




# Critical Issues In Transportation

THE EXECUTIVE COMMITTEE of the Transportation Research Board, as part of its mission to promote innovation and progress in transportation through research, periodically develops and disseminates a list of critical issues in transportation. In 1997 we do so with a recognition of the many challenges facing the U.S. transportation system, the transport industry, and the research community. Some of these challenges (outlined in the Introduction below) are highlighted by concerns being voiced in the current debate over the focus, funding, and priorities of the next reauthorizing legislation for federal transportation programs. We are likely to be engaged in discussion and debate over these and related issues in the months ahead.

Often in such debates, some of the most useful information that the research community can provide is a set of clear statements of the key issues. The critical issues have resulted from extensive Executive Committee discussion and reflect the broad perspectives represented by the Committee members. The members share the belief that a strong research program is vital to the development and application of new concepts and technologies to help solve the future challenges in transportation. The Committee offers the critical issues as a stimulus to policy makers, researchers, and others interested in transportation progress to begin the work needed to *move* the nation—its people and freight—forward into a new millennium.

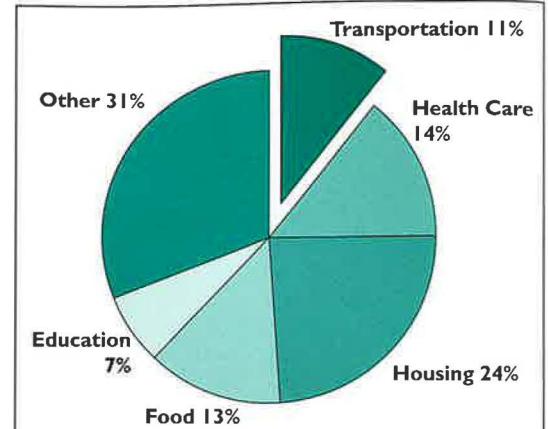


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# INTRODUCTION

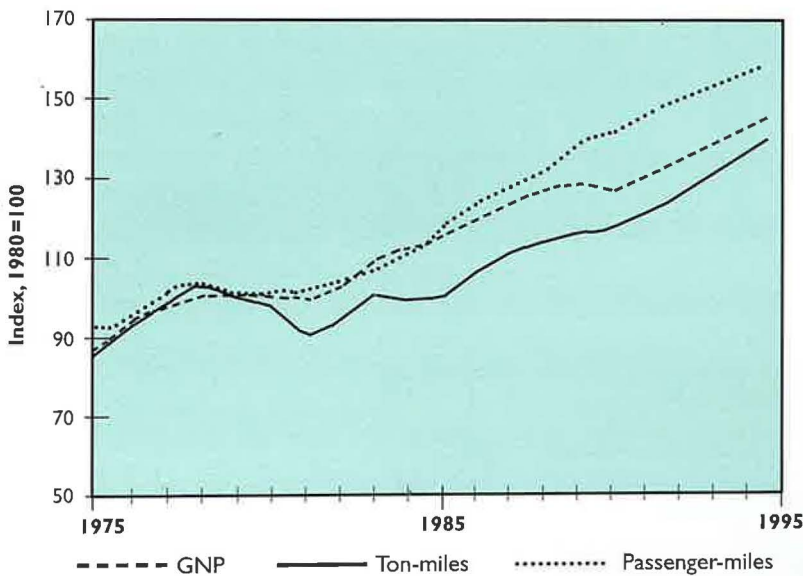
Almost every sector of American society depends, at some level, on the movement of people and freight. Americans travel about an hour each day on average, heading to and from jobs, stores, schools, and recreational and social activities. Yet while most individuals rely heavily on the passenger system, they may not realize the extent to which food, clothing, and other products depend on the efficient movement of freight—often using the same facilities on which personal trips are made. The transportation system serves as the lifeblood of the U.S. economy, and the flow is enormous: over 12.4 billion tons of freight moves through the system annually at a cost to shippers exceeding \$440 billion. Overall economic growth depends upon transportation (Figure 1). Together, spending for personal and commercial transportation represents about 11 percent of the total U.S. economy (Figure 2).

U.S. roads, public transportation systems, railroads, airports, ports and waterways, and pipelines and the many different kinds of consumers that rely on them represent a highly developed, complex system woven into the fabric of modern life. Although polls indicate that Americans are generally happy with the system, uncertainty and transition have become the watchwords of the late 1990s for the transportation sector. Demands on



**FIGURE 2 U.S. GDP by Major Social Function**

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation in the United States: A Review*, 1997.



**FIGURE 1 National Economic and Transport Trends**

SOURCE: Eno Transportation Foundation, *Transportation in America*, 13th Edition, 1995.

the basic, publicly provided infrastructure are growing even as debates about balancing the federal budget imply a static, if not shrinking, level of federal investment. Responsibility for decision making is shifting away from Washington—without a consensus about how authority will be shared for issues that affect both local and interstate transportation. Transportation, a cause of many adverse effects on the environment, also faces growing commitments to meet environmental goals. Moreover, demands on the system are changing rapidly as a result of the increased globalization of commerce, efforts by U.S. firms to remain competitive, changes in lifestyles and numbers of household workers, and increasingly rapid innovations in telecommunications and related technologies.

As the above challenges continue to unfold, research and innovation will remain critical to defining new approaches, solving problems, developing and applying new technologies for more effective use of the current infrastructure, and informing complex public and private choices. Research and innovation in transportation take place in many different fields—including engineering, construction, management, planning, economics, and human factors—and in diverse settings—including universities, government agencies, consulting firms, and industry. As budget constraints intensify and the challenges facing the transportation sector continue to evolve, it is essen-

tial to ensure that investments in research and development are commensurate with the immense scale and importance of transportation and that there is adequate coordination among the many decentralized research activities.

The Executive Committee of the Transportation Research Board periodically identifies critical issues in transportation. These are major issues facing the transportation sector that are national in scope, on which there are a wide variety of viewpoints, for which the impacts of possible actions are uncertain and decisions will be made at the policy level, and for which research is a critical input to informed debate. The committee has identified five critical issues currently deserving of particular emphasis:

- Mobility and Accessibility
- Sustainable Development
- Safety and Security
- Technological Innovation
- Institutional Roles

The following discussion raises what the committee believes to be among the most important questions facing the transportation sector in these five areas. These questions are meant to stimulate policy makers, researchers, and the public at large to begin addressing the key challenges that lie ahead.

## MOBILITY AND ACCESSIBILITY

Traditionally, government responsibility for transportation services has been perceived in terms of providing the public with mobility, or freedom to travel without undue constraint, and ensuring fair competition and adequate physical capacity for the efficient movement of freight. In recent years a new concept has developed—"access" to goods and services via transportation. These concepts of government's role in transportation have similarities—and important differences. The concept of *mobility* implies an emphasis on providing capacity, whereas the concept of *access* implies an emphasis on providing more choice in mode of travel and linking decisions about transportation spending with land-use policies.

- *How can national policies best be designed to support public preferences at the state and local levels? What institutional and policy changes are required to serve these somewhat different missions?*

### MOBILITY

Increased public investment in highways and transit capacity over the last several years has resulted in better pavement conditions, fewer deficient





bridges, and newer vehicle fleets. Given the age of many of these facilities, however, these increased levels of investment will have to be sustained just to keep up with expected deterioration.

Research has served the capacity mission by developing innovative ways to build, operate, and maintain facilities at less cost, and by developing and applying new technologies to manage and meet demand. Research in these areas does pay off. For example, a review of the recent \$150 million federal-state Strategic Highway Research Program, aimed at developing new materials and methods for highway construction, rehabilitation, and maintenance, projected returns on the research investment of 20 to 1. These potential benefits will come in the form of direct reductions in operating and maintenance costs for personal vehicles and public facilities, as well as better services to consumers.

Although greater efficiency of operation will stretch available funds further, continued growth in population, globalization of commerce, economic activity, and personal travel will demand additional capacity. Yet federal and state transportation agencies, with different responsibilities and modal perspectives, may be unable to fully consider multimodal approaches in their decision making.

- *Where and how can capacity be expanded to meet demand, and who should pay for it? How can available capacity—considering all modes as a system—be managed more efficiently?*
- *How can the durability and performance of aging infrastructure be extended to ensure the continued availability of existing capacity?*
- *What role can new information technologies play in expanding the capacity of the existing infrastructure?*

## ACCESS

The emphasis on access in transportation policy has renewed concern about long-standing weak links between national- and state-level transportation investments and local land-use policies. Much population growth and development are occurring in the outlying counties of metropolitan areas, and current land-use policies often permit more new development than existing rural roads can serve adequately and safely. Reformers believe that more focused, higher-density development can reduce the need for travel, while also ensuring that access to job opportunities and services is more widely shared by all groups. This is, however, a contentious and controversial area among professionals and researchers, and careful analysis is needed.



- *What is being learned from the states and metropolitan areas that are experimenting with new approaches and institutional arrangements for managing and directing growth?*

Because of past inability, or reluctance, to regulate development patterns, a different set of options is being examined to recover the costs to society of the transportation services through either increased taxes or fees. If users had to pay the full price of using transportation facilities, there would be less excess investment and a potential constraint on unplanned development. There is, however, substantial public and political opposition to tolls, which is often expressed as concerns about equity and fairness. Access concerns place particular emphasis on underserved population groups, such as elderly and rural residents, who are less able to rely on automobile transportation than the majority of Americans. Moreover, many unemployed inner-city residents without automobiles face difficulties in getting to entry-level jobs in the suburbs. Yet small-scale experiments are being proposed—even tried—in several communities.

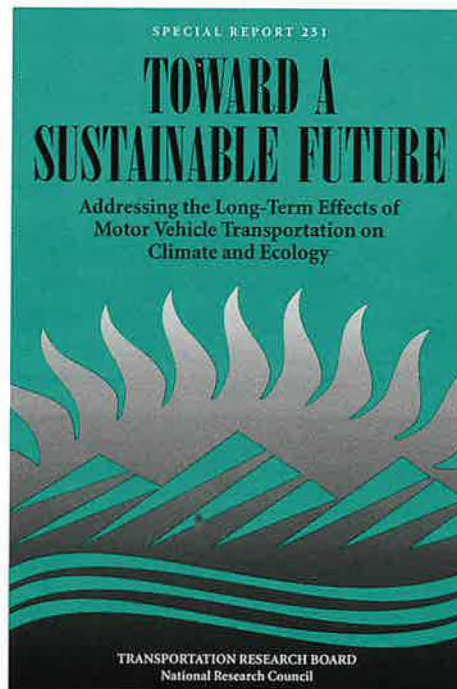
- *Which land-use and pricing approaches appear to be cost-effective and politically feasible?*
- *How can the full social costs and benefits of transportation be better estimated and communicated to guide public decision making?*
- *How can and should the transportation sector respond to members of the aging population, who depend almost exclusively on automobiles, but for whom driving is increasingly difficult?*
- *What should be done about residents in rural areas who depend on rural transit and intercity bus transportation? How wide is the gap between needs and service, and how can it best be closed?*
- *How can transportation service providers help those who need transportation in order to make the welfare-to-work transition, and how can this service be provided at an affordable cost to taxpayers? What will happen to rural residents on welfare who lack access to automobiles and low-cost public transportation?*

## SUSTAINABLE DEVELOPMENT

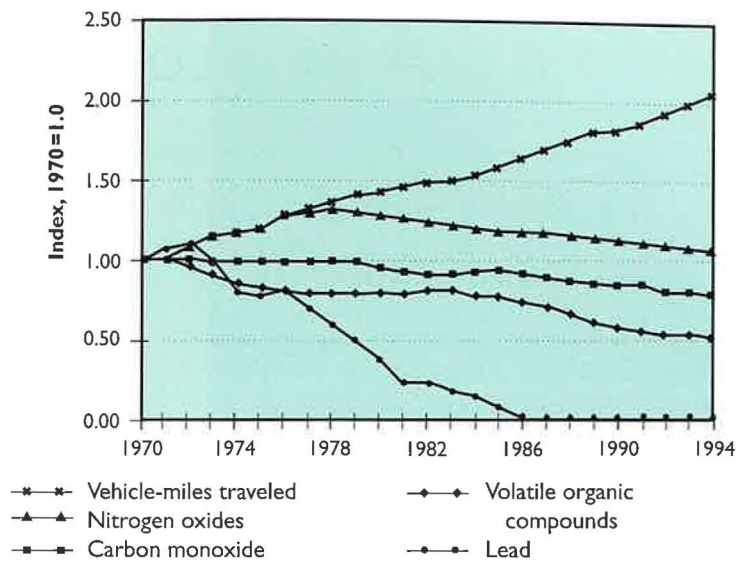
Sustainable development is a broad term that may be defined as striving to meet the multiple needs of the present while ensuring that future generations will have adequate resources to meet their needs. Transportation is one sector of modern economies that affects sustainability profoundly in terms of growth and mobility, the environment, resource consumption, and social and economic opportunity. Effective and efficient transportation services are particularly important to the U.S. economy because of its large physical size and low population density in contrast to most of its trading partners, and because of the link between good transportation and economic competitiveness. The benefits of public investments to the private economy are considerable. Recent estimates indicate that the net social returns from highway investments have exceeded those of private capital throughout most of the post-World War II period.

- *How can transportation investments and regulations be designed to serve the goals of sustainable development at both the local and national levels?*

The issue of sustainable development arises most cogently within the transportation sector with regard to adverse environmental impacts and



This major new TRB study reviews the long-term environmental effects of motor vehicle transportation and the policy options for reducing these effects.



**FIGURE 3 Motor Vehicle Emissions and Miles Traveled, 1970-1994**

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 1996*, 1996 (Fig. 7-2, p. 133).

energy consumption. There is intense debate in both Washington, D.C., and state capitals about the form and extent of environmental regulation. Although transportation has a variety of adverse effects on the environment, most of the debate has focused on air quality. Polls indicate that the public strongly supports the goal of cleaner air, yet some of these same polls also indicate that the public rejects by an equal margin options that could reduce transportation emissions, such as increased funding for and reliance on public transit or ridesharing. Through research and innovation, transportation providers have developed and introduced technologies that have led to sharp reductions in vehicular emissions per vehicle mile traveled. As a result, despite a more than doubling of total travel in the past 25 years, transportation emissions regulated by the Clean Air Act have either stabilized or declined (Figure 3). With ever-increasing demand for transportation, however, it is unclear whether this success can be sustained.

Moreover, there is growing concern about transportation's significant and increasing role in climate change through emissions of carbon dioxide, the major greenhouse gas resulting from human activity. Transportation accounts for about one-third of carbon dioxide emissions from the United States; both total carbon dioxide emissions and transportation's share are growing. Because of the transportation sector's nearly complete reliance on fossil fuels, the sector is particularly vulnerable to the need for major change—or higher costs—if the

world's nations should agree to curtail or even hold steady total emissions of greenhouse gases. Moreover, because of the limited domestic supply of petroleum, our transportation system could become increasingly reliant on foreign sources, making the United States more vulnerable to interruptions in oil supplies. Yet political incentives to address energy security have waned; the public is not expressing concern because, despite a spike in gas prices during 1996, the inflation-adjusted price of gasoline is currently lower than at any time since World War II.

Science and technology can continue to contribute to the provision of high-quality and efficient transportation with fewer adverse environmental impacts. Investments in data collection and analytical tools can inform pending local, state, and national decisions that depend on the benefits and cost-effectiveness of transportation investment and demand management options, and on the interrelationships among transportation investment, land use, and environmental impact. But if these investments are to be maximized, several key questions need to be addressed.

- Which measures are most valid, and what data should be collected? Which models best reflect short- and long-run environmental and economic impacts?
- Innovations can be introduced through more flexible and efficient regulatory approaches, but what specific form should these new approaches take?
- How can market processes be brought to bear in meeting sustainable development goals?
- Continued and increased public and private investment in R&D in vehicles, alternative fuels, catalysts, and other technologies can continue to result in vehicles that are more energy-efficient and less environmentally damaging, but what technologies will consumers accept, and what additional cost will be acceptable for reduced environmental damage and increased energy efficiency?

There is also renewed interest in new forms of urban development, which are being introduced around the country. Better design and higher density of development could result in less reliance on private automobiles and thereby reduce energy consumption and vehicular emissions.

- To what extent do new urban developments affect travel behavior? What are the net benefits? How substantial could the effects be in the United States, given the well-established development patterns in which the majority of citizens live?

# SAFETY AND SECURITY

Safety (particularly from motor vehicle collisions) and security (from terrorist and criminal acts) are of increasing concern to the traveling American public. Several key questions in these areas need to be discussed.

## SAFETY

U.S. transportation systems are as safe as, and in some cases safer than, those of other industrialized nations. The safety record of the various modes has continued to improve over time. Total deaths from motor vehicle crashes, which account for 93 percent of transportation fatalities each year, have remained fairly constant during the last 25 years, even as the level of motor vehicle use has more than doubled (Figure 4). This is an admirable record; however, the public has ever-increasing expectations for safety, while it has become more difficult to reduce fatalities and injuries, particularly in view of traffic growth on an aging infrastructure. In some respects, the obvious technological problems have been addressed, for example, by better designs for occupant protection when crashes occur.

- *What are the next priorities for technology and policy in addressing safety, and how can they be identified, evaluated, and developed?*

Operator error continues to be the most frequently cited contributing cause of motor vehicle crashes (as is also the case with air and marine travel). Operator errors are frequently attributed to fatigue and inattention. In highway transportation, alcohol- and drug-impaired driving are major contributors to injuries and deaths (alcohol is implicated in 40 percent of fatal highway crashes). With growing congestion, aggressive driving has also become an increasingly troublesome phenomenon. Technology can offer new breakthroughs in crash avoidance, but these must be very carefully designed to be consistent with human behavior. For example, sophisticated antilock braking systems for cars and trucks do not appear to be resulting in the expected benefits, even though they work as designed.

- *What policies, practices, and technological innovations are available and cost-effective for addressing the behavioral issues associated with crash avoidance?*

In addition, national transportation policy—and funding priorities—are increasingly reflecting

greater attention to nonmotorized transportation modes (primarily walking and cycling) as core elements of a balanced transportation policy.

- *How can we fully and safely integrate nonmotorized modes into our transportation system, in terms of both infrastructure and operations?*

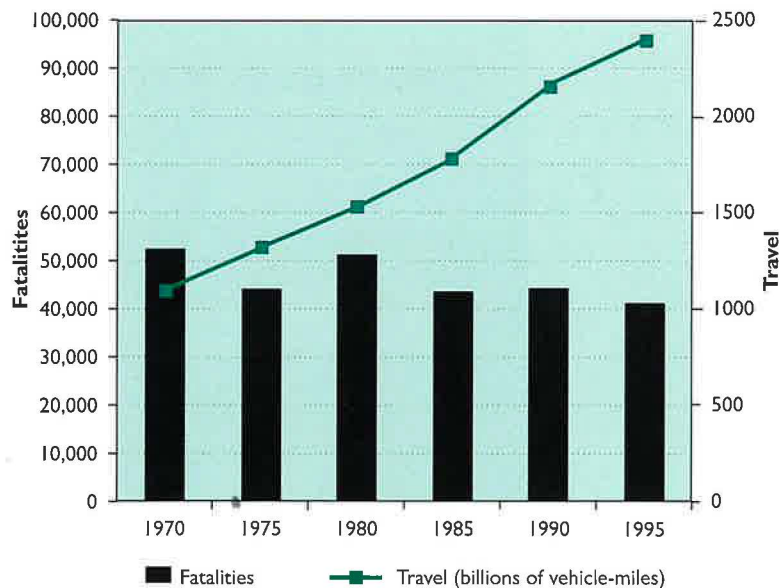
- *Where and when are such policies as traffic calming and facility separation appropriate? What is the role of information technologies in nonmotorized user safety?*

## SECURITY

Along with the traditional concerns about transportation safety, the American public is increasingly worried about terrorism, sabotage, and criminal activity. Such threats have been evident for some time in international aviation, but may be spreading more broadly throughout the transportation sector.

- *How vulnerable is the U.S. surface system to threats of terrorism and sabotage, and what should be done to address these concerns?*

- *Given that U.S. passenger systems were designed to be accessible, easy to use, and capable of processing masses of users efficiently, what kinds of changes to increase security will users accept and be willing to pay for?*



**FIGURE 4 Highway Fatalities and Travel**

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 1995*, 1995 (Table 2, p. 15).

Concern about personal vulnerability to crime is also growing among transportation users, particularly women and the elderly.

- *What strategies and new information technologies can be used to address a growing concern about crime that threatens to erode the benefits provided by the transportation system?*

While the increasing reliance on information systems for traffic management and tracking of freight movement has brought many gains, it has raised a new set of security concerns. Sophisticated criminals capable of breaking into carrier data systems are targeting containers of high-value goods and stealing billions of dollars worth of domestic and cross-border freight each year. The potential ability of hackers to disrupt highway traffic control systems is troublesome.

- *What new security systems and procedures are needed for protection against threats to transportation information systems?*

ture and traffic operations and control, and the private sector taking the lead in many areas of vehicle technology and operations. As the owner and operator of most of the transportation infrastructure (with the exception of the majority of railroads and pipelines), the public sector has the principal role in organizing and funding research to address the infrastructure's operational needs. The overall level of public investment in R&D, however, is very low. For example, total public R&D spending represents less than 0.3 percent of gross expenditures in the highway sector, far less than the 5 percent or more of gross revenues invested in R&D by high-technology industries, and even less than the 0.5 to 1.5 percent invested by mature low-technology industries. Yet as low as it is, highway R&D spending far exceeds public investment in R&D for public transit, airports, and passenger rail service. Not surprisingly, then, the pace of innovation in the public sector is slow.

The federal government has attempted to accelerate the pace of change: it has taken the lead in investing in R&D for "smart vehicles and infrastructure," the results of which could lead to reduced congestion and safer operations, as well as to less need for system expansion to meet growing demand. The early returns on the federal government's risky but potentially high-payoff investment have begun to materialize and may show significant benefits over the next several years.

- *How substantial are the potential benefits of public investment in "smart vehicle and infrastructure" R&D, and who will benefit?*

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## TECHNOLOGICAL INNOVATION

Technological innovation in transportation is a joint public and private enterprise, with the public traditionally taking the lead in most areas of infrastruc-



- *Can the private sector assume more responsibility?*
- *How can cost-effective solutions best be shared across the country?*

The federal government, in partnership with the states, has also emphasized increased technology transfer in order to speed the adoption of promising new technologies, materials, and practices.

- *What mechanisms for the transfer of new approaches work best in a decentralized public transportation sector such as that in the United States?*

The federal government also attempts to foster technological innovation through basic research into vehicles, fuels, materials, and service delivery to meet environmental and energy goals, a role that is the subject of substantial debate. The current administration has been striving to coordinate transportation research across the numerous programs and federal agencies involved. At the same time, proposals to balance the federal budget imply sharp reductions in federal R&D in alternative fuels and vehicle technologies and suggest that R&D in transportation infrastructure will remain at low levels.

- *How can the federal role in research best be accomplished for the good of society?*
- *Is it realistic for the United States to rely more heavily on the private sector for the conduct of basic research in the public interest?*
- *Will proposals to devolve more authority to the state and local levels and reduce federal involvement in transportation result in reduced investment in research on surface transportation infrastructure?*

The technological revolution being brought about by the “information highway” has potentially broad ramifications for both personal and commercial demand for traditional transportation services. The private sector has leapt ahead with applications of new information technologies in freight logistics, whereby carriers are tracking and managing millions of individual shipments every day. The application of these technologies is resulting in reduced costs and improved services for shippers, but is also placing new demands on public infrastructure to provide more “just-in-time” service (i.e., scheduling of regular, more frequent deliveries to arrive just at the time inventory is needed).

- *How much will telecommuting affect daily travel behavior and demand? How will access to the*

*world via the Internet affect where businesses and individuals choose to locate?*

- *Is there enough capacity in the transportation infrastructure to meet both the increasing demand for “just-in-time” service and rising demand for personal transportation?*

The pace of change in the public sector is slow for a variety of reasons. For example, aside from low investments in R&D, public officials are typically unwilling to accept risks (and are frequently prohibited from doing so by law and regulation). Increased interest in relying more heavily on the private sector for services formerly provided publicly stems in part from the greater opportunity and incentive the private sector has to innovate. In addition to privatization, incentives to innovate can be brought about through new forms of performance contracting, through design-build approaches, and by having the private sector build and operate a facility before transferring it to the public sector. The United States may have much to learn from international experience in these areas.

- *How can the benefits of privatization best be harnessed to serve the public?*
- *How can greater emphasis be placed on specifying performance instead of product characteristics to give private providers greater latitude in introducing new approaches?*
- *What experience from abroad with newer forms of project development, financing, and operation can be transferred to the United States?*



## INSTITUTIONAL ROLES

During the last several decades, the joint responsibilities of government at the federal, state, regional, and local levels for the planning, design, funding, and operation of transportation infrastructure have been fairly stable and predictable. Today, however, fundamental questions are being raised about the federal role and indeed the overall governmental role in transportation. The concepts of deregulation and privatization are receiving more attention than ever before.

To balance the federal budget, and in concert with the direction of national policies in a variety of areas, the federal share in funding of transportation construction and renewal appears likely to

continue to diminish. State and local governments have been bearing an ever-growing share of transportation investment for the last decade; more than two-thirds of every public dollar spent on transportation is now provided by state and local governments (Figure 5).

- Will the gap between funding and needs grow as the federal contribution diminishes?
- Can the United States maintain a truly national system if the federal share of investment continues to shrink? When greater autonomy is given to local areas to invest in infrastructure to meet local needs, what is the assurance that the investments will meet the needs of interstate and international commerce, or that the massive investments in intercity systems will be adequately maintained?

The existing transportation institutions and divisions of responsibility between public and private sectors were designed in earlier decades in consonance with the massive investment in infrastructure after the end of World War II, most of which served to link the nation's cities, towns, and metropolitan areas. As public agency missions shift more toward system operation, management, and

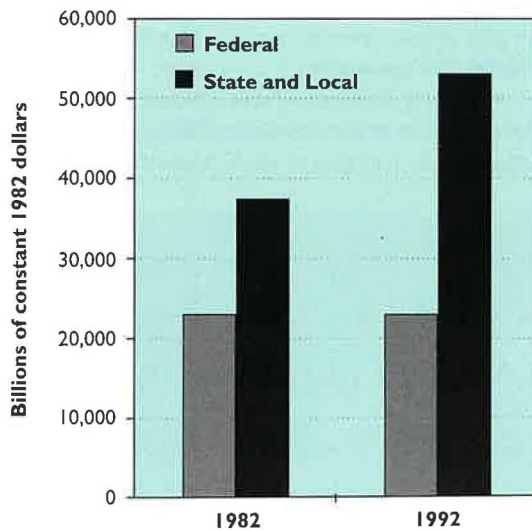
maintenance, there is an increasing need for the development of new institutions, revenue streams, and funding mechanisms, particularly at the local level. As these new institutions and roles are developed, it will be necessary to find ways of providing the private sector with an expanded role in financing, providing, and managing infrastructure.

- What new administrative models of shared decision making and funding can be devised to meet local, regional, state, and national needs?
- How can the public and private sectors work together more effectively and efficiently to ensure greater efficiency of freight movement at ports, airports, and rail terminals?

Deregulation has swept through the private transportation sector during the last two decades, dramatically affecting airlines, trucking companies, railroads, and bus operators. These policies reflect the general view that markets allocate resources more efficiently than government does and represent a general trend toward reduced governmental involvement in private decision making. Opinions vary about the net benefits of these policies, but by most accounts, productivity has increased and prices charged to consumers have decreased, with no disruption to the long-term trend in improved safety.

An emerging area of debate concerns the growing concentration of the railroad industry and the increased difficulty of gaining entry to the airline industry. In the railroad industry, mergers and consolidations (including the prospective sale of Conrail) have reduced the number of major companies down to just four, with considerable speculation that the nation may be left with only two transcontinental railroads. Although railroads face stiff competition from the trucking industry in many corridors, some fear that this competition will not be adequate to protect consumers if railroad concentration continues. Concern is also being voiced about the fate of the many shortline railroads that provide feeder service. In the airline industry, the prospects of tighter safety regulation of new entrants could lead to reduced competition.

- With a decreasing number of competitors, how can the public sector foster adequate competition within and across modes?



**FIGURE 5 Government Spending on Transportation, 1982 and 1992**

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 1996*, 1996 (Table 2-11, p. 52).

## CONCLUDING COMMENTS

Improvements in transportation practices, technologies, materials, and policies have been the products of research and innovation in a broad range of disciplines and fields in a variety of public and private settings. As a result, transportation vehicles and infrastructure today are safer and built to higher environmental standards than they were 50 years ago. But these advances did not happen by accident. They occurred because previous generations had the foresight to design institutions, develop incentive systems, and invest in research, education, and technology transfer in ways that resulted in an ongoing process of innovation and institutional change.

The challenges in transportation facing the current generation are no less critical in both eco-

nomical and social terms and demand no less foresight and innovation. Regardless of how the transportation system unfolds in the future, it will likely be more technologically complex and more tightly coupled with social and economic systems. The educational establishment, and the governments and individuals that support it, will be challenged to foster the development of future researchers and professionals who will be able to operate successfully in an environment characterized by increasingly sophisticated technologies and more complex institutional settings. Wise investments and policy choices in support of innovation will continue to be essential if American society is to provide the transportation services needed to serve the public into the next millennium.

