For example, the Michigan Incremental Train Control System, the result of a partnership among FRA, Michigan DOT, Amtrak, and Harmon Industries, is operating on a 20-mile line in revenue service. Testing at 90 mph is expected to begin soon. The North American Joint Positive Train Control Initiative, sponsored by FRA, the Illinois DOT, and the Association of American Railroads, is moving on an ambitious schedule towards completion by the end of 2002.

The major development in the introduction of high-speed rail comes with Amtrak's introduction of the Acela trains in the Northeast Corridor. With higher-quality service in terms of comfort and convenience, Amtrak is pinning its financial hopes on the success of this service.

Commuter rail growth in many areas of the country has increased local and regional services without the construction of new infrastructure. For example, the Atlanta, Georgia, area has an ambitious 11-year rail plan, approved by the Georgia Regional Transportation Authority and the Georgia Rail Passenger Association, to relieve highway congestion. When completed, the railway will connect 70 percent of the state's population.

Grade Crossings

Grade crossing issues are paramount concerns for safety and mobility in many areas. Several states are exploring low-cost technology to improve safety at crossings, particularly on lines with increasing volumes of passenger trains. Many areas also face increased rail traffic volumes that tie up crossings and cause substantial delays for street and highway traffic.

Ohio DOT has launched a major rail crossing safety initiative—a planned 10-year, \$200 million program—drawing on federal, state, and industry sources to address safety, mobility, and economic development concerns.

Marine Transportation

Marine transportation received increased attention in the past year, with the formation of the Marine Transportation System National Advisory Council, a private-sector and stakeholder counterpart to the federal interagency committee on the Marine Transportation System (MTS), formerly the interagency committee on Waterways Management. A series of regional dialogue sessions on the MTS initiative complemented meetings of the two groups.

The U.S. Army Corps of Engineers (USACE) also conducted regional dialogues on "America's Water Resources Challenges for the 21st Century," encompassing water transportation infrastructure as well as water systems, water treatment, flood protection, and multipurpose projects. Among the major topics of discussion were environmental issues—particularly air emissions from marine and port operations—and safety issues, as the number and type of users on the MTS increases. TRB and the Marine Board (MB) are working on several MTS-related initiatives, including efforts to quantify and measure the system's capacity performance and to encourage research and innovation.

Channel Deepening

Channel deepening projects are a major MTS component, as ports seek to accommodate newer and larger commercial cargo ships. For example, the Port of Houston Authority is issuing more than \$20 million in bonds for widening and deepening the Houston Ship Channel by 2003. The project will ensure safe passage for larger ocean vessels and will include additional lanes for barges on both sides.

Near the end of 2000 the U.S. Congress passed two important pieces of legislation. In October, President Bill Clinton signed the Energy and Water Appropriations Bill, which includes funding for ports—Oakland, California, for example, will receive \$14 million for harbor deepening operations—and for maintenance dredging. Final passage of the Water Resources and Development Act 2000 came in November; it authorizes deepening and modification of federal navigation projects at ports such as New York–New Jersey and Los Angeles. The legislative actions also gave the go-ahead and funding for projects at Wilmington, North Carolina; Baltimore, Maryland; Jacksonville, Florida; Gulfport, Mississippi; and Brunswick, Georgia; and for maintenance dredging on the Great Lakes–Seaway system.

USACE has contracted with the National Research Council (NRC) to explore the process for determining "environmental windows"—the time period during which the ecological impacts of dredging will be at a minimum, as determined by regulatory agencies. Early this year, TRB-MB and the NRC Ocean Studies Board will convene a workshop of experts to establish a dialogue on

- ◆ The degree to which environmental windows are based on scientific evidence;
- ◆ The current level of consistency in the regulatory process for establishing these windows; and
- ◆ The institutional process utilized by regulatory agencies to create these windows.

Port Projects and Services

States, ports, and private entities are considering a variety of new projects and initiatives. The Port Authority of New York and New Jersey (PANYNJ) is contemplating a Port Inland Distribution Network, a system of satellite facilities in New York, New Jersey, Pennsylvania, Connecticut, and Massachusetts for the PANYNJ's container operations. A study by the New York City Economic Development Corporation has concluded that two freight-rail tunnels under New York Harbor could be self-financing, linking points east of the Hudson River with the northern New Jersey mainline track of CSX and Norfolk Southern.

There have been considerable discussions and analyses of expanding coastal waterborne services; studies by the U.S. Department of Defense and the Maritime Administration support a coastal network of low-cost domestic terminals servicing a fleet of high-speed cargo ferries on established coastal routes. Proponents maintain that such services would decrease the number of trucks on congested Interstate systems, improving highway safety and helping the environment. Suggested services include a barge feeder route between Port Elizabeth, New Jersey, and the Connecticut port of New Haven to alleviate congestion on the I-95 corridor.

Other concepts studied in the past are now coming on line, such as FastShip's plans to establish a terminal in Philadelphia for a high-speed 7-day service between the United States and Europe, using a similar terminal in Cherbourg, France. While many established ports look for ways to market their facilities, Rhode Island is developing a new port at Davisville and Quonset Point, a former U.S. Navy base.

In a November 2000 statewide referendum, Alabama voted to approve a constitutional amendment to provide \$100 million for port investments during the next five years. The projects will include a new container facility connected to a rail intermodal facility, a forest products warehouse, a metal products terminal, upgraded bulk facilities, new railway tracks, and open storage. Ballot measure requires that more than one-fourth of all new oil and gas royalties go to a fund for the new port facil-

ities as well as for road and bridge improvements. A study by the Alabama Commerce Commission had found that the Alabama State Docks and the Port of Mobile could play bigger roles in the state's economic development efforts.

Inland Waterways

On the inland waterways, Inland Rivers, Ports & Terminals, Inc., an association of inland waterway port and terminal operators, organized a trip in early 2000 to investigate inland port developments and barge technologies in Europe. The Port of Pittsburgh Commission, with a \$400,000 grant under TEA-21 and \$100,000 from its own operating budget, is undertaking a SmartBarge initiative to promote waterway exports through technology innovation.

USACE faces increased pressure over plans to expand locks on the Upper Mississippi and Illinois rivers. The Pentagon requested that a National Academies study panel— assembled by TRB and the Water Science and Technology Board— evaluate the Corps' Upper Mississippi River–Illinois Waterway Navigation System Feasibility Study by December 2000.

A major debate concerns the breaching of dams to restore depleted salmon runs on the Columbia–Snake River system. The dams provide hydroelectric power and irrigation to agricultural lands and are a factor in the 465-mile marine transportation network of ports and tug-and-barge operations for bulk and container shipments to coastal ports. Although several studies have examined the economic and environmental impacts, a near-term resolution is not likely.

Ferry Renaissance

Ferry transportation garnered considerable attention in the past year, with the U.S. DOT hosting a national ferry conference in Seattle, Washington. Major themes included regulatory and safety issues, expansion of ferry services, ferry operations, new technology, and financing.

The National Ferry Study, authorized under TEA-21 and scheduled for completion before the end of 2000, was one of several ferry topics featured in the July–August 2000 ferry theme issue of *TR News*. The special issue reflected the efforts and interest of TRB and MB to increase awareness of the many aspects of ferry transportation—both passenger and freight—and the desire to integrate ferries into regional and national transportation systems. Several new ferry services, terminal improvements, and vessel purchases have resulted from the TEA-21 legislation.

Active heavy ferry traffic in harbor, Juneau, Alaska. Ferry transportation gained attention in the past year. The National Ferry Study, authorized under TEA-21, was completed at the end of 2000.

