

Specialists in the Transportation Research Board Technical Activities Division are in a unique position to identify the current concerns and learn about the activities of the transportation community. The TRB Annual Meeting, Board-sponsored conferences and workshops, standing committees, publications, and contact with thousands of organizations and individuals provide TRB staff with information on all modes of transportation from both the public and private sectors.

A major source of such information is the annual field visit program, through which TRB staff meet on site with each state transportation department, many universities, transit and other modal agencies, and industry representatives. The objectives of the program are to (a) learn of problems facing these organizations and transmit information from states, industry, or educational institutions that can help solve those problems; (b) learn of research activities that are in progress or contemplated and exchange information on similar research being carried out elsewhere, thus preventing duplication of efforts; (c) identify new methods and procedures that might be applicable elsewhere; (d) identify innovative or experimental work that may not be widely published, but is worthy of broader attention; (e) describe the Board's range of services to new staff at transportation agencies that support TRB; and (f) identify potential candidates for TRB committees.

Presented here are the issues, concerns, and recent program changes in transportation identified by the TRB Technical Activities Division staff through this year's field visits, supplemented with related information from other sources. The time period covered is July 1, 1997–June 30, 1998, unless otherwise noted.

NEW CHALLENGES— NEW OPPORTUNITIES

TRB's 1998 Field Visit Program

Overview

Not surprisingly, the primary topic of discussion during this year's field visits was the Transportation Equity Act for the 21st Century. TRB staff heard mixed opinions (mostly positive) on the impacts of TEA-21 on the states. The higher funding levels of the act are obviously welcome, and appear to have alleviated some of the usual concerns about allocation among the states and the relative shares among modes.

A concern of many states is the difficulty of obtaining and retaining the human resources—both employee and contractor—needed to carry out the act's expanded surface transportation program. As noted in the following sections, the increased need for human resources under TEA-21 follows significant reductions in state staffing levels that occurred during the past decade. Partly in response to this human resource issue, along with the continuing desire to improve operations and programs, new ways of doing business are being pursued to carry out the mandates of TEA-21. States also noted that some of the earmarked projects included in TEA-21 are not on their high-priority list. Despite these concerns, the states appear to view TEA-21 as a welcome follow-up to the Intermodal Surface Transportation Efficiency Act of 1991, and certainly are pleased with the higher funding levels that will help meet their extensive highway and transit needs.

One relatively new approach to conducting business is the contracting out of design and construction operations. The nature of the interaction between state staff and contractors is evolving, and will continue to do so for some time as both groups become more familiar with the practice. One area of immediate concern, related to quality assurance, is the absence of validated performance measures on which to base the evaluation of contractor performance.

This past year saw increased attention to providing flexibility in design standards. Building on the Federal Highway Administration publication *Flexibility in Highway Design* (1), the Maryland Depart-



Many states are exploring concepts for flexibility and innovation in highway design.

ment of Transportation and FHWA convened a conference, "Thinking Beyond the Pavement," to share information on innovative design concepts that can better meet the needs of all affected parties. Follow-up efforts to pursue these concepts are under way in several states.

A number of other challenges shared the spotlight with the above issues this year. Among these were rail mergers, freight movement, environmental issues, and year 2000 (Y2K) computer issues.

The next section addresses current practice in the states with regard to the implementation of research results. Implementation considerations are receiving greater attention each year as the states and federal agencies attempt to address a long-standing gap between research results and their actual use. Institutional issues related to human resources and management, finance, environmental concerns, and planning are then reviewed. Finally, issues associated with intermodalism and individual modes—marine, aviation, rail, transit, and highway—are examined.

Implementation of Research Results

The TRB State Representatives requested that TRB staff gather information on the implementation of research results during the 1998 field visits. As noted, considerable attention has been given to the subject of implementation in recent years—by the states, federal agencies, the American Association of State Highway and Transportation Officials, TRB, and others. The objective of the TRB staff review, as a complement to other work in this area, was to obtain a snapshot view of how the states are approaching the implementation issue.

The states share a common desire to do more toward ensuring that implementation takes place when warranted; no state believes it has the perfect solution in place. Perhaps not surprisingly, there is quite a range in the implementation approaches being taken by individual states. Many states have formalized, well-documented procedures, while others follow an informal, less-structured approach. Regardless of the specific approach adopted, there are also significant differences in the level of attention and effort devoted by individual states. These differences result from a number of factors, including (a) the nature and size of the state's research program, (b) the perceived value of research and the commitment to implementation on the part of the DOT, (c) limited staff resources, and (d) the presence or absence of a champion to promote and sell the importance of implementing research results.

Common Characteristics of State Implementation Programs

The following characteristics were found in the implementation programs of most states, though not all. These characteristics are discussed here not with the intent of specifying program essentials, but simply of reporting features incorporated by many states into their programs.

Documented Procedures

Most states have manuals that describe the research program development process in considerable detail, covering how projects are identified, selected, monitored, and carried out. The implementation aspects of the research are often less well detailed, perhaps because of the more ad hoc approach that often characterizes implementation. Those states that have a fully documented implementation approach are generally in the early stages of applying that approach.

Oversight Committee

In many states a research advisory committee, made up of representatives from the research and operational units and sometimes from outside the DOT, has responsibility for selecting research projects. Often a small committee is designated to oversee each research project. In some states these same committees play a role in the implementation phase to ensure that implementation aspects of the work are addressed effectively throughout the process, as well as in follow-up after the research has been completed. Follow-up is the key, too often neglected, part of the process. Given the competing demands on people's time, maintaining interest and enthusiasm through the implementation process can be

challenging. This is unfortunate because *effective implementation requires time and effort*.

Implementation Plan

Most states require that the final report for each research project address implementation. Some states also require that implementation be discussed in research proposals. Other states believe the practical, applied nature of their research obviates the need to address implementation explicitly. The more comprehensive approaches include summary reports that track all projects through the implementation stage, serving not necessarily as a report card, but as a means of ensuring that implementation does not get side-tracked.

Limited Staff Resources

Staff resources are clearly a common concern among almost all states. Staff shortages frequently exist within research units, some of which have been severely downsized. In most cases, it is these units that are responsible for at least overseeing the implementation effort, and they often have total responsibility in this area. No state devotes a staff unit solely to implementation. Individuals serving on the research committees noted above have full-time, demanding jobs in operational units. These individuals are typically division heads with limited time, who often must deal with staff shortages in their own units. *And effective implementation requires time and effort.*

Differences Among Implementation Programs

In addition to the above commonalities, there are a number of ways in which state implementation programs differ. Some of the more salient differences are reviewed below.

Commitment of Top Management to Research and Implementation

Some state chief administrative officers and other top management staff are fully committed to ensuring that the research conducted in their DOT is directed at meeting the department's needs and that implementation will follow the production of usable results. To illustrate, one state has a research implementation committee overseeing each project, and that committee is required to forward a recommendation regarding implementation to the CAO. If the recommendation calls for implementation and the CAO agrees, the research findings become state practice. Of course there are reasons, such as the size of the research program, why this approach would not work in every state.

CAO interest in research and implementation is often generated from outside the DOT. For example,

several CAOs involved in the Strategic Highway Research Program have become champions for implementation. Nonetheless, given the relatively short term of office of many CAOs, research and implementation are often not high on their list of priorities. They, too, have other demands on their time. *And effective implementation requires time and effort.*

Willingness To Take Risks

For many good reasons documented in numerous reports, risk taking is difficult for public agencies, and DOTs are no exception. Nonetheless, in recent years there appears to have emerged a greater acceptance of the need to assume some risk in order to obtain improved products. Still, there remain wide differences among the states in the willingness to experiment. Some states prefer to wait for others to experiment; some have little choice in this regard in light of their R&D budgets.

Champions

Certainly much of what is accomplished would not get done without someone to step forward and make it happen. Such champions emerge in various ways among the states. In some cases the research director mounts an aggressive implementation program. In other cases individuals come forward, often from operational units, to press for the adoption of a new procedure or product. As noted above, in some states this individual is the CAO. One point was emphasized in the field visit interviews: the most effective champions come forward on their own. A champion needs encouragement and support more than appointment. The states are fortunate; they have many champions—although not enough.

Organizational Issues

States with divisional offices (geographic divisions) face the added challenge of involving staff from these offices in the implementation process. There is broad agreement on the need for such involvement because the divisions are the eventual beneficiaries of the research, as well as its implementers; yet their involvement adds complexity to the implementation process. Related to this organizational issue is the extent to which individuals from outside the department are involved. In the planning area, for example, other governmental agencies often have a stake that must be considered. Industry can also be both contributor and interested party. States are in various stages of involving these groups; the extent of this involvement often depends on the nature of the research being conducted.

Additional Observations

The field visits generated a number of additional observations with regard to implementation. First,

the states noted several opportunities to improve the implementation process:

- ◆ Addition of a development stage to bridge the gap between research and implementation.
- ◆ Greater marketing of the value of research and the need for follow-up when useful results are produced.
- ◆ Development of measures of success in implementation. Cost/benefit analysis for the entire research-to-implementation process was also cited.
- ◆ Provision of an earmarked budget for implementation (one state sets aside 20 percent of the research budget for this purpose).

Second, peer review of a number of state R&D programs has been conducted in recent years and has generally received a positive reaction. While there were some early concerns about the potential for outsiders to be unfairly critical, most states that have taken part in these reviews have found them constructive.

Third, there is considerable variation in the extent to which individual states actively and systematically seek implementable research findings from other states, FHWA, the National Cooperative Highway Research Program, and other organizations. Few states have a program in place to pursue such findings on a routine basis. Some seek this information as needed, while others rely on individuals' participation in outside activities. Technology transfer centers play a key role.

Fourth, implementation of SHRP products, in particular Superpave®, was cited a number of times as a unique and effective implementation approach. At the same time, those familiar with the program recognize that SHRP implementation involves a major effort on the part of the states, FHWA, AASHTO, TRB, and others. *And effective implementation requires time and effort.*

Finally, other notable implementation-related activities include the following:

- ◆ At its midyear meeting in April 1998, AASHTO approved a resolution calling for the Standing Committee on Highways, in cooperation with the Standing Committee on Research, to "... establish a senior level Steering Group and to charge it with the responsibility of providing leadership and guidance to the Member Departments on the deployment of selected new technologies."

- ◆ The AASHTO Task Force on SHRP Implementation has kept AASHTO committees and senior managers focused on the goals of SHRP implementation and the commitment of resources to accomplishing this task. Noted in particular was the Task

Force's creation of the SHRP Lead State Teams and the continuing support of those teams.

- ◆ The TRB SHRP Committee has served as a major counselor to FHWA, AASHTO, and the states regarding technology transfer and implementation activities. The committee provides recommendations on technology transfer, standards setting, and other tasks needed to encourage acceptance and utilization of SHRP research products by operating transportation agencies, and functions as an independent sounding board for FHWA and AASHTO implementation plans. The committee also provides feedback to FHWA and AASHTO on the progress of implementation among user agencies.

- ◆ TRB's Research and Technology Coordinating Committee is preparing a special report on technology transfer for FHWA highway research.

- ◆ NCHRP Report 382, *Facilitating the Implementation of Research Findings: A Summary Report*, and ongoing Project 20-33(2), *The Role of Procurement and Contracting Approaches in Facilitating the Implementation of Research Findings*, are directly related to this topic.

In summary, while there is variation in the way states are approaching the implementation of research findings, there are common elements employed by most states. At the same time, given basic institutional differences among the states, such as program size and organizational structure, a standardized process is neither desirable nor appropriate. What is needed is continuing and increased attention to implementation, including the necessary funds and human resources. *After all, effective implementation requires time and effort.*

Institutional Concerns

Key institutional issues raised during the field visits relate to human resources and management, finance, environmental concerns, and planning.

Many states have documented policies regarding implementation. For example, as stated in California DOT's research manual, "It is the policy of the Department to incorporate valid and appropriate research findings into the Department's operations as rapidly as possible. Implementation may include a new or revised procedure, standard, design, specification, test method, computer program, or manual change."

Human Resources and Management

Federal funding increases under TEA-21 over the next 6 years present state DOTs with both opportunities and challenges. A principal opportunity will be the crafting of new or enhanced programs to deliver transportation system improvements desired by the public. The related challenge will be to assemble and manage the expanded human and organizational resources needed to effect these improvements.

Many state DOTs have legislatively imposed caps on their complement of full-time employees (FTEs), as well as rules limiting the maximum salaries that can be offered to different classes of employees. The program growth associated with TEA-21 will produce an increased demand for certain types of employees, especially experienced engineers and project managers. Many DOTs expressed the concern that they will not be able to staff sufficiently to meet the new challenges of TEA-21, not only because of FTE and salary caps, but also because of shortages in the current talent pool. Competition among DOTs and the consulting community for experienced employees may well increase. One outcome of these pressures may be a movement to more streamlined project management and contracting procedures, as well as greater use of the private sector by the public transportation agencies.

TEA-21 will cause the universities with transportation degree programs to consider whether and how to increase enrollment in these programs. In the ISTEA era, the imperative for university programs was to meet the changing demands of the transportation profession associated with intermodalism, intelligent transportation systems, and other emerging fields. Under TEA-21, much of the increased funding will be used to improve and rehabilitate existing highway and transit systems—a use that demands a professional workforce with traditional engineering skills. Thus while there is a continuing need for professionals with new skills, there is now a concurrent increased demand for those with traditional skills. Given the urgency of this demand, short-run needs for trained professionals may be met by on-the-job training for junior professionals and efforts to attract employees from related fields.

To consider the longer-term intermodal education and training needs of the profession, TRB and FHWA sponsored a conference in November 1997 on Intermodal Transportation Education and Training. And at the 1999 TRB Annual Meeting in January, the TRB Committee on Education and Training held the Forum on Transportation Education and



Training: Responding to the Changing Needs of the Profession.

Finance

TEA-21 authorizes \$218 billion over the life of the program, 1998–2003. For the previous 6-year period, ISTEA authorized \$156 billion; thus TEA-21 provides a funding increase of almost 40 percent (not considering inflation). The states will be the principal beneficiaries of this increase. Since most of the TEA-21 programs require a 20 percent state match, however, a concern of some state DOTs is how to produce the funds needed for this purpose.

This concern is particularly salient in light of the recent decline in the growth of state motor-fuel taxes, the major source of state transportation funds. During 1986–1991, 46 states raised their motor-fuel taxes; 29 states did so more than once. In the 1992–1997 ISTEA period, only 23 states raised their motor-fuel taxes, and of these only 10 did so more than once (2). A number of factors may explain this marked decline in revenue growth. First, during the 1980s increased automobile fuel efficiency played a role. Second, that same period saw slow growth in federal aid for transportation. Third, the price of gasoline dropped in the 1980s, which made it possible to raise gas taxes without greatly affecting the total retail price of the product. These three factors made it desirable and possible for states to raise fuel taxes in the 1980s to maintain adequate levels of funding for their transportation programs. In the 1990s, pressures on the states to raise taxes lessened when the federal-aid program increased significantly, and the rate of growth of vehicle fuel-efficiency slowed.

Much of the increased funding provided by the Transportation Equity Act for the 21st Century will be used to improve and rehabilitate existing transportation systems.

The Puget Sound Regional Freight Mobility Roundtable, whose members include representatives of ports, shippers, railroads, trucking companies, air carriers, federal agencies, and state and local agencies, has been instrumental in building alliances and promoting freight access improvements. An example is the FAST Corridor, designed to support the increasing volume of freight moving through the region.



A less easily measured cause of the lack of growth in state fuel taxes in the 1990s is the antitax political environment of the period at all levels of government. Many state DOTs are now weighing the feasibility of requesting tax increases to match the higher levels of federal aid TEA-21 will bring. If raising taxes is determined to be infeasible, states will need either to find new funding sources or to divert a larger share of their existing state transportation funds to the federal program. Much of the federal program is oriented to capital improvements, and this may inhibit the states' abilities to maintain their existing infrastructure.

Asset management is currently an important topic for transportation operating agencies, and there is a controversial financial management aspect to this topic. The Government Accounting Standards Board (GASB), which sets accounting standards for state and local governments, has recommended that state DOTs change their accounting practices to better reflect long-term debt and the condition of capital assets. The GASB proposal would apparently require DOTs to inventory all major infrastructure assets, such as land, highways, and bridges; estimate the useful life of these assets; estimate their depreciation; and update this information on an annual basis. It is argued that implementing this proposal will provide the public, elected officials, and the private-sector financial community with a needed fuller picture of state DOT finances. Many state DOTs, however, believe the cost to accumulate and report such information would far outweigh any potential benefits. Discussion is ongoing on whether to accept the depreciation method recommended by GASB, find a less burdensome means of achieving

the same accounting goal, or reject the GASB proposal entirely.

Environmental Concerns

The authorization of TEA-21 provides a new context for the continuing discussion on whether and how to streamline the transportation environmental review process. The states had recommended a number of changes to current procedures, including a proposal to delegate to the state DOTs responsibility for environmental reviews for all projects, except those requiring an Environmental Impact Statement. This so-called "pilot program" was opposed by the private-nonprofit environmental community. The pilot program was not adopted in the final legislation, but the idea of devolving environmental reviews to the states will undoubtedly re-emerge.

TEA-21 includes a mandate for the federal government to streamline the environmental review process. This is to be accomplished by requiring that all federal and state agencies with an interest in environmental review of a federally aided transportation project act concurrently and expeditiously. The U.S. DOT rulemaking to implement this streamlining process will no doubt be subject to intense scrutiny as interested parties seek to ensure on the one hand that the environmental process is not weakened, and on the other hand that the states are not burdened with new regulations.

Another TEA-21 change may have major environmental implications: the requirement that the Secretary of Transportation, U.S. DOT, eliminate the Major Investment Study (MIS) approach and integrate the MIS requirements into both the planning process and the National Environmental Policy Act (NEPA) project development process. This requirement is open to some interpretation. If the focus is on "eliminate," MIS may simply disappear. If the focus is on "integrate," all aspects of MIS must be covered jointly in the planning and NEPA project development processes. In the latter case, a linkage is made between corridor planning and project development, raising the possibility that environmental concerns will be addressed in the planning process before project alignments are determined. Some believe that such a practice could avoid many environmental conflicts before they occur, eliminate many needs for mitigation, and shorten the time required to complete projects.

Opponents argue that considering environmental concerns during the planning process is ill-advised, as metropolitan planning organizations and many state DOT planning departments lack the appropriate environmental analysis skills. It is also argued that duplication of effort between the plan-

ning and project development processes will result.

Finally, 1998 was a good year for transportation-related environmental concerns in NCHRP. For the fiscal year 1999 program, AASHTO's Standing Committee on Research selected 11 environmental projects, totaling almost \$3 million and representing about 15 percent of the program. New projects address wetlands, highway runoff, air quality, social and economic impacts, cultural resource significance, and technologies for improving environmental analysis. Many of these projects were originally conceived during TRB's 1996 Environmental Research Needs Conference and documented in Circular 469, *Environmental Research Needs in Transportation*.

Planning

The core metropolitan and statewide transportation planning requirements remain intact under TEA-21, which emphasizes the role of state and local officials and transit operators in tailoring the planning process to meet their mutual needs. Among the changes occurring in the planning process at the metropolitan and state levels is greater emphasis on (a) multimodal planning, including the use of performance measures and life-cycle comparison of investments in alternative modes; (b) freight transportation, including increased interaction with the private sector in the identification of needed improvements in freight movement/distribution; (c) multistate transportation planning, especially with regard to multistate transportation corridors; and (d) rural transportation needs and requirements.

There is increased interest in the development of statewide transportation system models (passenger and freight) as a result of new technology that allows networks and databases to be developed more rapidly and less expensively. The need for models is increasing because of the growing complexity of demands on planning, including consideration of multimodal trade-offs, air quality concerns, limited resources, and financial constraints. Integration of operations and management, including ITS, into the planning process is receiving increased attention. And as noted in the previous section, there is now a greater emphasis on considering environmental impacts at an early stage of the planning process.

Intermodal and Modal Concerns

Intermodalism

Intermodal linkages are required at land–water and land–air boundaries, as well as at road–rail interchange points, to effect the transfer of freight and passengers between modes. Intermodal connections

range from road and rail access routes to state-of-the-art cargo-handling equipment and communications technology designed to maximize throughput and minimize transloading times and costs. Those involved with landside infrastructure planning and investments must ensure that access to ports, waterways, and airports is sufficient to sustain current and projected traffic and operations.

As is evident in the TEA-21 legislation, federal, state, and local agencies will continue to give increased attention to intermodal connections. The need for cooperation, coordination, timely decision making, and action to improve the overall efficiency of transportation systems was frequently mentioned in discussions with state and local officials. Many officials offered examples of shared responsibility for ensuring an integrated multimodal transportation system that is adequate to meet the current and future needs of users and the expectations of the public.

One requirement of TEA-21 is the National Highway System (NHS) Intermodal Connectors Condition and Investment Study on the condition of freight connectors, improvements to connectors, and impediments to those improvements. This study will consider more than 600 freight facilities and nearly 700 passenger facilities with connectors



Intermodal linkages for both freight and passengers are vital to local Puget Sound region, where trucks, automobiles, and passengers transfer between water and land.

to or on/adjacent to the NHS, and will encompass highway, bridge, and nonhighway infrastructure, as well as regulatory and institutional impediments to intermodal terminal access. Other TEA-21 intermodal provisions include the following:

- ◆ The National Corridor Planning and Development Program enables grants to states and MPOs for the coordinated planning, design, and construction of corridors of national significance (including high-priority corridors cited in ISTEA), recognizing the importance of major surface transportation links and trade corridors.

- ◆ The Coordinated Border Infrastructure Program enables grants to border states and their MPOs for improving the safe movement of people and goods at the U.S.–Mexican and U.S.–Canadian borders. The grants can be used for improvements to transportation and supporting infrastructure, safety and enforcement to facilitate cross-border movement, operational improvements, and modifications to regulatory procedures.

The *Regina Maersk* is among the first of new generation of mega-containerships that pose major challenges for ports and landside infrastructure.



- ◆ The Transportation Infrastructure Finance and Innovation Act enables U.S. DOT to provide credit assistance to public and private sponsors of major surface transportation projects to assist them in gaining access to capital markets. Eligible projects include intermodal freight transfer facilities on or adjacent to the NHS, as well as highway and capital transit projects, international bridges and tunnels, and intercity passenger bus and rail projects.

Because virtually any transportation via water or air involves a transfer to another mode, the ability to make efficient intermodal transfers and access to the necessary facilities are especially critical at ports and airports. While TEA-21 provides for significant opportunities and improvements in surface transportation, additional provisions and action will be needed to ensure that marine and aviation intermodal connections are adequate to meet current and projected freight and passenger demand in both domestic and international markets.

Several additional intermodal issues challenge public-sector planners and decision makers at all levels, military transportation and logistics personnel, and the commercial freight transportation and logistics sectors. These issues include logistics in a changing regulatory and technological environment, the impact of freight transportation service on global competitiveness, emerging energy and environmental concerns, national security requirements, and the continuing pressure to do more with less. In both the military and commercial sectors today, there is an ever-increasing demand 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 both to the new logistics processes and to market competitiveness. Such information also has implications with respect to safety and security and the ability to respond quickly to congestion, crashes, natural disasters, or intentional sabotage on any component of the transportation system.

In response to these concerns, TRB assembled a steering committee in 1998 to plan another in a series of national conferences on intermodalism. This conference will provide a forum for discussing current issues and practice in intermodal freight transportation planning and operations both in the United States and abroad. Topics to be addressed include freight capacity across all modes; intermodal connectors; technology standards; equipment trends; institutional relationships; and the implications of these factors for public-sector and military planners, private-sector service providers, and shippers.

Marine Transportation

Recognizing that interdependence among modes requires increased cooperation and communication, U.S. DOT and other federal agencies concerned with water resources launched an initiative to examine the marine transportation system and its intermodal linkages. Through a series of regional listening sessions, state and local agencies and stakeholders were given an opportunity to identify and discuss critical issues relating to competitiveness, safety, security, the environment, infrastructure, and technology. The material gathered from the regional sessions set the stage for a national conference during which senior leaders from the public and private sectors participated in a solution-oriented interactive forum on the use, management, and operation of the nation's marine transportation system and its intermodal connections.

The nation's ports and waterways are used by multiple and sometimes conflicting users, including commercial shipping services, passenger ferries, recreational boaters, fishing vessels, cruise lines, and gaming vessels. As the types and volume of traffic continue to grow, those who use and maintain the system face increasing economic, safety, and environmental pressures associated with aging infrastructure, dredging and channel depths, congestion, waterfront land use, and landside access. Fragmented and overlapping federal responsibilities, inconsistent interpretation of regulations, and poor communications have sometimes resulted in misplaced priorities and ineffective policies, as well as an increasing lack of understanding and appreciation.

While the marine transportation system is recognized as being vital to the nation's economy and security, how to pay for the system's maintenance and modernization is an issue of continuing debate among both policymakers and stakeholders. Finding an alternative to the harbor maintenance tax and securing the funding necessary to keep port projects on track continue to be top priorities in both coastal and inland port areas. While ocean shipping reform legislation passed in the final days of the 105th Congress, the failure to enact the Water Resources Development Act was a disappointment, particularly in states such as Maryland, Georgia, Florida, and California where major port projects may be delayed.

In the past year—designated by the United Nations as the Year of the Ocean—significant progress was made toward increasing awareness of the benefits and vital role of ports, waterways, and marine transport. Progress was also made in encour-



Scenes from Seattle—containerships at Port of Seattle (left) and recreational boaters at the Ballard Locks—illustrate multiple uses of ports and waterways.

aging researchers, planners, and policymakers to devote the attention and resources necessary to ensure that the nation's system of ports and waterways can function safely and efficiently as part of the overall national transportation network. The need to consider global transportation trends and requirements as well was evidenced in 1998 with the arrival of the first so-called "megaship" in North America. The *Regina Maersk* made stops at selected East Coast ports as Sea-Land and Maersk evaluated potential sites for their "port of the future." Despite the heightened awareness and new developments, much remains to be done. Industry will be looking to lawmakers and officials who have indicated that maritime affairs will be a high priority for the next Congress, with a focus on ocean shipping, as well as on the railroad, trucking, and port infrastructure needed to support the largest oceangoing vessels.

Aviation

Everyone in the transportation field, or certainly in the aviation sector, is familiar with the forecasts for significant increases in the demand for air travel. The challenge faced by the aviation community—from the Federal Aviation Administration technologists trying to improve and update the components of the National Airspace System to the airport operators and planners trying to meet the qualitative and quantitative needs of both passengers and air freight—is to match capacity with that demand.

State Aviation

From the state aviation planner's perspective, one of the most important, and least predictable, elements of the job is funding—both federal and state. Some states are blessed with a stable, predictable source of funding for aviation, but many states depend on the

Wiley Post Airport near Oklahoma City is an essential part of the regional system of airports.



mood of their legislature in any given year. A major challenge to those charged with managing the problem is effectively communicating the real needs of the state or region to their legislators. A solid, business-like case must be made and presented to key decision makers, or there will be little hope for improvement in the system. Stability—or at least predictability—in federal funding would also be helpful in providing a basis for the development of a rational, coherent approach to meeting existing state needs. As in the past, the large commercial airports are generally well equipped to compete for funds. However, meeting future capacity demands will require the efficient integration of lower-tier airports, which have fewer financial options; adequate and efficient intermodal access (as discussed earlier in this section) will also be necessary.

Airports

Those responsible for airport infrastructure believe that in principle, the expected doubling of passenger (and cargo) demand within the next 10 years can be met by investing \$4–10 billion each year. Even if funding were ensured (which, as noted above, is not the case), targeting of that investment poses several critical-path problems. One such problem is that differing growth rates among airports create the potential for choke points within the system. In addition, volume increases (both passenger and cargo) may force traffic away from larger airports to lesser facil-

ities that may not have had the funds or lead time required to meet the new demand. If these smaller airports cannot respond, already burdened major hubs may be unable to expand capacity rapidly enough to meet the increased demand. Capacity, safety, and security are only three of the issues that will necessitate the expenditure of significant resources as demand rises. The cooperation of state and regional planners, as well as federal assistance, will be necessary to accommodate these pressing needs. Although balancing the economic viability of many smaller airports against the political need for these airports is a difficult task for planners at the state level, many of those interviewed during the field visits suggested that some sort of triage must be done for the survival of the most competitive (and economically beneficial) facilities.

Commercial Aviation

Commercial aviation (major airlines, regionals, and business aviation) has had an outstanding year, setting records in a number of categories. This success has in turn resulted in strong union demand to recoup concessions offered during the lean years and made contract negotiations considerably more contentious. Alliances, mergers, and codesharing (e.g., United/Lufthansa, American/British Airways), while offering untapped opportunity for even greater profits, have already had some negative impact on competitors and regulators. The full effect of such trends is uncertain, and both Congress and consumer groups are concerned about a lack of competition and potential monopolies.

Regional airlines, now highly sophisticated organizations, are expanding even more rapidly than the majors. With the advent of regional jets and inextricable ties to major airline marketing partners, the regionals are setting records. Business aviation, bolstered by a solid economy and the fractional ownership concept, is also on a sound basis. Fractional ownership involves the shared leasing of one or more aircraft among multiple corporate owners. This relatively new idea has expanded the business aviation market significantly. Many smaller companies are now able to share access to a corporate aircraft that they could not afford to own/operate on their own. Business and general aviation are both concerned about their vulnerability to regulatory action, the greatest concern being the levying of user fees. Should such fees be imposed, these operators would be less able to pass costs on to their customers, and their economic health could change overnight as a result. Finally, rotorcraft markets are expected to remain stable. Key factors here are new technology and the regulatory environment.

Air Cargo

Air cargo, critical to world distribution systems and expanding at a remarkable pace, is still in its infancy. Forecasts call for a threefold expansion by 2015. Meeting this demand requires much more than competing for land and airside capacity and real estate. Indeed, meeting air cargo demand is an excellent illustration of the need for thinking intermodally. Customer satisfaction and the competitive efficiency of U.S. businesses do not depend on how the system works, only *that* it works. To this end, business and government at all levels must develop a rational, integrated system of transportation that responds to demand by providing the most efficient and seamless services possible.

Safety

An extremely broad term covering a variety of issues and concepts, safety has always been a critical concern and is increasingly drawing the attention of both government and industry. The sheer volume of programs and intensity of interest in the subject should be useful in advancing the goal of significantly reducing accident rates as the volume and density of air traffic increase. The FAA's programs, along with those of the National Aeronautics and Space Administration, the Flight Safety Foundation, the Airline Pilots Association, and the Air Transport Association, to mention just a few, are coordinated to varying degrees and focused on multiple risk areas. There are questions, however, regarding the ideal balance among these independently sponsored safety programs. Clearly there is already a steady cross-pollination of both people and ideas. One question raised repeatedly during the field visits concerned the need for, or wisdom of, coordinating or synchronizing these widespread efforts in order to improve the safety levels of the entire system, both nationally and internationally. How should or could this be done, and by whom?

Environment

There have been significant gains in protecting the environment, yet opposition to aircraft and associated noise, traffic, and runoff problems remains a major deterrent to the development of the infrastructure needed to meet future requirements. There is confidence that technology will continue to improve the situation, as well as to boost productivity, but compliance with environmental requirements will add to system costs. To illustrate, in one state \$50 million of a \$90 million dollar runway construction project was spent on environmental compliance.

Research

A perception often voiced by state officials is that there is essentially no nationally supported aviation research program that addresses research needs collectively identified and endorsed by the states as important issues. As aviation research funds are very limited, many states end up with rather fragmented efforts—spot research, rather than a comprehensive, long-range approach to nagging issues such as improved methods of traffic counting or low-cost solutions to deteriorating pavement at small, non-commercial airports.

Rail

U.S. railroads experienced a record-breaking year in 1997 by two measures of freight transportation: nearly 8.7 million intermodal trailers and containers were handled, and the total volume of freight transported topped 1.3 billion ton-miles. Both measures surpassed the previous records, set in 1996. These new records were set despite serious congestion problems in several parts of the country during much of the year.

The U.S. railroad map continues to change now that the Surface Transportation Board (STB) has approved the purchase of Conrail by Norfolk Southern (NS) and CSX. This transaction creates two strong competitors that will, in fact, return competitive rail freight service to many areas of the eastern United States where such service has been lacking for decades. The STB views the merger of portions of Conrail with NS and CSX as a source of substantial public benefits. Because of safety concerns that had arisen from previous railroad mergers, the Conrail sale was subjected to unusual scrutiny. NS and CSX were required to prepare detailed Safety Integration Plans, explaining how

Aviation research needs include low-cost solutions to deteriorating runways and taxiways.





Supply of railcars is a critical issue with bulk shippers, who rely heavily on rail service to move their products.

they proposed to provide for the safe integration of portions of Conrail into their respective systems, as a condition for STB approval.

By spring 1999 the map will change still further if the STB approves the acquisition of the Illinois Central by Canadian National. The result would be a Canadian-U.S. system extending from coast to coast and to the Gulf of Mexico. This merger is intended to provide a larger area of single-line service and produce operating efficiencies.

State DOTs have a number of concerns related to freight railroads because actions taken by rail carriers frequently impact the economies of the communities involved. Preservation of competition in mergers helps ensure the quality and cost of service needed by businesses to remain competitive. States that sponsor programs to help maintain shortline railroads base these investments largely on the benefits of employment by the industries and businesses that rely on rail freight service. State economies dependent on agricultural products are impacted by the supply (or shortage) of grain cars to meet shippers' seasonal needs. Impacts can result from the abandonment of rail lines or from the sales of lines to regional and shortline carriers that frequently follow mergers of large carriers.

The degree to which states react to these concerns varies. Some states make substantial investments each year, particularly in maintaining shortline railroads; an example is Pennsylvania, where the number of shortlines has risen by nearly 25 percent in recent years. Other states are constitutionally prohibited from investing in privately owned railroads. In a unique case this year, the Colorado state legislature took the initiative to appropriate funds for the purchase of an abandoned rail line that will be sold or leased to a shortline operator. A number of states are making significant investments in rail access to ports, where in many cases highway access for moving intermodal containers is increasingly congested.

TEA-21 provides several new funding mechanisms that can be used for railroad projects.

State concerns about passenger rail focus on the future of Amtrak's conventional rail services, as well as on potential high-speed rail development as an option for providing increased passenger-carrying capacity in high-density corridors. Florida and California are continuing efforts to finance true (i.e., 125 mph or faster) high-speed rail developments. A number of other states are planning incremental high-speed rail operations, whereby investments are aimed at higher speeds in staged development, generally using existing freight lines. For example, the Midwest Regional Rail Initiative is a cooperative effort of nine midwestern states, Amtrak, and the Federal Railroad Administration that involves developing a plan for more frequent, reliable, and intermodally accessible passenger rail service at speeds up to 110 mph on a 3,000-mile network with Chicago as its hub. In addition, Amtrak's plans for high-speed service on the Northeast Corridor are progressing; electrification between New Haven and Boston is well under way, and new trainsets now being built will soon be available for testing.

Given the record volumes of traffic on many freight corridors, conflicts occur between schedules for freight and passenger trains. These conflicts are complicated by several factors, including liability issues, compensation for the freight railroads that own the rail lines, and capacity constraints. A potential solution to capacity constraints lies in the development and implementation of positive train control technology. FRA, the state of Illinois, and the Association of American Railroads are embarking on a joint project to develop positive train control that will be used initially for a line in Illinois, but is intended to have nationwide benefit and applicability to other corridors.

The Amtrak Reform and Accountability Act of 1997 created a \$2.3 billion capital fund to help the passenger railroad system attain the goal of financial viability by 2002. In the interim, annual operating appropriations are still required. The STB has approved Amtrak's movement of express freight shipments on its trains to raise additional revenue. And the planned high-speed rail service on the Northeast Corridor is projected to boost ridership and revenue significantly.

Rail safety statistics continue to show improvement. Of great concern to both industry and public officials is the issue of grade-crossing safety. FRA and several states are undertaking a variety of R&D initiatives to improve the safe operation of grade crossings. Examples are North Carolina's sealed

corridor approach and New York's public-private Intelligent Rail Crossing project. Many western and midwestern states continue to face the issue of delays for motorists at grade crossings because of the increasing movement of long coal trains. These issues are difficult to resolve because of the cost and impracticality of constructing grade separations at all the affected crossings.

Transit

Overall, it has been a rather remarkable year for transit. The passage of TEA-21 heralds dramatic changes and advances for the transit sector, demonstrated by the following elements of the legislation:

- ◆ Over the 6 years covered by the act, \$41 billion for transit programs, \$36 billion of which is guaranteed
- ◆ Increased funding for all transit program components
- ◆ Preventive maintenance as an eligible formula expenditure
- ◆ Small urbanized area transit agencies permitted to use all formula funds for capital or operating needs
- ◆ Preservation of the federal-state-local partnership established under ISTEA
- ◆ Retention of ISTEA's flexible funding provisions
- ◆ Expanded considerations for new-start criteria (reduced infrastructure costs due to compact development, cost of sprawl, population density and current ridership, and technical capabilities of grantee)
- ◆ Substantial special programs (magnetic levitation [MAGLEV], high-speed rail, welfare-to-work, coordinated border-crossing infrastructure development, ferry boats and terminals)



TEA-21 includes provisions for the National Ferry Study, now under way within FHWA, and funding for ferry service development.

- ◆ Increase in nontaxable transit and vanpool benefits from \$65 to \$100 per month after December 31, 2001

If fully funded over the 6 years of TEA-21, transit will benefit from a rare opportunity to maintain and improve its operations.

As in earlier years, rail systems continue to expand in both mileage and service. Light rail is under consideration in Minneapolis-St. Paul, Minnesota, and intercity rail is being analyzed in Florida. Commuter rail in Madison, Wisconsin, and monorails in Seattle, Washington, and Irvine, California, are distinct possibilities. Already open for service in Boston, Massachusetts, is an automatic peoplemover system.

Interest in bus rapid transit as an alternative to rail has grown significantly. Advanced-technology bus fare collection systems are being installed, and the potential of ITS in the areas of dispatching, maintenance, customer service, and safety is being explored. Many systems are beginning to incorporate low-floor buses. Fixed-route and paratransit services are becoming more responsive to provisions

Participants at TRB Rail Passenger Caucus, held November 1998, view San Diego LRT extension.



of the Americans with Disabilities Act (ADA) and other specialized transportation needs of their riders, including those in rural areas. ADA certification of paratransit rider eligibility continues to be a difficult issue, however.

Transit safety and security are a high priority of operators. It is difficult to prevent grade-crossing accidents, especially in suburban fringe or rural areas, if drivers do not heed warning devices. Personal security among riders appears to have improved on many urban systems; however, the threat of terrorism cannot be discounted. International terrorist groups have announced the targeting of American urban infrastructure systems, especially during early spring 1998, when U.N. military forces were ready to take action in the Middle East. An issue of a different sort is the potential impact of the Y2K computer software problem on transit operations.

Highway Transportation

Design

During the past few years, staff reductions have made it necessary for many highway agencies to increasingly contract out design work to the private sector. The emphasis today is on design-build projects, in which the same contractor both designs and constructs the project. The I-15 reconstruction project in Utah is one of the most visible projects utilizing this concept. Some states may not contract this way because of legal restrictions, but many of those states in which design-build is permitted have already applied the concept.

Flexibility in highway design is another topic of considerable interest, especially since publication of the FHWA document *Flexibility in Highway Design* (1). Some states, such as New Jersey, have stricter standards than those in the AASHTO Green Book, whereas others allow more lenience, especially on lower-volume roadways. States continue to value information from management systems, such as pavement and bridge management systems, for use in enhancing the decision-making process.

There is considerable interest in NCHRP Project 1-37, which has the objective of producing a revised AASHTO guide for pavement design by the year 2002. In the past, pavement design has been carried out primarily with equations based on empirical data. The revised AASHTO guide will rely on mechanistic design, which is based on the mechanical properties (stresses, strains, and deflections when subjected to loads) of pavement materials. These mechanical properties must be related to distresses (e.g., cracking, rutting, rough ride), and empirical

data are required to form these relationships. The SHRP Long-Term Pavement Performance (LTPP) database and information from the states' pavement management systems provide these empirical data, not only for calibration, but also for improved prediction of pavement performance. Emphasis remains on design for rehabilitation, rather than on new pavements on new alignments. Rapid, automated, nondestructive pavement testing of surface condition, structural support, and thickness is essential.

Bridge designers are using the load and resistance factor design (LRFD) specifications developed under an NCHRP project and adopted by the Subcommittee on Bridges and Structures of AASHTO's Standing Committee on Highways. Computer programs that facilitate the design process are becoming available and continue to be improved. Susceptibility to scour and mitigation techniques at bridge piers and foundations are other aspects of structures receiving considerable attention.

In general, the states are using NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, for the selection of new roadside safety appurtenances. However, there is concern about the magnitude of the effort required to upgrade these appurtenances, as well as legal aspects and possible future revisions to the procedures. International harmonization of testing and evaluation procedures for roadside safety features is being pursued by FHWA.

States appear to be moving away from the use of metric (SI) units since mandates for their use have been removed. Some states have passed local laws directing agencies to continue to use English units. Others have experienced resistance by contractors. Some states, however, have elected to proceed with adoption of metric units for plans and specifications.

Materials and Construction

State transportation agencies continue to focus on the implementation of Superpave and the use of high-performance concrete. Approximately 40 states should be using the Superpave performance-graded asphalt binders by early 1999, and as many states should be using the mixture specifications by the year 2000, the target date for full implementation. Experimentation with high-performance concrete is now being directed to pavements as well as bridges. A few states also plan on using high-performance steel in bridges in the near future.

Retirements, mandated reductions in force, growing numbers of new tests and materials, and increasing construction workloads challenge state materials and construction engineers. More states

are beginning to adopt new material acceptance procedures and to use contractors and consultants for quality control assurance as they strive to maintain high-quality construction. A major challenge for many states is developing a comfort level with changes in the construction and materials acceptance process.

With most construction projects now in the categories of rehabilitation and reconstruction, there is a major concern, primarily from states with large metropolitan and urban areas, about the renewal of highways and bridges subjected to high traffic volumes. These states are considering designs that will last longer and require minimal maintenance. They are also seeking and experimenting with construction techniques that minimize impacts on motorists and businesses. The California DOT, Caltrans, was the first to take the lead in addressing this problem by sponsoring a workshop on the topic.

Constructibility reviews, nighttime construction, and innovative contracting practices are all being used by states in varying degrees as they cope with the reconstruction, rehabilitation, or improvement of existing facilities. States are beginning to look more closely at the concepts suggested in the recently completed NCHRP project on constructibility and are seeking to mitigate the annoyances associated with nighttime construction.

Recycling remains a continuing standard operating procedure for most state transportation agencies. Recycled materials include reclaimed asphalt pavement in hot-mix asphalt, as well as a host of other resource materials not recovered from transportation facilities or traditionally used in transportation.

Soils, Geology, and Foundations

Rockfalls and landslides have continued to pose major problems for several states, and the increase in precipitation from El Niño has added to these problems. In rockfall-prone areas, roadside ditches are constructed as catchment areas for rocks that roll down the slopes. In 1997 several states contributed to a pooled-fund study, conducted in Oregon, aimed at refining the design criteria for these roadside ditches.

Along with the routine tests used for evaluating aggregates, some states are considering the use of image analysis and such techniques as X-ray diffraction, X-ray fluorescence, and thermogravimetric analysis. NCHRP has projects whose objective is to recommend a suite of tests for evaluating the performance of aggregate used in asphalt and concrete pavements and unbound layers. A few states have ongoing investigations on alkali silica reactivity.



Central Artery/Tunnel Project in Boston, Massachusetts, is example of urban highway renewal.

These include research on the mitigation of such reactivity through the addition of Type F fly ash and/or lithium nitrite, and the development of rapid methods for identification of virgin aggregates susceptible to the problem, as well as recycled concrete containing the suspect material.

The most common method used to evaluate soft and unsound aggregates is the sulfate soundness test. The general consensus among the states is that a better test is needed to improve performance predictability. A large number of states have some experience in the use of flowable fill, also known as controlled low-strength material, and most have some type of specification to ensure the quality of the material.

Use of lightweight materials, such as tire shred, is on the rise. Many states have completed or planned projects involving the use of tire shred as fill material for embankments. A few states have good experience with the performance of embankments constructed of tire shred, while many are still monitoring experimental projects. Other uses being investigated for scrap rubber include construction of drainage structures and repair of landslide areas. There is limited experience with the use of expanded polystyrene as a lightweight fill material, but a few states are considering pilot projects. For non-traditional materials such as tires, fly ash, and bottom ash, most states require information on the environmental effects of using such materials, in addition to their engineering properties.

In the foundation area, use of drilled shafts has increased. The integrity of the shafts is evaluated using nondestructive test methods. The most common method used for this purpose appears to be the

cross-hole sonic log. This method determines the characteristics of a subsurface foundation by analyzing the return signature of sonic waves sent through a borehole drilled parallel to the foundation. Only a few states have any experience with the LRFD method for pile foundations, but many have plans for implementing this method in the near future.

The chronic problem of the bump at the end of the bridge has continued, and there appears to be no effective solution. The approaches most commonly used to mitigate the problem are obtaining better compaction of fill material, using an approach slab, using lightweight material to minimize differential settlement, and achieving complete settlement of embankment by some means before initiating construction.

The surveying of bridges for scour susceptibility has been a major task. Some states have monitoring efforts that employ sliding collars, fixed sonar, movable sonar, and floatouts. Riprap appears to be the most common countermeasure for mitigation of scour. Other countermeasures being used or tested include gabion mattresses, cable-tied blocks, and concrete lining. There are some efforts directed at the use of remote sensing devices to monitor and detect critical scour conditions during storm events.

Maintenance

Worker safety and the safe and efficient movement of traffic through work zones remain a top priority for transportation agencies. Double fines for speeding in work zones are common in most states. The number of truck-mounted attenuators in use continues to increase as maintenance workers hail the devices as lifesavers. Increases in driver aggressiveness are adding to concerns for worker safety.

New maintenance management systems using geographic information system and global positioning system technologies are being developed and implemented by several agencies. In addition to recording equipment, materials, and labor expenses, these systems can accommodate information on asset condition by location, as well as forecast workloads. Laptop computers are being used increasingly by field units to input maintenance activity data, access agency information systems, transmit weather information, and communicate via e-mail over the Internet. Regional working groups have been found to be an effective mechanism for improving the transfer of information on bridge maintenance and inspection.

Many agencies are investigating the use of preventive pavement maintenance programs as a means

of optimizing the use of scarce resources. Preventive maintenance activities applied at the appropriate time have led to a sixfold reduction in rehabilitation costs. The major obstacle for an agency shifting from a worst-first policy to a preventive pavement maintenance program appears to be obtaining a long-term commitment from the public, the legislature, and upper management. Good experiences have been reported with the use of automated pothole patchers and crack-sealing machines to improve the efficiency and effectiveness of pavement maintenance operations.

Strategic maintenance planning discussions have focused on the development of public outreach initiatives to identify stakeholders and share success stories that illustrate the benefits of system preservation. Integral to these activities is the need to champion the implementation of improved products, including materials, equipment, and technologies that can improve the efficiency and effectiveness of maintenance operations. Also being discussed is the need to develop guidelines for improving the prioritization of system preservation activities and to communicate the benefits of a proactive system preservation program to the maintenance community.

Maintenance quality assurance programs based on statistical sampling are being explored as a means of assessing levels of service. Quality initiatives are being used to improve customer relations, and phone surveys are helping to determine how well these initiatives are doing. Other agencies are finding focus groups and advisory committees more effective than surveys at identifying customer needs. Quality review processes are being used to improve maintenance procedures and the use of materials.

During the field visits, increased use of contractors to supplement agency forces in the conduct of maintenance activities was noted. While several agencies expressed satisfaction with their efforts at contracting maintenance activities on selected roadway sections, others expressed frustration with contractors that fail to comply with contract requirements. Emergency response capabilities are another growing concern in the maintenance community as agencies are required to reduce the numbers of employees through early retirement programs and legislatively mandated reductions in staffing.

AASHTO's Snow and Ice Cooperative Program is a focal point for state and local agencies to evaluate and implement new technologies in winter maintenance operations. Ground-speed controllers used to adjust the dispensing of materials to truck speed were described by several agencies as cost-effective investments. There were mixed reports on the effec-

tiveness of anti-icing techniques in improving traffic safety during winter events and reducing the need for deicing materials. Field crew attitudes and training appear to be key elements in the successful application of anti-icing techniques. Agencies are also continuing to install and network road weather information systems as a new source of both real-time and forecast information to improve winter maintenance operations (although maintenance supervisors must be given sufficient time to determine the accuracy and reliability of the information provided by these systems and how it should be used in the decision-making process). Thermal mapping has been cited as an effective means of improving a road weather information system network. Several agencies are examining the idea of distributing the information from these systems to the public at rest areas and via the Internet. To ensure consistency across jurisdictional lines, standard protocols for the presentation of weather information are being developed.

Efforts to identify best practices in vegetation management are focused on activities of adopt-a-highway programs, wildflower management activities, reduction of herbicide usage, and effective landscaping practices. Use of rest areas by commercial vehicles, privatization of rest areas, and expansion of utility locations on rights-of-way were noted as areas of concern by a number of states. Lead-based paints, cradle-to-grave treatment of hazardous materials, stormwater runoff, wetlands, environmental awareness training, and handling of alternative fuels were identified as continuing environmental maintenance issues. Encapsulation was noted as a viable option in addressing bridge painting issues.

The Iowa, Minnesota, and Michigan DOTs are continuing their cooperative efforts to develop basic maintenance vehicles with a global positioning system, telecommunications capabilities, surface and temperature sensors, materials applicators, vehicle weight sensors, and road surface friction meters. Several agencies noted the need to upgrade and integrate their equipment management systems along with other agency information systems, and the need to develop a computer-based model for optimizing equipment replacement.

Traffic Operations

Traffic operations continue to be a major focal point in transportation. Continuing increases in congestion, rapidly advancing technology, deployment of ITS, reductions in the public-sector workforce, environmental concerns, and public-private partnerships, among other factors, are affecting the way

traffic engineers are and will be providing transportation services.

The ITS program has served as a catalyst for initial efforts to build and deploy an infrastructure that is moving ITS from research and development into everyday practice. A major development in the traffic operations area is the integration of subsystems with real-time control adjustments to respond to traffic fluctuations.

The Intelligent Vehicle Initiative (IVI) is a collaboration among government, industry, and academia aimed at applying computer, communications, and vehicle control technologies to the vehicle-highway system. The program was established because research has demonstrated that intelligent vehicle control technology has the potential to offer major improvements to existing highways in both safety and efficiency.

The development of IVI technologies is becoming a reality as many of the processing and communications capabilities are increasingly incorporated in the design of today's vehicles. In the near future, vehicle manufacturers will install in-vehicle computing technology that will offer such IVI features as location and route guidance, adaptive cruise control,

Highway Capacity Manual

TRB Special Report 209, *Highway Capacity Manual* (HCM), is one of the most widely used documents in the transportation community. Translated into several languages, the HCM is the standard reference on which transportation analysts around the world rely for state-of-the-art methods. In 1997 TRB published a major update to the manual that incorporates revisions to nine chapters. Extensive revisions were made to Chapter 3, "Basic Freeway Sections"; Chapter 9, "Signalized Intersections"; Chapter 10, "Unsignalized Intersections"; and Chapter 11, "Urban and Suburban Arterials." In addition, Chapters 1, 4, 5, 6, and 7 were modified to make them consistent with the other revised chapters. The new chapters continue to use U.S. customary units in order to maintain consistency with the remaining chapters of the HCM. However, a Metric Analysis Reference Guide is also provided, and this document details the conversions necessary to conduct a metric analysis. The *Highway Capacity Manual* was recently issued on CD-ROM.

Despite the extensive improvements incorporated in the 1997 update of the HCM, plans are under way for a complete revision in the year 2000, largely as a result of research conducted under the National Cooperative Highway Research Program. The HCM 2000 will be published in both print and multimedia (CD-ROM) formats. Ongoing research in freeway weaving, freeway systems, two-lane highways, transit capacity, bicycle and pedestrian capacity, interchange ramp terminals, and enhanced procedures for transportation planning will be included.

To order the print and CD-ROM versions of the current *Highway Capacity Manual*, use the Publications Order Form in this issue, contact the TRB Business Office (202-334-3214), or use TRB's on-line bookstore (<http://www2.nas.edu/trbbooks/>).

enhanced vision systems, and collision warning and avoidance systems.

Nonrecurring traffic congestion that results from accidents and vehicle breakdowns accounts for more than 60 percent of the delay on the nation's urban freeway system. As a result, techniques for freeway incident management are the subject of considerable interest in many states and urban areas. Incident management involves the clearing of accidents and breakdowns quickly and the efficient management of congested traffic during the incident. Many areas of the country already have comprehensive incident management programs in place, and others are in the process of developing such programs. Studies of existing incident management programs clearly prove that they are cost-effective in reducing traffic congestion, enhancing safety, and improving air quality.

Light-emitting diode (LED) devices are also being introduced rapidly into the transportation market as advances in semiconductor technology make these devices technically and financially feasible for public agencies seeking alternative illumination technologies to reduce life-cycle costs. Although LED technology is relatively new, the perceived cost-effectiveness of the devices has resulted in their rapid acceptance for such traffic control

products as traffic signal lamps and changeable message signs. The principal benefits of LED devices are the reduction in power consumption and improved durability due to their solid-state design. In addition, their flexibility could potentially allow alternative designs for traffic control devices. For instance, a single-head traffic signal utilizing LED technology to form different shapes for each signal phase will soon be tested. However, since this technology is still relatively new, there remain gaps in knowledge regarding the devices' long-term durability and conformance to color and intensity standards.

Issues related to the use of high-occupancy vehicle (HOV) lanes and high-occupancy toll (HOT) facilities have recently emerged. Some areas of the country are reexamining their use of HOV lanes because of a perception that the lanes are underutilized. In one state, this reexamination has resulted in the conversion of an HOV lane back to a general-purpose lane. Other localities are examining the use of HOT lanes as an alternative to HOV lanes.

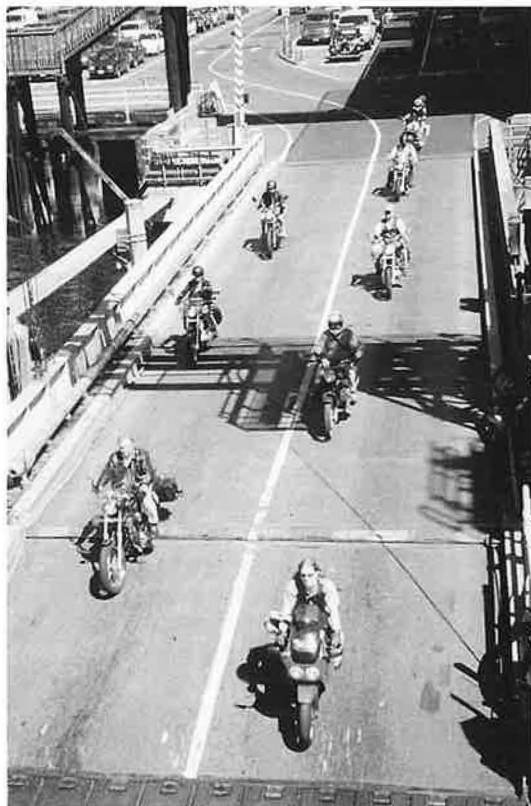
There are essentially two HOT lane concepts. The first, implemented on Route 91 in Orange County, California, is to allow carpools and vanpools free access to the toll facility. The second concept, implemented for the I-15 HOV lanes in San Diego, California, is a "value-pricing" project that allows single-occupant vehicles to use the existing HOV lanes for a fee that varies dynamically in response to traffic volume. Both of these alternatives to HOV lanes are generating a considerable amount of interest and debate.

Safety

One provision of TEA-21 is an incentive program to assist states in upgrading crash record information systems. To qualify for the maximum incentive, a state must meet several criteria, such as completion of a traffic records assessment and establishment of a traffic records coordinating committee and plan. States with an active safety management system already have such a coordinating committee in place as part of that system.

Using linked medical data from the Crash Outcome Data Evaluation Systems of seven states, the National Highway Traffic Safety Administration clearly demonstrated the safety and cost/benefits of motorcycle helmet laws. While helmets are only 36 percent effective in preventing deaths, they are 65 percent effective in preventing brain injuries.

Safety zones have been used for many years around schools to safeguard child pedestrians. More recently, this concept was applied to reducing pedestrian injuries and fatalities among older adults. Persons age 65 or older accounted for 12.8 percent of



Adherence to safety differs among individuals, as demonstrated by inconsistent use of motorcycle helmets.

the population in 1996, but 22.4 percent of pedestrian fatalities. A method for developing older-adult pedestrian zones was devised and applied in Phoenix and Chicago; these zones accounted for 52–54 percent of older-adult pedestrian accidents. A variety of engineering improvements, such as overhead pedestrian warning signs, trimming or removal of obstacles to sight distance, improvements to sidewalks and/or signals, installation of rumble strips before a high-use crosswalk, and public information and education countermeasures, were used in these zones. An impact evaluation conducted in Phoenix showed that although total accidents (pedestrian and vehicular) increased citywide during the study period, accidents involving older pedestrians decreased by 13.7 percent. Most significant, there was a 46.3 percent decrease in total pedestrian accidents in the older-adult pedestrian zones. Pedestrian accidents in comparable areas outside the zones increased 9.9 percent. Thus, the zone concept and the countermeasures applied were successful in reducing both older-adult and other pedestrian accidents within the zones. A guidebook entitled *Zone Guide for Pedestrian Safety* (3) was developed for use by any organization working to increase pedestrian safety in its community, and is available from NHTSA.

Alcohol involvement in fatal crashes, while once again decreasing, is still at 38 percent. Continuing efforts to identify and implement successful countermeasures are a high safety priority. Maine, for example, reduced the threshold for driving under the influence for repeat offenders from .10 to .05 blood alcohol content (BAC). A 6-year follow-up study concluded that this group's involvement in fatal crashes had decreased by 25 percent. Given the success of that project, Maine is now reducing the BAC level for a convicted repeat offender to zero.

California evaluated the deterrent effect of vehicle impoundment on unlicensed drivers and those with suspended or revoked licenses. There were 18 percent fewer traffic convictions and 25 percent fewer accidents among such drivers with no previous conviction whose vehicles were impounded than among such drivers whose vehicles were not impounded. The results were even more dramatic among repeat offenders whose cars were impounded: 34 percent fewer convictions for driving with a sus-

pended or revoked license, 22 percent fewer traffic convictions, and 38 percent fewer accidents. Thus California found strong support for impounding vehicles driven by unlicensed drivers and by those with suspended or revoked licenses.

Another technique for dealing with drivers with suspended or revoked licenses was used successfully in Ohio County, West Virginia, and Salt Lake County, Utah. A "hot sheet" listing a small proportion of drivers suspended for impaired driving was distributed to police agencies. The number of drivers arrested for operating after license suspension or revocation increased by 14 percent in Salt Lake County.

Safety audits are being demonstrated and pilot tested in several states. The concept of the safety audit is to identify safety-related design and operational problems during engineering and design, instead of after construction. Early identification and correction not only improve safety performance, but also reduce the cost of retrofit fixes.

Three-dimensional visualization has many uses, including design review from a safety perspective, and is being used in several states. For example, South Carolina successfully changed public opinion on a proposed bridge rebuild after 3-D animation accurately portrayed the design and operation of the proposed bridge to the affected community. To introduce 3-D visualization to decision makers and engineers, TRB developed a 10-minute videotape based on the 1995 Conference on 3/4D Visualization in Transportation and NCHRP Synthesis of Highway Practice 229, *Applications of 3-D and 4-D Visualization Technology in Transportation*. A 20-minute videotape providing more technical information is also available.

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