

HIGHWAY RESEARCH AND INNOVATION

ROLE OF THE PUBLIC SECTOR

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Americans depend on highways for personal, business, and commodity transportation. In turn, highway agencies depend on research and technology programs—including basic and applied research, development, demonstration, technology transfer, and education—to provide the means to make highways longer-lasting, more efficient, safer, and less damaging to the environment. Public agencies play a key role in directing, supporting, and delivering the results of research and in transferring technology. The efforts of the public sector in this capacity are of increasing importance as the nation's highway system faces serious problems, such as worsening urban and suburban traffic congestion, traffic accidents, continuing air-quality problems in many metropolitan areas, and a growing list of rehabilitation and repair needs that compete for declining public resources.

The highway system is large by any measure: approximately 6.2 million kilometers (3.9 million miles) of roads, streets, highways, and bridges administered by an estimated 39,000 agencies at the federal, state, county, and local levels. Many more private firms are involved in highway construction and maintenance and highway transportation-related activities; at least 20,000 firms are involved in construction and maintenance activities alone. Although large, this highway industry is fragmented and decentralized, with many small firms doing business locally or regionally within a single state; in 1991 only about 12 percent of highway-construction contractors performed work outside their home states. The industry is predominantly comprised of small businesses with small profit margins and little incentive for innovation, in part because the products they deliver—primarily basic materials such as asphalt, concrete, and aggregates—must meet highly detailed design specifications. The objec-

tive of these specifications is to protect the public's investment, but such requirements may also discourage new or innovative products. Each of the numerous large public agencies involved in highway transportation acts as a monopoly in its own market, so market-based incentives for improvement do not apply to them. Low-bid contracting procedures often preclude better products that can improve performance or reduce life-cycle costs. The result is little opportunity or incentive for private research to identify and deploy better products.

Expenditures for highway research and technology have historically been low, as reported in Transportation Research Board Special Report 244, *Highway Research: Current Programs and Future Directions*. The highway industry spends on the order of 0.3 percent of total highway expenditures on research and technology—less than traditionally low-technology industries such as paper products, primary metals, and petroleum refining, which spend about 0.9 percent of their revenue on such activities. Despite limited investment there have been significant successes in several areas of highway research. The opportunity exists for further improvement, particularly because nearly one-half of all highway expenditures are for construction, reconstruction, and other capital outlays for which even small cost savings or product improvements could translate into major benefits to the nation. Without sufficient support for research, however, additional improvements and benefits will not be forthcoming.

TANGIBLE RESULTS OF RESEARCH

The major source of new products and innovation for the highway industry consists of three public-sector programs: the Federal Highway Administration's research, development, and technology transfer program, the research portion of the State Planning and Research Program, and the state-

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supported National Cooperative Highway Research Program administered by the Transportation Research Board. In 1993 expenditures for these programs totaled approximately \$275 million and covered a broad range of topics. Among the many examples of success in these programs, two stand out: advances in highway safety and improved methods for pavement construction and maintenance.

Improvements to Highway Safety

Motor-vehicle crashes are a leading cause of death and injury in the United States. The National Highway Traffic Safety Administration estimated lost productivity, medical costs, and property damage to be more than \$137 billion in 1991. Efforts to reduce this costly toll—on the basis of research to identify, develop, and evaluate safety strategies and interventions—have yielded significant improvements in safety performance. Although motor-vehicle travel has more than doubled since the mid-1960s, the number of deaths per million vehicle-miles traveled has been reduced by more than one-half. If improved performance is to be sustained, persistent highway-safety problems such as substance-impaired driving, crash risks among young drivers, and hazards to pedestrians safety will continue to demand attention. In addition, emerging problems such as the growing population of older drivers, more trucks and combination trucks, and safety implications of intelligent transportation system technologies will have to be addressed.

Many factors have contributed to the improvement of highway safety, including more forgiving highways, more crashworthy vehicle designs, increased use of occupant restraints, and growing public intolerance of substance-impaired driving. These improvements are the result of systematic research by the private and public sectors to identify, design, and test alternative solutions to highway-safety concerns. Engineers now have better information for making design decisions about highway curves, grades, and ramps for the wide range of passenger cars, trucks, and buses on the road. Research has also led to the development of crash cushions, breakaway supports, and longitudinal barriers that reduce the potential for extensive property damage and injury if drivers run off the road. Materials for higher sign reflectivity and more visible traffic-control devices have also resulted from investment in research.

Pavement Construction and Maintenance Cost Savings

The recently concluded Strategic Highway Research Program, a highly focused five-year, \$150 million research program, was aimed at developing better ways to build and maintain roads and bridges. Conceived and funded by the state highway agencies, the objective of SHRP was to achieve more substantial benefits than the incremental improvements that had been made over the years. One result was a breakthrough in asphalt-pavement mix-design procedures, called Superpave™, that yields an asphalt mix that can be

Public investment in highway research has contributed to such technology advances as the rock-containment system being installed along Interstate 75 in Kentucky.



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Worker installs special netting to prevent rocks from falling into roadway along I-75, Kentucky.

customized to a site's specific traffic loads and climatic conditions. The resulting pavement resists rutting and cracking and lasts longer, improvements that yield substantial time and cost savings for the driving public. Colorado highway officials found that a Superpave asphalt mix design costs approximately \$70,000 (\$1 per metric ton) more than a conventional mix, yet would ultimately save an estimated \$5 million on a 12.8-kilometer (8-mile) stretch of highway over a projected 10-year design life.

SHRP addressed another topic that had not received much research attention in the past but affects many drivers: winter maintenance. Research showed that an anti-icing strategy involving the application of materials to the pavement to lower the freezing point of water helps prevent snow and ice from forming, making driving safer and plowing operations easier. Anti-icing strategies were found to be less expensive and time consuming than traditional deicing operations. In Maryland the anti-icing strategy has proven to be more environmentally benign, reducing the need for sand and salt to maintain traction in the winter and minimizing costly roadside clean up in the spring.

SUMMARY

Applied problem-solving research is integral to the current and future success of the nation's highway system. Such research provides answers to the wide range of questions related to the delivery of safer, longer-lasting, and more cost-effective highways. The fragmentation, decentralization, and procurement procedures of the highway industry give the private sector little incentive to adopt innovative products or processes or to seek them by supporting research. As a result, the public agencies that own and operate the nation's highways rely on federal and state research programs for the innovations necessary to improve the financing, planning, traffic operations, safety, construction, maintenance, and rehabilitation of the highway system. Public programs also make up the core of technology-transfer activity in the highway industry and are an essential link between the agencies that sponsor and undertake research and the owners of the highway system.

In Special Report 244 TRB's Research and Technology Coordinating Committee reported that "well-planned research activities will help the United States find its way through the range of complex options that may be available to achieve long-term transportation goals." The committee called for increased funding for research and technology, more private-sector support, and combined public-private partnering to meet pressing concerns. More exploratory and high-risk research was recommended to identify and evaluate new technologies with potential application to highway transportation and to broaden the research perspective to encompass interactions among all modes of transportation as well as the range of environmental, physical, social, and economic consequences of highway development. The need to devote greater attention to the innovation process was also stressed; support of field tests, demonstrations, training, and other tasks were recommended to promote widespread use of research products.

The committee identified several issues for emphasis, including the role of highways in the nation's future transportation system, the range of environmental concerns that confront highway and transportation agencies, contracting and procurement practices for highway construction and research, the need to support breakthrough research to encourage innovative technologies, and the importance of more systematic examination of topics that cut across traditional modal and disciplinary boundaries so that all possible solutions can be considered.