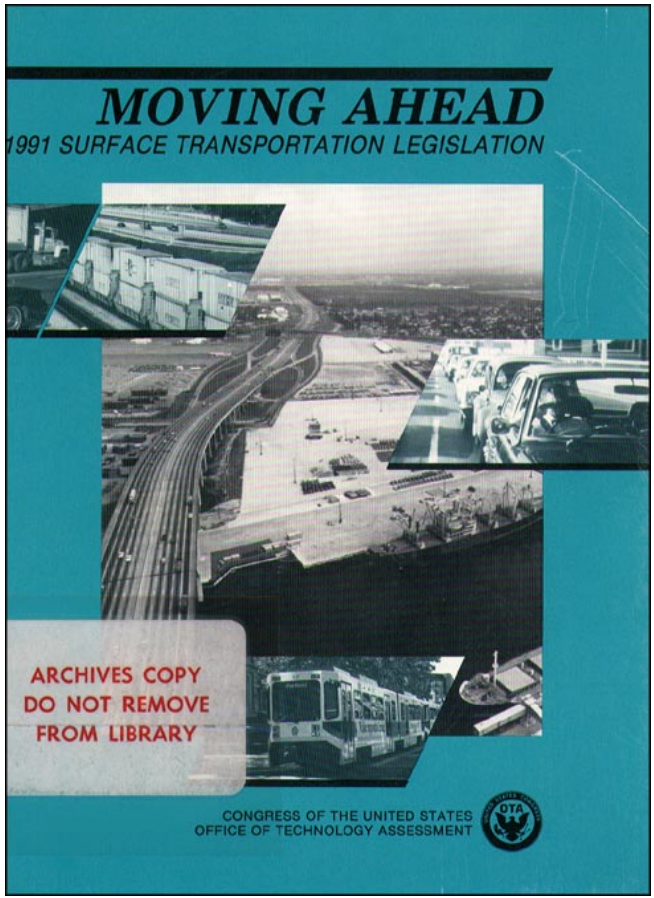
Moving Ahead: 1991 Surface Transportation Legislation

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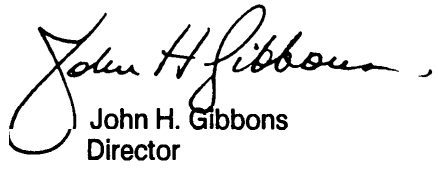
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FOREWORD

Crumbling highways in rural areas, crushing traffic congestion in cities, and overwhelming and competing demands on the Federal, State, and local government dollars needed to fix these problems made reauthorization of Federal surface transportation legislation a major agenda item for the 102d Congress. Anticipating heated debate on highway, transit, and related surface transportation issues, the Senate Committee on Environment and Public Works asked OTA in May 1990 to use the information and background accumulated during its infrastructure studies, Rebuilding the *Foundations* **and** *Delivering the Goods,* **and undertake a focused analysis of surface transportation policies, programs, and technologies. The Committee wanted to use this new study,** *Moving Ahead: 7997 Surface Transportation Legislation,* **to help identify changes and set new priorities for Federal surface transportation assistance programs. Previously Senator Hatch had asked OTA to evaluate technologies for heavy trucks, and since motor carrier issues are an integral part of surface transportation legislation, the decision was made to undertake a single study addressing these related requests.**

The categorical grant programs and apportionment formulas that are part of most current Federal aid to surface transportation are extremely complex and incorporate some of the most divisive and contentious aspects of legislative decisionmaking. To ensure that a spectrum of policy options is laid out, *Moving Ahead* **provides four illustrative, generic models, with program components that can be mixed and matched. Safety, research and development agendas, and motor carrier issues, with special attention to heavy trucks with multiple trailers, are also discussed.**

Workshop participants and a number of government, industry, and private citizen reviewers gave us an invaluable range of information. OTA is grateful for the time and energy committed so generously by each individual. Their participation does not necessarily represent endorsement of the contents of the report, for which OTA bears sole responsibility.



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Moving Ahead: 1991 Surface Transportation Legislation

INTRODUCTION

Federal transportation assistance and regulatory policies affect the daily lives of every citizen and the activities of every industry. Federal surface transportation programs also directly affect over 800,000 miles of roads, 270,000 bridges, local transit authorities, Amtrak and State-run commuter railroads, and motor carriers. However, current Federal surface transportation policies reflect political goals and decisions and institutional alignments established decades ago, some as early as 1916. The agenda receiving priority for the past 35 years was set in 1956, when the Federal Government accepted the mission of creating high-quality, efficient, coast-to-coast intercity and farm-to-market highways, to provide for defense, foster State and local economic development, and open access to remote rural areas. At that time, the Federal Government took on the mission of financing construction of an interstate highway system, in addition to aid already provided for other State road programs. Totali Federal cost to complete the Interstate system (probably in 1995) is now estimated at $128 billion.'

in contrast to its longstanding support for highways, the Federal Government did not participate in mass transit funding until the 1960s and 1970s, when it began supporting the conversion of failing private transit companies to public ownership. Later, Federal subsidies were extended to rail and bus capital investment and to supplement farebox revenues with the goals of supporting urban renewal and economic growth. However, Federal aid for mass transit, which has totaled $62 billion, peaked in 1981 at $4.7 billion and has declined steadily in real dollars since then. in 1988, State aid to transit agencies surpassed Federal assistance levels, which had fallen to $3.3 billion.[2]

Unlike these Federal programs, the United States has changed profoundly during the last 35 years: the national economy, demographics, regional and metropolitan development patterns, technologies, family lifestyles, political attitudes, and governmental institutions are all significantly different. (See box A for a summary of key changes.) Characteristics such as metropolitan sprawl and traffic congestion, growth of the trucking industry, the migration of manufacturing jobs to the suburbs, and urban air pollution are largely outgrowths of Federal policies that encouraged highway construction. At the other end of the problem spectrum are dilapidated highways in large, sparsely populated States where inadequate funds have prevented reconstruction of roads essential to providing goods and services.

Regardless of the origin of these developments, the environment of the 1990s presents new and different issues and problems. Transportation programs for a primarily urban population that competes in a high-tech global economy cannot operate effectively under rules set in simpler times. Moreover, rural populations have remained underserved under those same rules. Recognizing that policies and programs established so long ago need changing now, the Senate Committee on Environment and Public Works asked OTA for help in assessing how highway and transit legislation being considered in 1991 could best be reshaped to chart a course for the future. This document represents OTA's response to that request. The major issues surrounding the reauthorization of highway and transit legislation are laid out and four illustrative types of surface transportation programs are presented in chapters 1 and 2. Chapter 3 is devoted to the discussion of motor carrier programs, with special attention to issues related to longer combination trucks.

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[1] Senator Daniel Moynihan, "Statement on the Surface Transportation Efficiency Act of 1991, " *Congressional Record,* vol. 137, No. 51, Apr. 9, 1991, p. 3.

[2] U.S. Congress, Office of Technology Assessment, ***Rebuilding the Foundations: A Special Report on State and Local Public Works Financing and Management, OTA-SET-447*** (Washington, DC: U.S. Government Printing Office, March 1990), p. 63.

Box A--Trends Affecting **Surface Transportation**

Demographic Trends

The U.S. population is projected to increase by 32 million people between 1990 and **2010,** with the group aged **45 to 64** showing the most growth. The South and West accounted for **90 percent** of population growth in the 1980s, and these regions will continue to grow the fastest. One-quarter of the population now lives in the seven largest metropolitan areas. Almost all new population growth is expected to occur in the suburbs of major metropolitan areas, where almost two-thirds of the metropolitan population already lives. Three-quarters of new metropolitan area households, vehicle owners, and jobs will be in the suburbs.

Implications for Surface Transportation

Strong demand for transportation services by the larger numbers of middle-aged persons and growth in vehicles per household will cause travel to outpace both population and economic growth, increasing traffic congestion, particularly in and among suburbs and in newer cities built without consideration of mass transit. Demand will rise for alternative types of mass transit, such as ridesharing and van and car pools, and more efficient intercity travel. Already deep, the chasm between service needs and fiscal capabilities of both rural and urban jurisdictions will grow. States with large land areas and small populations, responsible for rehabilitating and maintaining a large share of the Nation's Interstate, primary, and secondary highways, will find it increasingly difficult to squeeze adequate resources from State budgets to meet the system needs. Air quality problems will intensify in most metropolitan areas.

Economic Trends

The shift from goods production to service delivery will continue, with production employment dropping by up to 16 percent by 2000 and service employment increasing 13 percent. The Nation's labor force growth rate will slow, primarily because the supply of younger workers is shrinking. More flexible manufacturing technologies will encourage decentralized manufacturing and just-in-time delivery. Demand for transportation of industrial raw materials will drop, but overall transportation demand will expand, especially for light, high-value products. This will put a premium on speed and reliability--values likely to favor air and truck transport, although rail can be competitive in selected corridors. Changes in communications and transportation will accelerate economic globalization, encouraging growth around selected deep water ports and major airports. Maintenance and reconstruction must be assured for rural highways, the major transportation connections for remote areas.

Implications for Surface Transportation

Highway travel is expected to continue to increase over the next 30 years, putting additional burdens on existing roadways. Economic globalization means west coast ports and interrnodd connections will become relatively more important, as Pacific trade grows. The need for expanded capacity and improved intermodal connections will intensify around international and domestic airports.

Environmental Trends

The economic and political importance of environmental preservation and restoration issues will accelerate. While pollution from heavy industry may decrease as a result of economic restructuring, the challenge to control nonpoint sources of air and water pollution will grow.

[1] Trends and analysis in this box are based on material in U.S. Department of Transportation, ***National Transportation Strategic Planning Study*** (Washington, DC: March 1990), chs. 1-5, and OTA research.

Implications for Surface Transportation

As the link between transportation and the environment is better understood, the environmental impacts of all proposed public works projects will be scrutinized more carefully by public and private groups. Air quality issues are likely to be major determinants of public policy on transportation and land use.

Energy Use Trends

Transportation accounts for approximately two-thirds of all petroleum use, an amount that equals imports, and of that over 70 percent is consumed by highway transport. Substantial increases in world energy and petroleum demand and uncertainty of supply are expected to keep energy prices fluctuating. Fuel efficiency of new cars doubled between 1973 and 1988, and OTA sees the potential for substantial further improvement.

Implications for Surface Transportation

Despite uncertain petroleum costs, major modal shifts are unlikely, although the cost-effectiveness of transit and other nonhighway transport will increase. Higher gas prices may limit discretionary trips and, over the long run, encourage denser land use and development. But unless legislation or world events focus on the full societal costs of highway travel and force energy costs radically higher, and land-use policies change dramatically, highway travel will continue to increase.

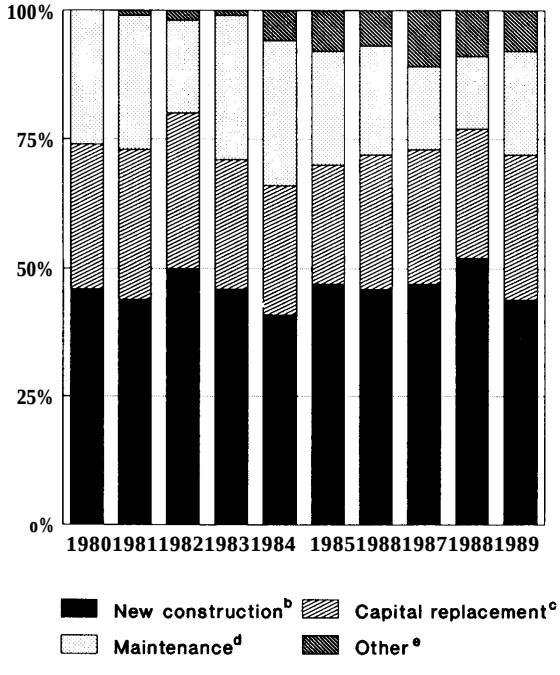
Chapter 1

Transportation System Needs for the 1990s and Beyond

Historically, Federal funding has focused on new construction to increase urban and rural highway and transit access and capacity and, to a lesser extent, on system preservation. Analyzing Federal spending by project types, new construction and capital replacement have absorbed about 75 percent of Federal spending during the last decade.[1] Project improvements more closely associated with maintenance and system preservation (restoration, rehabilitation, and resurfacing) have rarely claimed 25 percent of Federal spending and are now around 20 percent (see figure 1-1).[2] State spending, which accounts for about 50 percent of all highway expenditures, also favors new construction and reconstruction.[3]

During the 1960s and 1970s, construction of new roadways and more lanes was the typical prescription for resolving congestion problems. Most major urban areas built Interstate beltways to carry through traffic around congested downtowns. But building roads in metropolitan regions encouraged vastly increased vehicle ownership and travel demand, particularly in the low-density suburbs, and beltways now carry predominantly local traffic, despite their designation as part of the Federal Interstate system. By 1991, land scarcity, air quality mandates, intergovernmental rivalries, and competition for public

Figure I-l—Types of Highway Improvement Financed by Federal Aid[a]



[a] Includes obligations for Interstate construction, Interstate 4R (restoration, resurfacing, rehabilitation, and reconstruction), Primary, Secondary, Urban, and Bridge programs.
[b] Includes all first-time bridge and highway construction.
[c] Includes full or near full replacement of a bridge or highway section.
[d] Includes expenditures for rehabilitating and repairing existing structures to prolong useful life.
[e] Includes nonconstruction spending, such as safety.

SOURCE: Office of Technology Assessment based on material compiled by Congressional Research Service and reported in J.F. Hornbeck, *Maintaining Highway and Bridge Investments: What Role for Federal Grant Programs?* (Washington, DC: Congressional Research Service, May 31,1990), p. 7.

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1 In addition to classifying spending by grant program such as Interstate and primary, the Federal Highway Administration categorizes obligations by project improvement types: new construction, relocation, reconstruction, widening, resurfacing, restoration and rehabilitation, bridge replacement, and bridge rehabilitation. To simplify, these are grouped into four broad categories: new construction, capital replacement, maintenance, and other. New construction includes all first-time construction, construction of a new route to replace an old one, major and minor widening, and new bridges. Capital replacement covers full or near full replacement of a bridge or highway system and includes bridge replacement, major bridge rehabilitation, and highway reconstruction. Maintenance covers projects for rehabilitation or repairing existing structures to prolong life and to avoid total capital replacement. This group includes project improvement categories for restoration and rehabilitation, resurfacing, and minor bridge rehabilitation. The other category captures all nonconstruction spending.

2 J.F. Hornbeck, *Maintaining Highway and Bridge Investments: What Role for Federal Grant Programs?* (Washington, DC: Congressional Research Service, May 31, 1990), pp. 6-7.

3 U.S. Department of Transportation, Federal Highway Administration, ***Highway Statistics 1989*** (Washington, DC: 1990), p. 72.

capital have made relying on new construction in urban areas an expensive and obsolete policy. Rural States must be assured of the ability to maintain the roads they have--an assurance they now lack. New approaches and different programs are clearly a must.

Based on findings in Delivering *the Goods,*[4] OTA's recently released comprehensive study of public works infrastructure, the major system problems facing surface transportation in the 1990s and beyond are:

- rehabilitation and maintenance of existing facilities,
- urban mobility and congestion relief,
- rural accessibility,
- transportation system efficiency,
- compatibility with a healthy environment, and
- technological preparedness for the future.

As important, Fee*lera*l *financing and institution/ policies* need rethinking, including Federal investment levels and apportionment formulas, program priorities and design, needs and expectations of State and local governments and the private sector, and clarification of Federal responsibilities.

SYSTEM REHABILITATION AND MAINTENANCE

Across the country, highways, bridges, and transit facilities require major repair or reconstruction to maintain acceptable service levels. Because the rewards for regular maintenance are minimal compared to those for other more visible types of spending, investment in rehabilitation and maintenance has lagged seriously behind the need for decades. Currently, about one-third of the Nation's non-interstate arterials are deteriorated or deteriorating. Almost one-half of all bridges are structurally deficient or functionally obsolete. The maintenance backlog of large city transit systems includes rehabilitation of 2,800 miles of track, 11 million square feet of bridge structures, and 214 bus maintenance and storage facilities.[5]

To a large extent, today's need for massive reconstruction and capital replacement was predictable. The 1980s marked the end of the design life of millions of miles of roadways built in the 1950s and 1960s and of bridges and mass transit facilities constructed in the early part of the century. Moreover, the expected functional life of many highways and bridges has been shortened by heavier than anticipated use (including much greater use of heavy trucks) and the neglect of regular maintenance. Local governments have often diverted funding originally slated for pothole repair, bridge painting and resurfacing, and bus maintenance to match Federal and State construction grants or to address other priorities. Small, rural communities and States with low per-capita incomes are under particular revenue stress.[6] In Alaska, for example, communities depend on the Al-Can Highway for connections between Southeast Alaska and the panhandle and between the State and the lower 48. They are threatened with imposition of a 35-mile-per-hour speed limit and shutdown of sections of the road by the Canadian Government, because portions of the State's road are in such poor condition. Estimates for repair costs exceed the State's total annual highway budget. Addressing system rehabilitation and maintenance problems is the top priority for new highway legislation.

Major issues include: What Federal policy and funding changes can ensure systematic investment in rehabilitation and maintenance by all levels of government? What adjusters, if any, should be included in Federal programs to help States with few economic resources and large maintenance and rehabilitation costs?

METROPOLITAN MOBILITY AND CONGESTION RELIEF

Almost 80 percent of the U.S. population lives in one of the Nation's 282 metropolitan areas, and the metropolitan growth trend is expected to continue. Almost all new jobs and population increases are forecast to occur in the suburbs of metropolitan areas, particularly in the larger ones.[7] Travel on major urban highways increased 30 percent between 1983 and 1987.[8]

[4] U.S. Congress, Office of Technology Assessment, ***Delivering the Goods: Public Works Technologies, Management, and Financing,*** OTA-SET-477 (Washington, DC: U.S. Government Printing Office, April 1991).

[5] U.S. Department of Transportation, ***National Transportation Strategic Planning Study*** (Washington, DC: March 1990), p. 12-21.

[6] See Office of Technology Assessment, op. cit.,

Table 1-1—1989 Congestion Levels in Major Cities[a]

Cities	Congestion level ranking[a]	Congestion cost per vehicle ranking[b]	Total congestion cost ranking[b]
Los Angeles, CA	1	4	1
San Francisco/Oakland, CA	2	5	3
Washington, DC	2	1	4
Miami, FL	4	11	15
Chicago, IL	5	16	5
Seattle-Everett, WA	5	8	9
San Diego, CA	7	19	16
Atlanta, GA[c]	8	9	6
Houston, TX[c]	8	12	12
New Orleans, LA	9	28	27
New York, NY	11	3	2
San Jose, CA[d]	11	6	13
Boston, MA	13	6	7
Honolulu, HI[d]	13	19	31
San Bernardino-Riverside, CA[d]	13	2	14
Detroit, MI[c]	16	15	8
Norfolk, VA[d]	16	21	24
Portland, OR	18	18	26
Philadelphia, PA[c]	19	24	11
Phoenix, AZ[c]	20	14	17
Tampa, FL	20	35	38

NOTE: Annual congestion costs per vehicle range from $1,040 in Washington to $200 in Tampa. Total costs of congestion range from $5.8 billion in Los Angeles to $130 million in Tampa.

[a] Congestion level rank is based on the Roadway Congestion Index (RCI) developed by the Texas Transportation Institute. RCI calculates roadway mobility by combining average traffic volume per lane-mile for freeways and principal arterial streets, accounting for total vehicle-miles traveled and the capacity of each type of road.

[b] Congestion cost is the estimated cost of travel delay and excess fuel consumed paid by residents of large, congested urban areas. Delay is defined as the total vehicle-hours per day spent by motorists driving on congested roads. A constant monetary value of time is used for all urban areas, making price of fuel and time of delay the most prominent factors in the calculation of cost.

[c] These cities reduced congestion levels from 1987. Phoenix experienced the greatest drop, reducing congestion by almost 13 percent.

[d] These are preliminary values; some data items are being reviewed.

SOURCE: Office of Technology Assessment, 1991, based on Texas Transportation Institute, "1989 Roadway Congestion," research report 1/31-4, 1991.

Congestion, stalling workers and truck traffic, costs American business billions of dollars every year in lost productivity and adds significantly to air pollution. The total price to the public for delays caused by highway congestion is at least $30 billion annually, and while some places are beginning to attack traffic congestion, by and large it is a worsening and nationwide problem (see table I-l). A comprehensive Federal policy to deal with metropolitan regional congestion and urban mobility problems is long overdue. Initial components for developing such a policy must include analytic tools, such as reliable data and information collection, and quantifiable performance measures that incorporate incentives or financial rewards for improvements.

Actions that can be taken immediately include a combination of some additional capacity, better maintenance, and making existing roadways and bridges more productive and efficient through available intelligent vehicle/highway systems (IVHS) technologies. However, a program that emphasizes more highway spending alone is not adequate for the 1990s. Improved transportation alternatives--such as commuter rail, mass transit and other high-occupancy options, stronger regional transportation planning linked to land use and growth management goals, and better connections between transit and highways and other modes--must become parts of surface transportation programs.

Growing communities have economic resources they can tap to fund congestion relief measures, and they can direct new development into relatively efficient patterns. This is not the case for older, less affluent central cities and suburbs, where congestion problems are exacerbated by aging roadways and bridges and outmoded radial highway and transit patterns (New York and Philadelphia are prime examples).

footnote 4, ch. 1.

7 U.S. Department of Transportation, op. cit., footnote 5, p. 1-12.

8 Ibid., p. 10-18.

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Such cities need special help, and State governments need to recognize the role their major cities play in the overall economic health of the State and provide assistance, as appropriate.

Major issues include: How to restructure Federal transportation priorities and programs to help States and localities address congestion issues, including its staggering costs. What new technologies (such as planning aids) in addition to IVHS, can assist in managing and reducing congestion?

ACCESS TO RURAL AREAS

Transportation options for rural America are shrinking, while the costs for maintaining rural highways are rising.[9] To control costs and make their operations more productive, rail, air, and intercity bus transportation have abandoned service to many small towns, especially those in rural, low-density States, leaving cars and trucks as the only transportation alternative. Simultaneously, Federal and State programs, seeking to maximize economic benefit, generally target their subsidies for Interstate system and major highway construction, and capital replacement; county and local government shoulder most responsibility for maintenance. These costs are particularly heavy burdens for sparsely populated States that have extensive road systems, such as Montana and Wyoming, and for poor States like Alabama and Mississippi where per-capita income levels are far below the national average. Their ability to pay is not commensurate with the investment needed to maintain the roadway system on which they are dependent.

Major issues include: Determining the Federal responsibility for assisting rural and poor States in maintaining their road networks.

[9] The number of heavy vehicles operated by farmers and farm supply and marketing firms traveling on rural roads has increased substantially, while revenues to maintain and reconstruct the existing system are declining in real terms. For further information, see C. Phillip Baumel et al., ***The Economics of Reducing the County Road System: Three Case Studies in Iowa,*** DOT/OST/P 34/86/035 (Washington, DC: U.S. Department of Transportation, January 1986).

TRANSPORTATION SYSTEM EFFICIENCY

As a result of long-term Federal and private sector investment and regulatory policies, U.S. transportation infrastructure and institutions provide for multiple separate modes. To the detriment of shippers and travelers, the country does not have an efficient intermodal system, in fact or as a matter of policy. Trucks compete with railroads for freight market share and with automobiles on the highways. Highway and transit officials compete against each other for public support and limited public funding. U.S. Department of Transportation (DOT) modal administrators and congressional committees compete, too. While competition is an essential ingredient for continuing vigor in a complex transportation system, the trick is to achieve a balance between a healthy level and narrow, parochial feuding that strangles essential growth in productivity.

The resiliency and long-term growth of the economy depends on an efficient and balanced transportation system; intermodal cooperation and the linkages between the modes will be the keys. Without substantial improvement, inefficient freight transfers will cost industry dearly, and time-consuming commutes will reduce worker productivity. A political and institutional framework must be developed to address these issues. At present, for example, the groundside transportation needs of air and seaports--major traffic generators--are frequently left out of local transportation decision making.

Major issues include: What Federal institutional and funding changes can most effectively **encourage an efficient intermodal** *transportation system? What are the best ways to maintain the benefits of competition and still improve intermodal performance?*

COMPATIBILITY WITH ENVIRONMENTAL GOALS

Transportation and the environment (air, water, and land) are closely linked in the physical world and in legislation since the passage of recent environmental laws. Unless transportation plans are compatible with environmental goals and mandates, Federal transportation funding will be cut off or projects will be ensnared in lengthy, even irreconcilable intergovernmental or citizen disputes. As a result, environmental inter-

ests are emerging as full-fledged players in transportation decisionmaking.

The specific impacts of the 1990 Clean Air Act are just beginning to be understood by Federal, State, and metropolitan transportation policy makers and administrators. To achieve mandated decreases in car and truck generated pollutants, major changes are unavoidable in business operations, commuting and other travel patterns, land development, as well as, how decisions are made about transportation planning and investment. Linkages between highways and other environmental issues, such as noise pollution and wetlands functions and values, must also be better understood and processes improved for eliminating conflicts. New surface transportation legislation needs to establish processes that incorporate environmental issues as well as engineering and economic factors. Environmental considerations must be included in the early stages of policy and project planning.

Major issues include: How best to clarify lines of communication and authority between transportation and environmental officials and decisionmaking processes at the Federal, State, and local levels.

TECHNOLOGY FOR THE FUTURE

The Federal Highway Administration (FHWA) supports the vast majority of research and development (R&D) on highway technologies and has traditionally focused on research to underpin construction standards and regulations for operating safety. The Strategic Highway Research Program (SHRP) was established outside FHWA to promote a more far-reaching research agenda.

While FHWA'S 1991 and 1992 budget requests reflect some increases in the resources devoted to R&D, the time is right to expand FHWA'S research agenda and related surface transportation research programs still further. Priorities include technologies addressing highway capacity and congestion relief, structural preservation and rehabilitation, and integration of highways with other modes. For example, pavement durability research, such as that being conducted by SHRP, needs a permanent home in FHWA, since SHRP is slated to go out of existence within a few years. Automatic vehicle identification technologies that speed toll collection and other advanced traffic management technologies in IVHS offer significant potential for congestion relief and for cutting down on highway delays. High-speed rail and magnetic levitation systems need further work to determine their place in the intermodal intercity systems of the future. Many of these technologies are ready to implement, but additional evaluation or demonstration under FHWA sponsorship would help bring them into widespread use.

Bolstering the surface transportation research agenda raises questions about the effectiveness of the current research structure and funding arrangements. The informal cooperative arrangements now used between the Urban Mass Transportation Administration, the National Highway Traffic Safety Administration, and FHWA are better than nothing, but a strategic DOT plan for surface transportation is long overdue. Only when such a plan has been developed, with milestones and technology transfer mechanisms included, can a steady funding stream be contemplated. In addition, OTA's research points to the difficulties facing State and local officials in using new, advanced technologies. FHWA has mounted a substantial effort to re-establish technology transfer programs that were cut back a decade ago, but additional techniques for improving Federal technology transfer and ways to overcome institutional obstacles must be identified and implemented.

Major issues include: What institutional changes are needed to ensure rapid development and implementation of existing new technologies? What R&D programs are needed to evaluate next generation surface transportation technologies?

INVESTMENT AND INSTITUTIONAL ISSUES

Acknowledging an increased backlog of transportation projects, Congress raised the 1991 obligation ceiling for highways and mass transit to $17.8 billion, 17 percent over the 1990 level of $15.2 billion. However, budget constraints make it critically important that spending is strategically targeted and that its long-term implications are thoroughly considered.

Table 1-2—Proposed Federal Authorizations for Highway and Mass Transit, 1991-96
(in billions of unadjusted dollars)

	1991[a]	1992	1993	1994	1995	1996
Highways	$14.0	$15.8	$16.1	$16.6	$18.1	$20.1
Transit	3.3	3.3	3.3	3.3	3.3	3.3

[a]Estimated.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, *Summary of Highway Provisions of* 1991 Surface *Transportation Assistance Act* (Washington, DC: 1991).

Federal-Aid Levels

Compared to investment needs identified by government and industry groups, which range from $90 and $150 billion annually, the 1991 Federal appropriations and those projected by the Administration for 1992 to 1996 fall far short of levels necessary to recoup a decade of disinvestment and to leverage large increases in State, local and private investment. The proposed Administration 5-year highway spending plan barely keeps up with inflation through 1994 (see table 1-2); significant increases are not scheduled until 1995 and 1996. Transit funding would be maintained for the authorization period at $3.3 billion annually, which represents only a 1 percent increase over the past 5 years and a decrease in purchasing power as the result of inflation.[10]

While local and State officials and industry advocates are pleased by the increase in 1991 spending, they would like to see more spending drawing down the large trust fund balances maintained for highways and mass transit ($1 1 billion and $8.5 billion, respectively, in 1991). Under the Administration proposal, these are estimated to reach $16 and $9 billion, respectively, by 1996. " The balances would fall between 1995 and 1996 because current legislation reduces motor fuels taxes in October 1995 back to November 31, 1990 levels--a move that would eliminate the recent 2-cent per-gallon increase in the highway trust fund and the 0.5-cent per-gallon increase in the transit account and significantly reduce earmarked revenues.

Unlike mandatory entitlement trust funds, such as social security, highway and transit fund balances cannot be spent without being budgeted and appropriated. Thus, the annual surface transportation agenda must compete with other Federal priorities that are funded under the domestic spending ceilings imposed in the 1990 deficit reduction package.

Congress could consider whether the long-term economic and environmental benefits of a structurally sound and efficient transportation system are so compelling that they warrant recalculating Federal budget priorities (or strategies). A growing body of economic research shows a strongly positive relationship between public investment in infrastructure and economic growth.[12] If the Federal gas tax were raised gradually and continuously, the flow of earmarked transportation funds would increase, adding to the amounts available for improvements, and reducing the energy consumed during traffic delays and travel over bumpy roads.

Major issues include: Isa substantially larger Federal investment warranted to address transportation system needs and avoid detrimental economic consequences? And if yes, how can it be financed?

[10] Kenneth M. Mead, director, Transportation Issues, Resources, Community and Economic Development Division, U.S. General Accounting Office, testimony at hearings before the House Subcommittee on Investigations and Oversight, Committee on Public Works and Transportation, Mar. 5, 1991, p. 2.

[11] James L. Blum, assistant director, Budget Analysis Division, Congressional Budget Office, testimony at hearings before the Senate Committee on Environment and Public Works, Mar. 5, 1991, p. 13.

[12] Alicia Munnel, senior vice president and director of research, Federal Reserve Bank of Boston, testimony at hearings before the House Committee on Public Works and Transportation, Feb. 20, 1991.

Table 1-3—Current Federal Highway and Mass Transit Program Authorization

Program	1991 authorizations (in billions of dollars)	Percent
Highways:		
Interstate construction	$3.2	23%
Interstate 4-R[a]	2.8	20
Primary	2.3	16
Secondary	.6	4
Urban	.8	6
Bridge	1.6	12
Other	2.7	19
Subtotal	14.0	100
Highway and motor carrier safety:		
Subtotal	0.4	
Mass transit:		
Discretionary programs (new rail lines, modernization, and bus projects)	1.2	36
Formula (capital projects, planning, and operations)	2.1	64
Subtotal	3.3	100
Total	$17.7	

[a]Resurfacing, restoring, rehabilitating, and reconstruction. Reconstruction that includes lane additions and new interchanges is currently the largest program component.

SOURCE: Congressional Research Service, *Surface Transportation Reauthorization 1991: A Comparison of Current Law With the Bush Administration Bill* (Washington, DC: Mar. 25, 1991), pp. 6, 30.

Table 1-4--Administration Proposed Surface Transportation Act Authorization for 1992-96

Program	Authorizations (in billions of dollars)	Percent
Highway:		
Interstate completion	$7.2	8%
National highway system	43.5	50
Urban/rural	22.2	26
Bridge	10.7	12
Other	3.2	4
Subtotal	86.8	100
Highway and motor carrier safety:		
Subtotal	2.3	
Mass transit:		
Discretionary programs (primarily new starts)	2.0	12
Formula (capital projects, planning, and operations)	14.3	88
Subtotal	16.3	100
Total	$105.4	

SOURCE: Federal Highway Administration, *Mowing America Into the 21st Century* (Washington, DC: 1991), p. 16.

Program Priorities

Along with Federal-aid levels, the biggest issue facing Congress is how the money is to be spent. (See table 1-3 for current authorizations and table 1-4 for 1992 to 1996 proposed program authorizations.) Two issues are at the heart of the priorities debate: 1) the importance of system preservation and efficiency relative to construction and capacity expansion, and 2) the wisdom of concentrating Federal spending on a national highway network as opposed to supporting a balanced intermodal transportation system that serves both rural and urban areas efficiently.

Construction or System Preservation?

Despite a tradition of favoring construction as answers to transportation needs, the building bias is moderating. DOT, most State and local officials, and many highway and transit groups advocate targeting funding at system preservation and improvement to protect existing investment, improve safety, and reduce long-term maintenance and environmental costs.

Some interest groups recommend denying Federal funding of new highway construction, unless it is part of a State or rural government-approved program, and focusing Federal spending on system rehabilitation and performance enhancement. Others contend that adequate funding for construction is essential to provide access to underserved areas.

Highways or Intermodal Systems?

Federal policy and funding has generously supported construction of an excellent Interstate highway system, but this focus has helped create sprawling metropolitan areas, and is not well suited to the complexities of the 1990s, much less the 21st century. The Nation needs a robust and balanced intercity transportation system to compete effectively in the international economy. Investment in highways is, of course, an important part of such a balanced system. However, in a time of very tight budgets, too much emphasis on highways may divert resources from metropolitan transportation problems that have enormous consequences, and affect intercity passenger and freight travel and much of the Nation's population, its economy, and the environment. Furthermore, overemphasis on highway construction and capital improvements burdens rural areas with demands for rehabilitation and maintenance that they have difficulty meeting.

Federal policy could promote an intermodal model that integrates Interstate, other arterials, rural highways, waterways, freight and passenger rail lines and air corridors into a national transportation system. This concept includes metropolitan networks--made up of modern urban highways; high-occupancy, high-volume corridors; transit, commuter, and intercity rail routes; and intermodal transfer centers--all integrated and linked to air and seaports.

Major issues include: To promote the long-term national interest, should Federal spending priorities focus on expanding the national highway system or on developing a balanced transportation system that includes highways as one *component of a surface transport network?*

APPORTIONING FEDERAL AID

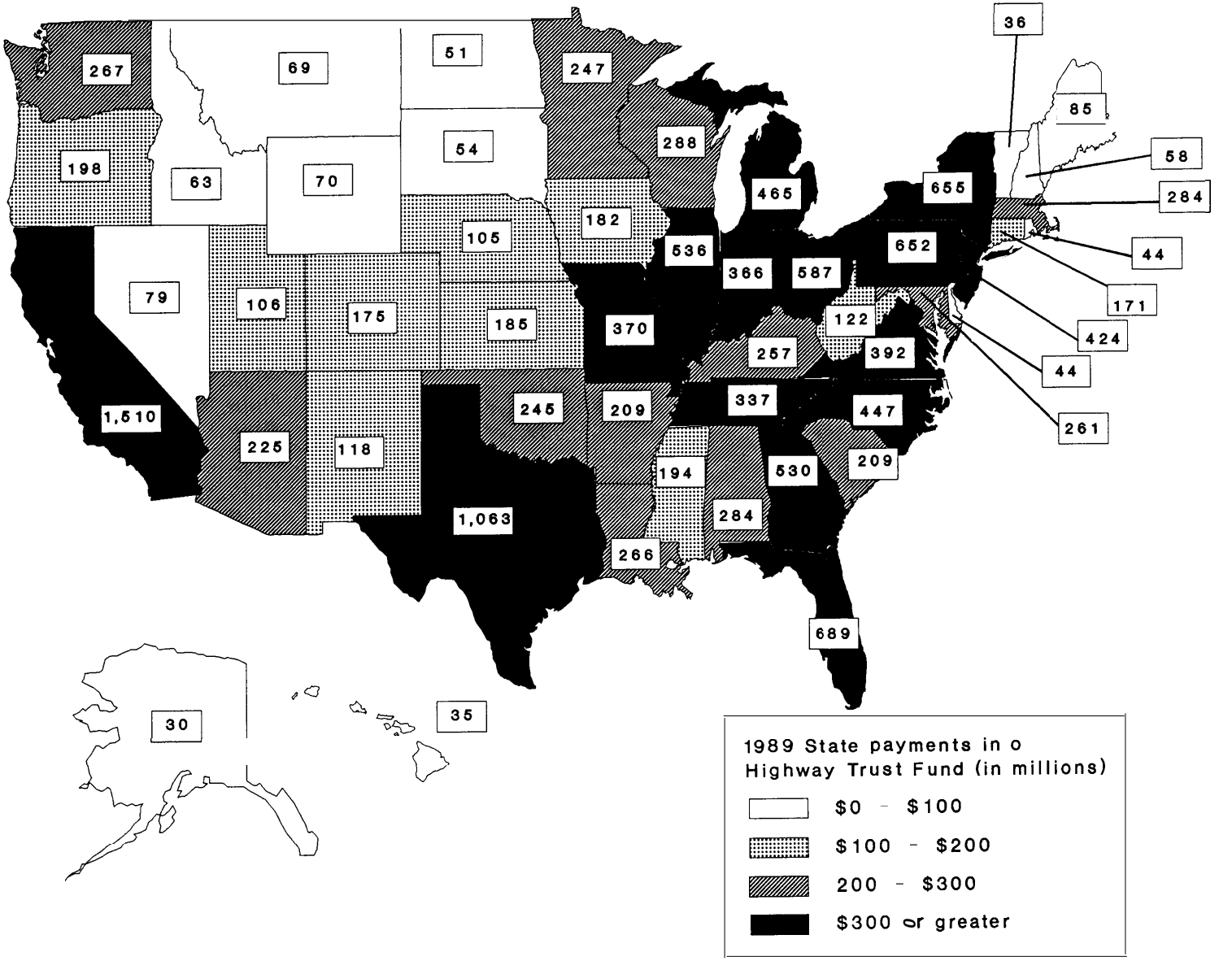
Because all States contribute to the Federal Highway Trust Fund, maintain backlogs of transportation projects, and count heavily on Federal aid, Federal apportionment formulas are important and controversial policies. The result of numerous political compromises made over many years, Federal-aid apportionment formulas are complex and hard to evaluate in respect to current national goals. Key formula factors are outmoded and hard to quantify accurately. (See table 1-5 for a summary of current apportionment factors.) Urban States protest that allocation formulas are weighted unfairly in favor of rural States, ignoring the heavy use of urban roads, and large rural States claim their Federal share is minimal compared to their needs and their key role in national highway networks. Rapidly growing States and metropolitan areas object to highway and transit apportionments based on decennial census counts, because they receive no credit for their above-average growth except at 10-year intervals. All States want to maximize their share of the Federal outlays and, at least, get back close to what they pay in through fuel taxes. (See figure 1-2 for a map showing State contributions to the Highway Trust Fund and figure 1-3 for current State Federal-aid apportionments.)

Table 1-5-Apportionment Factors for Federal Surface Transportation Aid, 1991

Program	Factors determining each State's apportionment
Highways:	
Interstate construction . .	State's share of the cost to complete the planned Interstate system
Interstate 4-R	Number of Interstate lane-miles Number of vehicle-miles traveled
Primary	State land area State rural population State rural delivery routes and city mail route mileage
Secondary	State land area State rural population State rural delivery route mileage
Urban	State urban area population
Bridge	State's share of the cost to replace or rehabilitate deficient bridges
Mass transit:	
Discretionary.	Urbanized area population
Formula	Population density within urbanized areas Transit system service and ridership

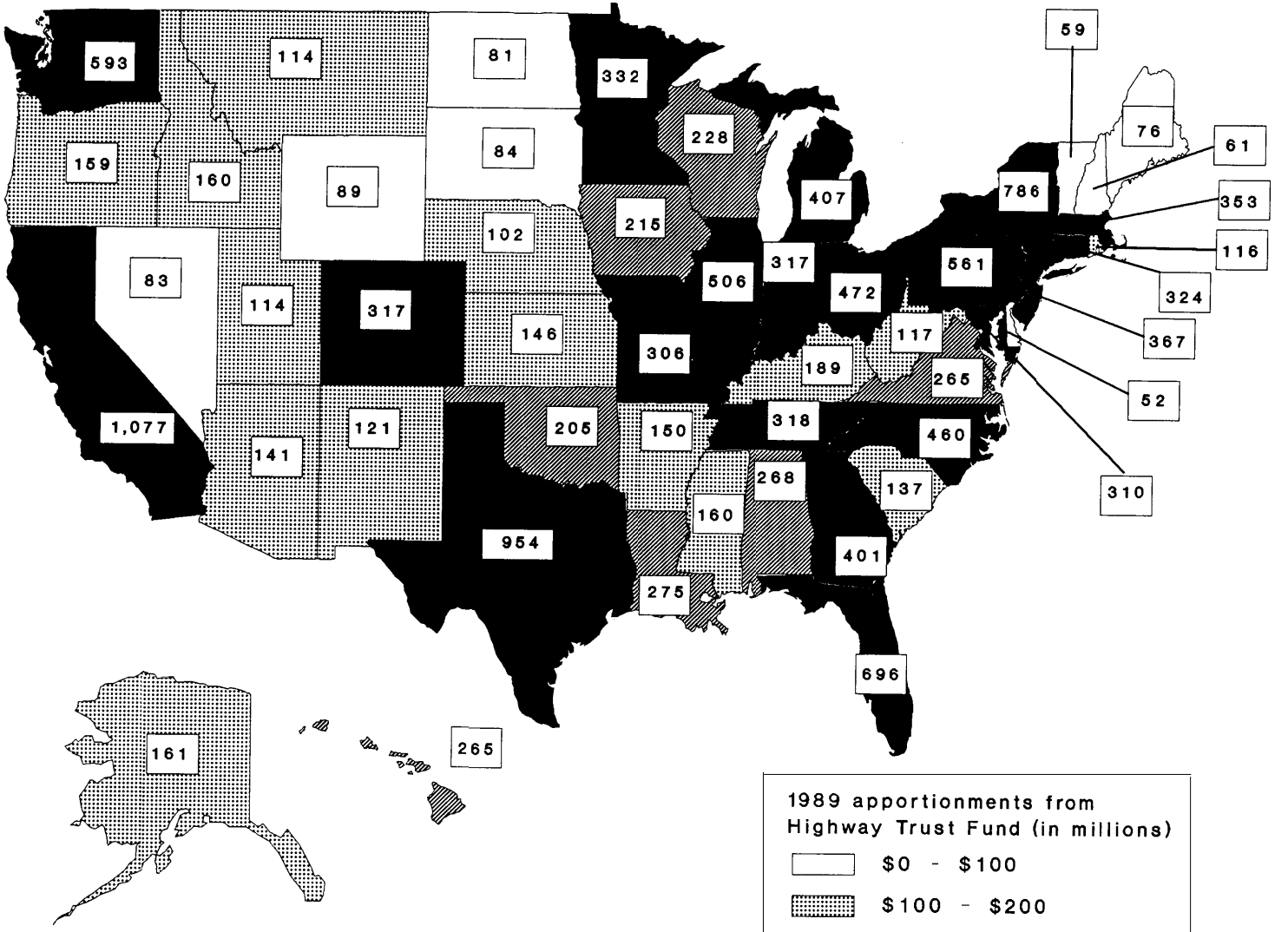
SOURCE: U.S. Department of Transportion, Federal Highway Administration, *Highway Statistics 1989* (Washington, DC: 1990); and Congressional Research Service, *Understanding U.S. Transportation Program Finances* (Washington, DC: 1990).

Figure 1-2—State Payments Into Highway Trust Fund, 1989



SOURCE: Federal Highway *Federal Highway Statistics 1989* (Washington, DC: 1990), p. 47.

Figure 1-3—Apportionment of Highway Trust Fund to States, 1989



SOURCE: Federal Highway Administration, *Federal Highway*

Box l-B-Fiscal Issues Differ Widely Depending on State Conditions

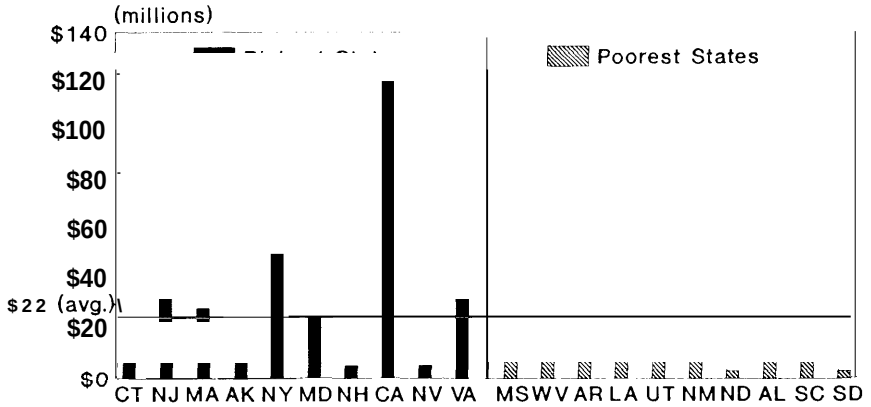
As Congress considers how to allocate Federal aid to States, two special problem types are of concern--areas with serious but short-term capital needs and those with large, long-term capital deficits. In many high growth areas, demand for transportation facilities and services exceeds immediate resources. Population increases have pushed demand for more capacity and investment to the South, Southwest, and west coast and to outlying metropolitan suburbs. State and local tax revenues are likely to grow as the economy prospers, but not fast enough to keep current with demand. (Figure l-B-l shows the different revenue raising capacity of State gas taxes in rich and poor States.) In addition to traditional grant aid, these places could benefit from strategies such as growth management, stronger State and regional planning, and stimulation of **private** investment. Federal incentives, such as seed money for capitalized revolving loan funds with repayment based on tolls or value-capture taxes maybe appropriate to fill the short-term capital gap.

On the other hand, in many rural States and older, central cities, investment needs for upgrading and rehabilitating transportation infrastructure are climbing, outpacing growth in State and local tax bases. The problem is particularly acute for low-density States like Alaska, Montana, and North Dakota where planned highways are left incomplete, and major roads remain unrepaired because of inadequate resources. In New York City and Philadelphia, which are extreme examples, massive investment is needed just to maintain minimal levels of service operation and safety.

Current Federal allocation formulas do not weigh the fiscal status of States or metropolitan areas. **Although timely and accurate measures of a State's or region's ability to pay or fiscal capacity or effort are difficult to develop,[1] these are critically important factors to consider if maintenance of structurally sound transportation infrastructure is to be achieved nationally. WhiIe** primary- and secondary-aid formulas include State land area and system size as factors, these are, at best, indirect measures of need and do not calculate fiscal capacity, ability to pay, or local effort. In 1990, six western States with a total population of 5,6 million (or 2 percent of the Nation) and incomes below the national average were responsible for maintaining almost 10 percent of the Interstate system. Similarly, the urban area-aid formula, based only on population size, does not consider economic factors.

[1]Per-capita income is the most current available indicator of fiscal capacity. The Advisory Commission on Intergovernmental Relations has developed comprehensive measures of fiscal capacity and effort, the most recent available data is for 1988. See U.S. Congress, Office of Technology Assessment, ***Delivering the Goods: Public Works Technologies, Management, and Financing, OTA-SET-477*** (Washington, DC: U.S. Government Printing office, April 1991).

Figure l-B-l—Yield Per Penny of Gas Tax in the Richest and Poorest States, 1989a
(by per-capita income)



KEY TO STATE ABBREVIATIONS: AK—Alaska; AL—Alabama; AR—Arizona; CA—California; CT—Connecticut; LA—Louisiana; MA—Massachusetts; MD—Maryland; MS—Mississippi; ND—North Dakota; NH—New Hampshire; NJ—New Jersey; NM—New Mexico; NV—Nevada; NY—New York; SC—South Carolina; SD—South Dakota; UT—Utah; VA—Virginia; WV—West Virginia.

[a]States listed in order from highest per-capita income to lowest per-capita income.

SOURCE: U.S. Congress, Office of Technology Assessment, *Rebuilding the Foundations: A Special Report on State and Local Public Works Financing and Management*, OTA-SET-447 (Washington, DC: U.S. Government Printing Office, March 1990), p. 71.

To reflect current Federal goals and more accurately relate to system needs and fiscal capacity, apportionment formulas need reform. Most in need of change are the formulas for primary and secondary roads, which are outdated and generally do not reflect accurately the most heavily used roads. Bonuses have been proposed for low-density States to compensate them for high per-capita road costs, but Congress may also want to consider modifying apportionment formulas or matching ratios (see next section) to assist States with low fiscal capacity. '3 (See box 1-B for a discussion of fiscal issues.) The five States with the lowest fiscal capacity and not receiving existing or proposed bonuses would be: Mississippi, West Virginia, Arkansas, Alabama, and South Carolina.

Major issues include: How to allocate Federal-aid amounts and balance equity, system need, and fiscal capacity, and also promote the Federal interest.

FEDERAL MATCHING RATIOS

Federally set matching ratios are important determinants of how much money each State gets. They are also pivotal policy issues, since high Federal matches profoundly affect State and local decisionmaking. For example, while a 90-percent Federal match for Interstate construction proved an effective strategy for building a national road system, the policy skewed State and local priorities toward construction and undercut investment in system preservation, maintenance, and transportation alternatives. Similarly, because Interstate receive a 90-percent Federal match, Interstate projects are often given priority over other needed State and local construction projects.

Matching ratios are used to reflect national priorities, and the Administration's interest in limiting Federal assistance for transit in large cities is seen in proposed new matching ratios, which substantially reduce the Federal match for new transit starts from 75 to 50 percent. The philosophical basis for this is that new projects must be well supported locally to be viable and a cost-effective Federal investment.

The 90-percent Federal share for Interstate was appropriate in the 1970s and 1980s, given the strong Federal interest in completing Interstate construction, but such a high Federal match for new programs is inconsistent with the notion that States can and should accept a larger financial role. However, if Congress wants to reduce Federal program matches substantially (selectively or for all programs) to leverage more State and local spending, the impact on individual States needs to be assessed. An increase from 10 to 15 percent in State matches may seem modest, but it can have enormous impacts on State budgets. Such a raise for the existing Interstate 4-R program, which provides funds for highway reconstruction and rehabilitation, would require almost $200 million in additional State investment. (See appendix A, table A-1 for the impact of a change from 20 to 25 percent in the State match for bridges.)

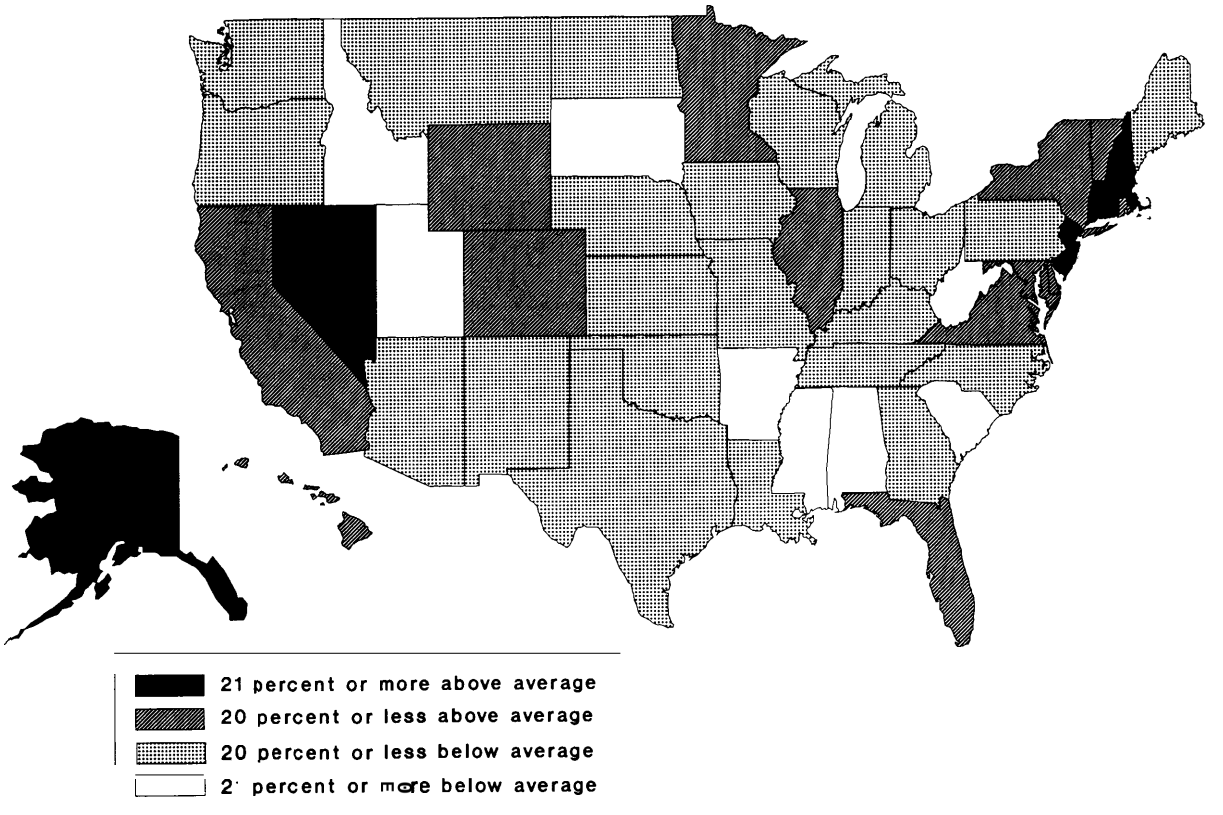
In States where the economy is particularly weak, an increased State matching requirement could severely limit State participation in Federal programs. The local burden of higher matches could be reduced if Federal regulations permitted more flexibility in what qualifies as the State share such as toll revenues, impact fees, and other developer contributions. On the other hand, matching ratios can be manipulated to promote equity. Existing law permits a reduced State match for States where the Federal Government has large land holdings. (See appendix A, table A-2 for those States receiving a match reduction now and those that are candidates for low-density bonuses.) Similarly, reduced matching ratios could be applied to States with low fiscal capacity (see figure 1-4).

Major issues include: How to use Federal subsidies effectively to promote national objectives and leverage more State and local investment without bringing unnecessary hardship.

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[13] Fiscal capacity refers to a State's relative ability to raise revenue from taxes and other sources. Historically, a State's fiscal capabilities have not been considered in apportioning Federal program funds, although States with large Federal land holdings have received special consideration. A State's capacity to raise revenue remains a salient issue, especially if Federal matching shares are reduced. One possible way to assist the five or so States with the lowest fiscal capacities would be to include provisions for them in Federal legislation for a reduced matching share.

Figure 1-4—State Fiscal Capacity To Raise Revenue (percent deviation from U.S. average)



SOURCE: Advisory Commission on Intergovernmental Relations, *1988 State Fiscal Capacity and Effort* (Washington, DC: 1990).

PROGRAM FLEXIBILITY

Under the current categorical structure, Federal aid is narrowly focused and comes with a myriad of strings and red tape. For reasons of efficiency and because State and local governments are footing a larger share of the bills and have become better informed decisionmakers, they are demanding more autonomy and administrative flexibility. This is especially true for metropolitan and rural programs where conditions and problems may be unique and programs need to be customized. For instance, the ability to transfer or combine program funds would greatly enhance local administrations' capacity to deal with issues such as port access or linkages between mass transit facilities and highways. Greater program flexibility and increased local and State autonomy has wide support, both inside and outside the Federal Government, although definitions of acceptable types of flexibility are likely to differ among interest groups.

Major issues include: Which programs most reflect Federal interests? What are appropriate reasons for Federal collection and redistribution of fuel taxes in flexible grants? Under a flexible program structure, how can States be held accountable for making good use of Federal dollars?

PERFORMANCE MEASURES

The Federal Government currently lacks understandable and reliable system performance measures, a situation that contributes to the general lack of direction evident in current Federal policy. For instance, although congestion is a top national issue, no standard approach is used for measuring congestion.[14] Of particular importance is the development of databases for recording and measuring congestion, intermodal activity, highway and bridge maintenance, and interrelationships of transportation with the environment and land use. Data of this sort are important for understanding transportation problems and their linkages, setting reasonable standards, measuring progress, and refining Federal programs and apportionment formulas. Furthermore, such measures are essential for planning transportation strategies for air quality compliance.

DOT is the most suitable entity to develop performance measures. In establishing an improved assessment system, Congress should be sure that the right questions are asked, that DOT has a mechanism to collect and analyze the appropriate information, and that the department is held accountable for results.

Performance Incentives

The Federal Government offers few rewards for superior performance of transportation systems. Federal dollars are divided up according to formula, project costs and through discretionary programs--all of which have little to do with performance. If reliable performance standards are developed, financial incentives for exemplary achievement can be a positive new tool. Since system maintenance and congestion are such major problems, they are good candidates for incentive programs. (See box 1 -C for sample maintenance and congestion incentive programs developed by OTA.)

REGIONAL PLANNING

Transportation problems are created and solutions stymied by the absence of strong regional and State planning to guide land use and transportation decisions. Because of the number of governmental units that operate (and overlap) in most metropolitan areas, decisionmaking is fragmented and narrowly focused, making it practically impossible to form a consensus on development goals and, thus, to build a framework for resolving regional transportation issues. Furthermore, State policies frequently thwart meaningful regional planning by limiting local authority, especially for revenue raising, and by failing to maintain a viable State planning process.

Major issues include: How can the Federal Government best promote effective State /and use and transportation planning and budgeting?

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[14] U.S. General Accounting office, ***Traffic Congestion--Trends, Measures and Effects*** (Washington, DC: November 1989), p. 3.

Box l-C--Sample Maintenance Award and Congestion Relief Bonus Programs

OTA developed these sample complementary programs to demonstrate types of incentives for which all States could compete. The National **Maintenance Award** Program seeks to improve transportation efficiency in States of all sizes and types, and the Congestion Relief Bonus Program is aimed at improving metropolitan transporbtion system productivity. Rural States are perhaps less likely to be interested in the congestion relief bonus program, but each has at least one city that might be eligible. Peer involvement by State transit, transportation, and planning officials in the award process is key.

National Maintenance Award Program

The purpose of the program is to reward States with cash awards (and appropriate publicity) for raising the largest percentage of highway lane- and bridge-miles to a higher maintenance standard compared to a base year.

Funding: A $2.5 million set-aside beginning in 1993.

Award criteria: Bonuses would be awarded to State Departments of Transportation (DOTS) that a Peer Review Board determines have made the biggest improvement in the condition of highways and bridges over a previous year's performance. The board, which could be set up by the Secretary of Transportation in conjunction with professional State and industry officials, would establish the evaluation measures or use the current Present Serviceability Rating System.

How it works: Annually or biennially State DOTS may submit applications to compete for the Maintenance award. The Peer Review Board would select winners in two to three divisions; the divisions could be based on size of the system, fiscal capacity, or percent of the system that is rural or urban. The award winners would have their techniques and strategies showcased so that other States could benefit. States may spend awards on any State maintenance-related program.

Congestion Relief Bonus Program

The purpose of the program is to provide a cash award incentive to metropolitan areas to reduce congestion and improve travel time and air quality (or make statutory or programmatic progress toward these goals). Involvement of highway, transit, and Metropolitan Planning Organization (MPO) officials in the program development is key.

Funding: One-half percent would be set aside, beginning in 1993 and increasing to as much as 1 percent by 1996, from the proposed highway or metropolitan program apportionments.

Eligibility: An MPO would be the only eligible recipient of the bonus grants. To qualify for the bonus award competition an MPO must have a Federal, State, and locally approved congestion reduction and management plan including a supporting data collection and analysis program that follows Federal guidelines--to be developed by the Secretary.

Earning bonus points: An MPO earns bonus points for quantifiable reductions in metropolitan area congestion (see possibilities below) and, for some nonquantifiable but supporting accomplishments (see possibilities below.) The details of this step would be worked out by the Secretary between 1992 and 1993 along with congestion management data collection and analysis guidelines.

Quantifiable improvements that earn bonus points

. increased vehicle occupancy rate (one point per X percent increase);
Ž decreased travel time (one point per X second decrease on designated arterial);
• decreased hours per month of severe congestion;
• improved air quality;

- **increased** ridership per capita and in the off-peak and better on-time performance of transit, or other appropriate transit indices; and
- improved level of service for major highways based on adopted standards.

Nonquantifiable achievements that earn bonus points

- approved congestion pricing policy and implementation plan for highways and bridges (note: prohibiting truck travel by time of day is not an effective form of congestion control);
- approved congestion pricing policy and implementation plan for parking;
- approved long-range metropolitan land-use development plan to support congestion relief policies;
- approved 5-year capital improvement program for surface transportation; and
- private sector commitment to participate in congestion relief evidenced by specific agreements for transit allowance if parking is provided free, for example.

How it could work: MPOs would compete for bonus points with other MPOs of comparable size. There could be four categories; the largest would be 3 million and over and the smallest up to 250,000. The value of each bonus point would be determined by the number of points earned in each size category divided by available funds. Once having earned a bonus point, an MPO continues to receive the cash bonus each year throughout the authorization period unless its performance deteriorates. The MPO's objective is to accumulate bonus points over the years as a result of continuous improvement. Therefore, it would be important to increase program finding each year because as more points are awarded each is worth less, unless the base is increased. MPOs could spend the bonus funds on enhancing any congestion relief or mobile source reduction air quality related activities.

SOURCE: Office of Technology Assessment, 1991.

Chapter 2

Where We Go From Here: Program Goals, Structure, and Funding

Addressing the issues outlined in chapter 1 will not be easy, and will require vision, difficult political compromises, restructuring of established program funding and institutional relationships, and, in all likelihood, some changes in lifestyles. However, unless we deal with the problems now, Americans will bear the costs of inefficient and unproductive transportation--through traffic delays, unhealthy air quality, inadequate access to transportation services especially in rural areas, higher prices, and a lower standard of living. Reauthorization of surface transportation legislation offers Congress the chance to shape a new program aimed at maintaining structurally sound, safe transportation networks and developing an efficient intermodal system that promotes a vigorous economy and an improved quality of life.

Although many agree that Federal surface transportation legislation needs revamping, opinions differ on program goals and structure. The Administration led off the legislative process in February with its proposed 1991 Surface Transportation Assistance Act (subsequently referred to as 1991 STAA), introduced as S. 610 and H.R. 1351. This proposed legislation substantially restructures the existing program and reduces the Federal share in almost all programs, although it maintains a highway focus and reemphasizes mass transit resources. Many transportation and environmental interest groups have also made recommendations.[1]

To help Congress sort through the numerous options and the tradeoffs associated with each, OTA developed four generic program models, A, B, C, and D, reflecting a spectrum of goals. Model A is the most similar to the existing program, while Model D represents fundamental changes in program structure. However, all models place higher priority on system preservation, operational improvements, and intermodal linkages than is currently given.

Three models assume a 5-year Federal spending level of $105.4 billion, which is the Administration's budget for highway and transit programs and within the agreed on budget ceiling; Model D proposes higher Federal spending. To illustrate how the policy goals of each model could be implemented through Federal spending, each model includes possible spending allocations for major programs. The intent is not to make recommendations, but rather to provide sample programs with components that can be mixed and matched and that serve as subjects for debate. Briefly summarized below, the models and their illustrative allocations of program funds are described more fully in boxes 2-A, 2-B, 2-C, and 2-D. Essential program components, such as land use and transportation planning, environmental concerns, safety, and research and development (R&D), that will be part of any reauthorization legislation, are presented later in this chapter.

GENERIC PROGRAM MODELS

Model A (see box 2-A) retains the current basic program categories and provides for a strong Federal role, preserving the present single mode (separate highway and mass transit programs) administrative structure. It emphasizes preserving the existing system by modifying project eligibility to fund highway reconstruction, maintenance, and repair. Funding for rural secondary programs is raised substantially. It also widens the funding eligibility of operational improvements, particularly those aimed at congestion relief. To address metropolitan area and urban problems, mass transit, urban highway, and bridge programs receive a higher funding priority than they do currently. *The tradeoffs of this model include: no increase*

[1] Proposals have been developed by the Surface Transportation Policy Project, the Coalition for Transit Now, the Campaign for New Transportation Alternatives, Federal Highways for the Future, the American Association of State Highway and Transportation Officials, and the American Public Transit Association. Most were released in Spring 1991.

Box 2-A--Model A Program Structure

Model A, based on the current structure, has six **major categorical programs.**

Interstate: Complete construction of the planned 43,000-mile system at current match; permit funding of maintenance and operational improvements; set Federal match at 65 percent for construction of new roads or capacity; 80 percent for reconstruction, repair, maintenance, and operational improvements; and 35 percent for toll facilities.

Primary: Retain major features of current program; permit funding for maintenance and operational improvements, including congestion relief; set Federal match at 60 percent for new construction, 35 percent for toll roads, and 75 percent for other program components; and initiate apportionment reform.

Secondary: Increase funding; retain major features of current program; permit funding for maintenance and operational improvement; set Federal match at 60 percent for new construction and 75 for other program components; and initiate apportionment reform.

Urban: Increase funding; retain major features of current program; permit funding for maintenance and operational improvements with priority to congestion relief strategies.

Bridge: Require bridge management program; reform bridge program apportionment; and increase program funding.

Transit: Retain major features of current program; emphasize capital replacement and increase funding to reflect transit's growing role in relieving congestion and environment problems.

Illustrative Expenditures **and Matching Requirements**

Programs	**5-year Federal expenditures** (in billions)[a]	**Federal share (percent)**[b]
Interstate	$35.0	90-65%
Primary	15.0	75-60
Secondary	5.0	75-60
Urban	9.0	75
Bridge	11.0	75
Safety'	2.4	75
Transit	18.0	75-60
Other	10.0	75
Total	**$105.4**	

[a] Research funds come primarily from set-asides from the first four State-aid programs.
[b] Where there is a range, the lower percentage is for new construction.
' Category includes highway and motor carrier safety.

in flexibility to adjust to State and local priorities and no emphasis on intermodal coordination. Existing interest groups and rural areas are more likely to be enthusiastic about this ***model than*** *urban or regional governments and those who feel the present program structure is outmoded.*

Model B (see box 2-B) and program expenditures are based on the 1991 STAA proposed legislation.[2] The National Highway System (NHS), planned to be about 165,000 miles, is the top Federal priority for the 5-year program, absorbing 60 percent of funding, if Interstate completion is included. The purpose of NHS is to connect underserved parts of the country through construction of additional roadways or through upgrading the capacity and service of existing highways. The Urban/Rural Program, designed as a State block grant, receives 25 percent of total funding. The States, with cooperation from local officials, are responsible for allocating Urban/Rural funds and overseeing programs.

The Federal matching share for NHS is substantially higher than for Urban/Rural programs and transit. State apportionment formulas for NHS and Urban/Rural are tied closely to fuel consumption taxes, an index used as a surrogate for highway use. System preservation is emphasized in some situations over new construction, and for the first time funding is provided for maintenance (on Interstate only) and operational improvements to address congestion. Highway system renovation and operational improvements receive a higher match than new capacity construction. Specifically, maintenance of Interstate highways is eligible for funding under the National Highway System program, a needed boost for rural States, and 3-R projects (restoration, rehabilitation, and resurfacing) retain 90 percent Federal funding. However, the fourth R (reconstruction) projects, which usually involve new construction like additional lanes and interchanges, drop from a 90 percent to 75 percent Federal match. State management programs are required for safety, pavement, congestion, and bridges. Highway projects in urbanized areas that increase capacity must be consistent with the State congestion management plan.

Transit funding is held constant for the authorization period, but cuts occur in grant programs for large systems and new starts. The primary source of funding for formula programs is shifted to the Mass Transit Account of the Highway Trust Fund, and a "flexibility" provision permits funding either highway or transit programs from this source. The language concerning land-use planning and air quality compliance is a step in the right direction, but it does not specifically require a State transportation plan and leaves lines of authority undefined.

The tradeoffs associated with this model include: the appropriateness of a program that moves "America Into the **21st** *Century" with an intercity highway plan as the conceptual framework of a national transportation policy; the Federal commitment and spending priorities necessary to support a 165,000-mile national highway system and that allocate only 25 percent of Federal funding to Urban/Rural problems; the low priority given to transit; and the question of whether States can afford substantially higher matching ratios. Transit groups and representatives of urbanized regions are unlikely to support this model.*

Model C is one type of program configuration using transportation and technology analysis reported in *Delivering the Goods.*[3] **Model C exemplifies a transitional program toward a future, fully intermodal system that addresses current mobility and environmental problems (see box 2-C). It emphasizes system preservation, metropolitan and rural needs, developing an integrated, balanced urban and intercity transportation system, and increasing system efficiency. Local decisionmaking is**

[2] For more specific information see S. 610 and H.R. 1351 and supporting documents; U.S. Department of Transportation, Federal Highway Administration "Facts Sheets," 1991; and U.S. Department of Transportation, Federal Highway Administration, ***Moving America Into the 21st Century*** (Washington, DC: 1991).

[3] U.S. Congress, Office of Technology Assessment, ***Delivering the Goods: Public Works Technologies, Management, and Financing,*** OTA-SET-447 (Washington, DC: U.S. Government Printing Office, April 1991), p. 201.

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Box 2-B-Model B (1991 Surface Transportation Assistance Act) Program Structure

Highway provisions establish three major programs:

National Highway System: Consists of Interstate system and at least 100,000 miles of other arteria
be determined by the States and the Federal Highway Administration. Eligible projects include construction,
reconstruction, maintenance for Interstate, operational improvements, intermodal linkages, and to
Federal project approval is required, and 15 percent is transferable to Urban/Rural at a lower
Apportionment is by formula: 70 percent State motor fuel use, and 15 percent each State total public
mileage and land area with adjustments for low density and Federal land holdings. Each State is g
0.5 percent of total program funds.

Bridge Improvement Program: Funds projects based on the relative level of serviceability at
percent Federal share, includes discretionary funds for high-cost projects, and requires insecpti
management system for National Highway System bridges.

Urban/Rural Program: Gives States flexibility in funding and administering projects under br
Federal guidelines. Eligible projects include construction, rehabilitation, operational and managemen
improvements, and planning and startup funds for traffic management and demand management.
be applied to transit projects. Apportionment is based on each State's contribution to the Highway
Fund with a bonus program for innovative solutions to congestion, air quality, or rural access. I
congestion, and bridge and safety management programs are required.

Transit Program:

Holds Federal spending steady, maintains current structure and broadens project eligibility but
operating aid to large cities and appropriations from the general fund; begins to rebuild transit re
development programs

Expenditures and Matching Requirements Based on the 1991 Surface Transportation Assistance Act

Programs	5-year Federal expenditures (in billions]	Federal share[b] (percent)
Interstate Completion	$7.0	90-75 %
National Highway System	44.0	90-75
Urban/Rural	22.0	60
Bridge	11.0	75
Interstate substitution and Federal lands	3.0	
Safety[c]	2.4	60
Transit	16.0	**60-50**
Total	**$105.4**	

[a] Research finds come primarily from set-aides from the first four State-aid programs and the Office of the Secretary of Transportation.
[b] Where there is a range, the lower percentage is for new construction.
[c] Category includes highway and motor carrier safety.

Box 2-C--Model C Program Structure

Highway provisions focus on three programs in addition to Interstate:

National/interstate Highway System: Consists of existing **43,000 Interstate** miles, plus up to 10 percent additional miles in undeserved corridors and regions. Eligible projects include repair, reconstruction, maintenance, operational improvements, traffic management and control, development of intermodal links, and limited new construction. Twenty percent is transferable to Metropolitan and Rural programs. Projects must conform to Federal standards and to adopted State transportation and air quality improvement plans.

Metropolitan Program: Funds surface transportation system improvements in Standard Metropolitan Statistical Areas and other urban areas (population over 50,000). Eligible projects include repair, maintenance, congestion relief, operational improvements, traffic management and control, transit capital and operating costs, intermodal linkages, and some new construction. The programs could be administered by regional metropolitan planning organizations in cooperation with the State; projects must conform to adopted State or regional transportation and air quality improvement plans. A restructured apportionment formula could be based on data collection and analysis programs that establish measures of need, equity, and desired performance.

Rural Program: Funds highway rehabilitation, repair, maintenance, limited new construction, and allows flexibility to address other unique needs of rural areas. Bonuses could be provided for the States with low fiscal capacity.

Bridge Program: Facilitates systematic bridge repair, reconstruction, and preventive maintenance.

Transit Program:

Maintains current structure; increases research and development funding, especially strategies that effectively serve suburban areas, institutionalizes preventive maintenance, and increases funding to reflect transit's role in relieving metropolitan congestion and air pollution.

Illustrative Expenditures and Matching Requirements

Programs	5-year Federal expenditures (in billions)	Federal share[a] (percent)
Interstate	$25.0	**90-70%**
Metropolitan	29.0	**75-60**
Rural	8.0	75-60
Bridge	11.0	**75-60**
Research, planning and special programs	10.0	
Safety[b]	2.4	**75**
Transit	20.0	**75-60**
Total	**$105.4**	

a Where there is a range, the lower percentage is for new construction.
b Category includes highway and motor carrier safety.

strengthened, and State/local long-range planning and financing coordination is required. It could add bonuses for low density and the poorest States.

Federal assistance for completing and maintaining the Interstate highway system and addressing the congestion and environmental issues of metropolitan areas (where almost 60 percent of the population live) are top priorities. The level of investment in rail and bus transit and high-occupancy travel of all sorts is raised to reflect the key role it can play in relieving these problems. Rural interests are protected by maintaining a separate program and funding is increased over current levels for improving rural accessibility and intercity travel and road maintenance.

Because the next 5 years will be a retooling period from a single-mode focus to building and maintaining a more balanced intermodal system, changes in apportionment formulas and matching ratios in this model need to reflect these goals. The *major tradeoffs of this program are that Interstate and regional highway spending, particularly for new construction, is not emphasized, and Federal spending control is considerably less. Although current metropolitan socioeconomic and land-use trends and public policy encourage single-occupancy automobile trips, this model places heavy emphasis on planning and development of intermodal systems and modal alternatives. It assumes that with stronger support at the Federal and State levels, Metropolitan Planning Organizations (MPOs) will overcome some of the political rivalries that limit their effectiveness now, but they may not succeed in this. State long-range planning must consider rural areas whose needs may be downgraded as urban representation in legislatures increases. Many interest groups will dislike the emphasis in this model on more centralized planning.*

Model D takes several further steps toward an integrated national transportation system. The underlying premise of Model D is a unified Federal surface transportation program, under which the U.S. Department of Transportation (DOT) combines the modal administrations of highways, mass transit, and passenger rail into one entity that operates under a unified budget. State transportation agencies would be encouraged to follow a similar pattern.

The majority of Federal funds would be allocated to States in the form of Surface Transportation Grants (see box 2-D). In accordance with State-developed, intermodal system plans, which are reviewed or approved at the Federal level for consistency with State air quality improvement plans, each State would decide how grant funds would be apportioned for highways, rural roads, bridges, transit, and a wide range of high-occupancy travel options. State autonomy would be abridged only if DOT decided the State planning process was deficient or the Interstate system was not being maintained to standards. Close cooperation would be encouraged at all levels of government for the planning, funding, and operations of surface transportation and air and water transport.

As part of program integration, the Highway Trust Fund would be restructured as the Surface Transportation Fund, eliminating the division between highways and transit. In developing an apportionment process for Surface Transportation Grants, Congress could consider factors such as fiscal capacity, incentives for congestion reduction, and the severity of air quality problems.

To tackle the backlog of rehabilitation and maintenance projects and to ensure the economic payoff of improved transportation efficiency, Model D increases funding 20 percent over projected budget ceilings for surface transportation. The new monies reflect the environmental, safety, and broad socioeconomic benefits of more efficient intermodal transportation. Potential sources of revenue would be a gradually increased Federal gas tax, a new tax earmarked for integrated transportation, and timely spending of the existing Trust Fund balances.

The major tradeoffs of this program are that it completes the financial and administrative integration of Federal-aid to surface transportation in one step and transfers most program approval responsibility to the States. Such changes pose major political hurdles since they require restructuring established and familiar program funding and institutional relationships,

130x 2-D--Model D Program Structure

The principal components of this model are an **Interstate Completion** and the **Surface Transportation Grant** Programs:

Interstate Completion Program: Would consist of completing Interstate construction projects already begun or authorized and a limited number of additional miles in underserved corridors. The Federal share is 90 percent. Construction must comply with Federal standards.

Surface Transportation Grant Program: Consolidates funding and program administration for highways, bridges, transit, commuter rail, and intermodal linkages. State Departments of Transportation administer grant finds, which are completely interchangeable once transportation, air quality, congestion, pavement, and bridge management plans are in place. Repair, maintenance, congestion relief, operational improvements, traffic management and control, transit capital and operating costs, intermodal linkages, and some new construction programs in urban and rural areas are eligible for funding.

Administering agents could be metropolitan planning organizations or local governments in towns and counties under 50,000 in cooperation with the State. Projects should conform to adopted State transportation and air quality improvement plans and metropolitan transportation improvement programs. The apportionment formula could be based on data and analysis that establish measures of need and desired performance. Factors such as fiscal capacity, population density, and severity of air quality problems could be considered. Funding is 20 percent higher than current ceilings.

illustrative Expenditures and Matching Requirements

Programs	5-year Federal expenditures (in billions)	Federal share[a] (percent)
Interstate Completion	$14	90-70%
Surface Transportation Grant Program (highway, transit and para-transit, rail, and bridge)	98	75-60
Research, planning and special programs	12	
Safety[b]	3	75
Total	**$127**	

[a] Where there is a range, the lower percentage is for new construction.
[b] Category includes highway and motor carrier safety.

including a significant narrowing of congressional program and project authority. Furthermore, to accelerate repair of existing systems, the model proposes a funding level 20 percent higher than the budget ceiling permits, necessitating changes in congressional priorities.

PUNNING, SAFETY, R&D, AND OTHER PROGRAM COMPONENTS

Compliance with and support for Federal safety and environmental laws are basic components of any reauthorization legislation. Close cooperation between Federal, State, and local transportation and environmental officials will be necessary to achieve compliance with the Clean Air Act Amendments of 1990. Information and planning tools to help transportation officials toward this end, safety programs, and R&D are other essential programs for urban and rural surface transportation.

Land-Use and Transportation Planning

While State land-use and transportation planning are crucial to efficient and productive transportation, few States have effective growth management planning programs. Local decision makers do not have control over activities of neighboring jurisdictions, and without a State requirement, regional consensus on development goals rarely develops. Moreover, State policies frequently limit local authority, especially for revenue raising, thereby thwarting meaningful regional planning and budgeting.

Since most States lack long-range transportation planning programs, MPOs funded by DOT, are largely responsible for the regional transportation planning being done now.[4] They are charged with preparing the federally required Transportation Improvement Program (TIP) which is a region's principal transportation planning instrument. Despite this potentially important role, their performance is generally uneven--hampered by severe budget constraints, local political rivalries, and lack of fiscal independence and State executive and legislative support. To change these conditions at the State and local levels, new surface transportation legislation could:

- **Require States to prepare and adopt a 5-year comprehensive, multimodal State transportation and financing plan (in consultation with MPOs) to guide State investment, development, and air quality improvement programs. Plan components should include land-use and growth management, congestion, safety, maintenance, and rural accessibility. The plan would cover all publicly and privately funded construction and rehabilitation projects. Annual or biennial reviews would ensure a realistic framework for annual updating of local TIPs and development of local plans for nonmetropolitan areas.**
- **Require States to identify a single MPO in each metropolitan statistical area, possibly with coterminous boundaries to those of the regional air quality district. In multi-State metropolitan areas, incentives for a single MPO or a strong regional compact will be needed.**
- **Increase Federal funding for planning, including the required TIP preparation, long-range, land-use planning (growth management in developing regions), and regional data collection and analysis. (See program allocation tables in the four generic models for specific sources of Federal funds.) This capability will be essential for States to allocate resources equitably among urban and rural areas and as a basis for preparing and evaluating air quality improvement plans. Regional congestion relief programs, approved and administered by MPOs, could receive a higher Federal match.**
- **Encourage States to use MPOs to plan for regional transit and commuter rail facilities, as well as ground links with rail terminals and air and seaports.**

Safety

Motor carrier safety and heavy tractor-trailer combination truck safety are discussed in detail in chapter 3, but an in-depth review of other aspects of surface transportation safety

[4] For further information, see U.S. Congress, Office of Technology Assessment, ***Rebuilding the Foundations: A Special Report on State and Local Public Works Financing and Management,*** OTA-SET-447 (Washington, DC: U.S. Government Printing Office, March 1990), chs. 3 and 4.

programs is beyond the scope of this document. However, OTA's research for its transportation safety studies and for Delivering the Goods points to the need for addressing safety by improving the physical condition of roadways and bridges. In addition, vehicle safety activities of the National Highway Traffic Safety Administration (NHTSA) need to be integrated more fully with the safety programs of the Federal Highway Administration (FHWA), especially in the area of human factors. DOT data collection programs for safety purposes and for use in regulatory and program analysis need to be made more systematic and comprehensive, especially in the areas of freight and passenger movements, to further understanding of accident rates.

Funding for highway safety could be raised over current levels to reflect increased vehicle ownership and travel. Priorities for expanded Federal effort include changes to safety programs necessary to accommodate an aging population of drivers and pedestrians, the large disparity between truck and car sizes, and the aging highway network. The Federal program match at 75 percent is a reasonable level, reflecting the Federal responsibility for safety regulation.

The concept of a Federal incentive safety bonus program, as proposed in the 1991 STAA is an excellent one. However, to be most effective, such incentives should be used to promote safety both through highway improvements (such as better signage, railroad grade crossings, and lane changes), and through improvements to driver and pedestrian safety (such as a decrease in drunk driving and the pedestrian injury and death rates). Current programs focus on one type or another, reflecting overly narrow interest group and congressional committee concerns.

Research and Development

At present, Federal R&D is funded primarily through the appropriated budgets for each separate mode (see table 2-l). OTA did not look in detail at surface transportation agency R&D activities related to intermodal surface transportation, but most of the few projects that exist are housed in the Urban Mass Transportation Administration (UMTA); the rest are scattered throughout the department. Congress could consider requiring DOT to undertake a comprehensive, departmentwide, in-depth review of surface R&D programs with the goal of developing a strategic R&D plan. Such an effort is long overdue. DOT's statement of R&D policy[5] is a general, broad statement of principles, not a strategic plan for meeting the future. To make best use of scarce dollars, the work of the Federal Railroad Administration (magnetic levitation), UMTA (mass transit and commuter rail, as well as some smart car/smart highway work), NHTSA, and FHWA must be coordinated and viewed as components of a strategy for moving toward an efficient intermodal transportation system.

Highway R&D

FHWA R&D is funded almost entirely through program set-asides from the Highway Trust Fund, with much of the money funneled to the States or entities outside FHWA. For example, the Strategic Highway Research Program (SHRP) receives 0.25 percent of each State's apportionment. SHRP, whose agenda is weighted heavily toward paving materials durability research, broke new ground by actively involving State DOTS in planning and execution of its R&D program, an effort that is expected to pay off in facilitating technology transfer. The work being done under SHRP is scheduled to be integrated into FHWA's research program at the end of the program's 5-year life. When that occurs, ensuring that program integration and close cooperation with the States continues is vitally important. These programs are of particular importance to States with large maintenance responsibilities.

Other highway R&D programs include FHWA contract and staff research and the Highway Planning and Research Program (HP&R), which is funded through a 1.5 percent State set-aside, out of which the SHRP funds are also allocated. Some aspects of these programs have been disappointing. For example, the HP&R Program provides States with resources for their highway planning and information gathering efforts, but States are able to devote only a small fraction of this money to actual research.

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[5] U.S. Department of Transportation, "A Statement of U.S. Department of Transportation Research and Development Policy," unpublished

Table 2-I-Surface Transportation Research and Development

Agency	FY 1991 funding (millions of dollars)	Funding source	Comments
Federal Highway Administration			
Highway Planning and Research Program	$51[a]	A portion of 1.5 percent set-aside of Federal-aid instruction funds from the Highway Trust Fund	Supports State and local planning, traffic measurement, and other research
National Cooperative Highway Research Program	8	5.5 percent set-aside of HP&R funds	Contract research managed by Transportation Research Board (National Research Council)
Contract and staff research	27[b]	Highway Trust Fund	10 percent inhouse research; balance in contracts
Strategic Highway Research Program	30	0.2 percent set-aside from Highway Trust Fund	Contract R&D focused on highway construction; 5-year program
Federal Railroad Administration	*15*	From appropriated budget	Inhouse and contract R&D (does not include $10 million for magnetic levitation rail initiative)
Urban Mass Transportation Administration	*2*	From appropriated budget	Development projects
National Highway Traffic Safety Administration			
Highway safety, motor vehicle, and other research	23	From appropriated budget	Highway vehicle and pedestrian safety
National Center for Statistics and Analysis	13	From appropriated budget	Data collection and anafysis

[a]Total funds forthe Highway Planning and Research (HP&R) Program are about $153 million, two-thirds of which is used for planning. The portion used for research is $53 million.
[b]Total indudes $8.8 million for intelligent vehicle/highway systems and R&D.
SOURCE: Office of Technohxjv Assessment, 1991, based on information from the Federal Highway Administration and the U.S. Department of Transportation.

Transit R&D

Federal support for transit R&D has been drastically cut back over the past dozen years, plummeting from $52 million in 1980 to $2 million in fiscal year 1991. Projects ranging from studies of the effects of fare increases on transit ridership (the results of these are still used today) to subway tunneling techniques fell by the wayside. A cooperative research program between the Federal Government and transit agencies never received full support and was dropped in the mid-1980s.

UMTA's plans now include a Transit Planning and Research Program that includes both national (or Federal) and State and local components.[6] Funding is planned to be almost 3 percent of the total transit program appropriation, with one-third retained by DOT for a national planning and research program and two-thirds to States for planning and research and a revived cooperative research program.[7] These plans seem carefully structured and well worth congressional support.

New Technologies

Despite the development by entrepreneurs of promising new technologies, few have actually been applied on Federal-aid projects. Moreover, companies trying to introduce new technologies often find the process time-consuming, cumbersome, and eventually unproductive or even defeating. Since it had the backing of its European parent, the company described in box 2-E was better able to devote resources to convincing public officials in the United States of the worth of its product than many of the small companies that have contacted OTA to express

manuscript, January 1991.
[b]U.S. Department of Transportation, Urban Mass Transportation Administration, "Planning and Research: A New Urban Mass Transportation Administration Program, [w]unpublished manuscript, March 1991, p. 2.
[7]Ibid., p. 7.

Box 2-E--Novophalt: A Tough Road

As Federal priorities shift from building new highways to rebuilding existing facilities, employing new technologies to increase the useful lives of the Nation's roads and bridges would seem to be a cost-effective approach. Technologies, such as cathodic protection and new techniques of repaving roads, although somewhat more costly to installI, could potentially save lives and billions of dollars by slowing infrastructure deterioration. But despite their availability, government timidity and cumbersome public procedures often prevent using such technologies during rebuilding.

The polymer modified asphalt binder, Novophalt, is one example of a new technology whose introduction has been impeded by the complicated approval process of the Federal Government and the reluctance of most public officials to stray from familiar paths. The binder, which increases pavement durability, consists of paving-grade asphalt cement and up of 4 to 6 percent virgin or recycled polyolefins. Developed in Europe, Novophalt has been used there since 1976 and was introduced to the United States 10 years later.

Although it costs an estimated **4 to 8** percent more per project than conventional asphalt mixtures, the company estimates that its product can extend pavement service life from 50 to 100 percent. If life-cycle cost estimates are used, Novophak officials argue, their product could potentially reduce costs up to 50 percent from those of conventional asphalt.[1] Studies by different Federal agencies appear to bear out the company's assertions. A report released by the Federal Aviation Administration (FAA), while not mentioning the product by name, said that polyethylene-modified asphalt may benefit runways where rutting, fatigue cracking, or thermal cracking presents a problem.[2] The Army Corps of Engineers also found asphalt concrete with the same properties as Novophalt to provide"superior overall performance."[3]

To demonstrate the merits of its product, the company has conducted 22 demonstration projects in North America on airport runways and highway reconstruction projects. In one such project, where the material was used in reconstruction of city streets in Manhattan, it performed much better than standard asphalt over the same period of time. Armed with such positive results, Novophalt officials hoped to win a contract for paving a new airport runway. However, their proposal was met with resistance by managers at the local **airport** authority, who were unfamiliar with the technology and had not read the FAA report about the performance of polyethylene-modified asphalt.[4] When the company sought a contract to repave sections of a local parkway system, Federal Highway Administration officials asked Novophalt to conduct yet another demonstration project in the area, despite their successful demonstrations for numerous State Departments of Transportation.

The company's experience is illustrative of the difficulties entrepreneurs face when trying to introduce a new technology into the public works arena, although Novophalt, as a foreign proprietary technology, faced some additional problems despite its U.S. demonstrations. Quite aside from questions of international competition, Federal agencies are wary of foreign technologies because of different operating conditions and perceived scarcity of data.[5] Furthermore, **public** officials **are concerned about the risks of** price changes or supply problems associated with purchasing a proprietary technology from a private source. Even though the FederaI Government encourages private industry to develop new technologies, the reluctance of officials to contract for proprietary innovations makes public works technology development an unprofitable venture for most companies.

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1 Walter **Tappeiner, Novophalt** America, Inc., personal communication, Apr. **11,** 1991.

2 U.S. Department of Transportation, Federal Aviation Administration, "Polyethylene Modified **Asphalt Cement,"** Engineering Brief No. 45, **AAS-200,** Feb. 21, 1990. f-

3 A. F. Stock and G. **Anderton,** "An Assessment of the Resistance to Permanent Deformation of **Modified** Asphalt Mixes$" paper presented at **Eurobitume,** Madrid, Spain, October 1989, p. **451.**

4 Hugh **Mields,** consultant, personal communication, Apr. 11, 1991.

5 U.S. Congress, Office of Technology Assessment, ***Delivering the Goods: Public Works Technologies, Management, and Financing, OTA-SET-477*** (Washington, DC: U.S. Government Printing Office, April 1991), p. 201.

their frustration over the futility of their efforts. Future R&D activities in DOT must make evaluation of the operating and cost-effectiveness of new technologies a priority, to begin moving the best of them into wider use. As one example caused by past inattention to the importance of technologies, the types of automated toll collection facilities now speeding drivers through toll facilities in Dallas, Texas, New Orleans, and Oklahoma have been available for some time, yet have only recently been implemented. FHWA has belatedly begun to emphasize Intelligent Vehicle/Highway Systems (IVHS) programs, but their benefits are still unrealized in numerous metropolitan regions with terrible congestion problems that IVHS could address. Demonstration projects, originally designed and used to test new technologies, now consist of many projects that break no new technical ground. Too often, they are used to fund improvements or construct a new local facility, giving demonstrations, originally a good idea, a bad name.

R&D Priorities

Top priorities for short-term R&D are technologies that address maintenance, rehabilitation, and system preservation, including: materials, construction equipment, processes, technologies, and techniques to ease both highway and urban traffic congestion and improve intermodal connections.[8] Materials that improve the longevity of pavement and bridges may cost more initially, but many ultimately prove cost-effective over the life of the facility. Asphalt products using recycled materials such as tires and plastics have proven successful under the right circumstances, and increased research could refine them to make widespread use a feasible option. FHWA'S emphasis on IVHS is an appropriate first step. IVHS technologies for highway operations and better traffic management can help alleviate congestion and also permit some forms of congestion pricing.

However, over the longer term, IVHS activities now under way in UMTA and NHTSA must be fully integrated in the DOT IVHS plan, and IVHS activities must be one component of a larger departmental strategic research program. Other surface transportation technologies that need support, including funding, in the near term include examination of the cost-effectiveness of separate high-speed rail or magnetic levitation train service in the most heavily traveled intercity corridors. Longer term construction and implementation of the appropriate system is likely to be desirable in these corridors to supplement existing services.

Evaluation or demonstration projects will be necessary to move these technologies into widespread use. A comprehensive, preproject review process, such as that employed by SHRP, for proposed demonstration projects could eliminate those with insufficient technical merit.

The natural aversion to risk by most government officials is often compounded with unfamiliarity with current technologies. Increasing the training given to highway officials at all levels of government could make these individuals more amenable to implementing new technologies. Expanding the National Highway Institute, as FHWA proposes, is an important first step for accomplishing this goal.

Long-range planning and R&D that look ahead to future problems simply do not exist at DOT, and this is a serious deficiency. The issue needs a careful scrutiny by Congress and DOT itself. A strategic, departmentwide R&D plan that looks beyond surface transportation is the first step toward implementing the national transportation strategy. Congress may wish to require DOT to address this issue in the near future.

Data Collection and Performance Measures

Accurate baseline data and performance measures are important keys to improving transportation performance. Transportation data collection was severely curtailed during the 1980s, and it will take time to acquire enough information to develop good performance goals. To plan for the future, DOT needs to knowmore about travel patterns, congestion causes, and land-use transportation relationships. As a first

[8] The Federal Highway Administration's draft report, "Research and Technology Program 1992-1996" (updated in August 1990), shows that the agency is moving toward setting priorities for its own research and development program. The report focuses heavily on highways, which limits its usefulness in addressing future transportation needs.

step, DOT plans to conduct a multimodal passenger and freight transportation survey in fiscal years 1992 and 1993. Congressional support for full funding of this effort is crucial. At present we are making decisions about billions of dollars in Federal expenditures based on 15-year-old data that were inadequate to begin with.

Private Sector Investment

Parts of the country with growing populations and relatively healthy economies can attract private investment for public facilities, and California has arranged several privately financed roads under special, carefully crafted agreements. The success of these projects in enduring the lengthy environmental impact statement process or a prolonged, severe economic downturn remains to be seen. Few other examples of such projects exist in this country, although they are more common in Europe. The legal and institutional framework in the United States indicates that public funding for transportation facilities is likely to predominate for the foreseeable future.

Chapter 3
Motor Carrier Issues

As Congress considers the reauthorization of the Federal highway program, two fundamental issues under debate are how to restructure the Federal-aid program and how to pay for the necessary highway improvements. Spearheaded by the American Trucking Associations (ATA), the trucking industry has made clear that if higher truck taxes are considered as part of a funding package, the industry will push for regulatory changes to increase their operating productivity. However, some of the suggested reforms have impacts that greatly concern other members of the transportation community, and debate on this issue has been intense. For example, States have long been in the process of developing agreements to bring their different motor carrier registration, permitting, and fuel tax procedures into greater conformity, so that national and regional trucking companies need not file for operating authority separately in each State. Some progress has been made; for example, the International Registration Plan now includes over 40 States. However, the International Fuel Tax Agreement includes fewer than 20 States, and no universally acceptable compact exists. Trucking companies contend that Federal preemption of State authority (always a difficult issue) in this area is warranted.

Issues of motor carrier safety have also been contentious, with industry sources maintaining that Federal data show that the heavy truck safety record per mile traveled has improved. However, safety reports contend that Federal data substantially underestimate carrier accidents' and that the federally funded Motor Carrier Safety Assistance Program needs to improve its enforcement activities and address uniformity issues associated with penalties and regulations.[2]

This chapter lays out what is known about the most recent very difficult issue--long heavy trucks, known as longer combination vehicles (LCVs)--to assist Congress in its deliberations on the highway reauthorization. It discusses their performance on the highway, the institutional and regulatory framework, technologies and programs that could enhance their safety, their effects on motorists and highway condition, and market impacts. It also provides information on an industry proposal to increase bus productivity by permitting longer intercity buses.

LARGE, HEAVY TRUCKS ON THE ROAD

The most recent Federal Highway Administration (FHWA) statistics show a total of 187 million motor vehicles of all types, of which 76 percent were automobiles, 0.3 percent were buses, and about 23 percent were trucks.[3] Light trucks--pickups, panel trucks, and delivery vans, generally of 10,000 lbs. or less gross vehicle weight (GVW)--make up the bulk (87 percent) of the 42-million-vehicle private and commercial truck fleet, although they play only a minor role in interstate commerce.[4] In 1989, 1.2 million truck-tractor power units and 3.7 million commercial-type trailers and semitrailers (most of the Nation's large, heavy trucks) were counted. Most tractor-trailer configurations travel close to 100,000 miles per year, and they dominate commercial interstate traffic.

One carrier industry proposal, greater standardization of State fuel tax programs and reporting requirements, is supported by the National Governors' Association consensus agenda[5] and may be feasible as a productivity

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[1] See, for example, U.S. Congress, Office of Technology Assessment, ***Gearing Up For Safety: Motor Carrier Safety in a Competitive Environment, OTA- SET-3 82*** (Washington, DC: U.S. Government Printing Office, 1988), ch. 7.

[2] See two reports by the U.S. Congress, Committee on Commerce, Science, and Transportation: ***Motor Carrier Safety Assistance Program (MCSAP): Options Intended to Improve a Generally Successful and Cooperative Federal-State Partnership Promoting Truck and Bus Safety,*** Senate Print 100-109 (Washington, DC: June 1988); and ***Reauthorization of the Motor Carrier Safety Assistance Program (MCSAP): Options Intended to Improve Highway Safety,*** Senate Print 102-10 (Washington, DC: March 1991).

enhancement. However, another industry suggestion--changing the Federal policy to allow States to determine individually whether and where to allow heavy trucks with multiple trailers, has generated substantial public resistance and enormous industry controversy. This issue is particularly salient in view of industry success during recent years in gaining permission to operate 53-foot trailers in a steady succession of eastern States, where they had hitherto not been allowed. This shift occurred after a Federal law was passed that included an industry-backed requirement for States to permit 48- and twin 28-foot trailers on highways built with Federal funds. State officials fear that industry supporters of LCVs will become active in individual State capitols if the Federal posture on this issue is altered.

While OTA's research on the subject of LCVs answered many questions, it raised almost as many more. A mountain of studies has been done by Federal and State Governments, universities, and industry groups, including a number by the Transportation Research Board (TRB), an arm of the National Research Council. However, each TRB study has looked at specific issues, and no conclusions on wider use of current LCV configurations can legitimately be drawn from them, despite some carrier claims. TRB has convened a planning group to consider the need for more studies on the subject.[6]

LCVs DEFINED

A relatively small subset of the Nation's tractor-trailer combination total, LCVs are typically multiunit combination trucks with gross vehicle weights in excess of 80,000 lbs. The most familiar type of multitrailer combination vehicles are western (or short) doubles, allowed on a national basis on the Federal highway network since 1982. These consist of one tractor hauling two 26- to 28-foot trailers, and while they are not considered LCVs, they have some of the same handling properties.

LCVs proper include turnpike doubles, Rocky Mountain doubles, and triple-trailer combinations (see figures 3-1 and 3-2). *Turnpike doubles* consist of one tractor hauling two trailers, each 45- to 48-feet long, can weigh up to 135,000 lbs., and typically have eight or nine axles. *Rocky Mountain doubles* consist of one tractor hauling two trailers, the first of which is 45- to 48-feet long and the second, 26- to 29-feet long. These vehicles can weigh up to 115,000 lbs. and typically have seven axles. *Triple combinations* consist of one tractor hauling three 26-to 29-foot trailers, can weigh up to 110,000 lbs., and have seven axles.[7] LCVs can also include bulk commodity doubles, in turnpike double or Rocky Mountain double configurations, used to transport dry bulk, liquid, or gaseous products in tank-type trailers. At present, Rocky Mountain doubles are the most widely used LCVs.

LCV operations of one type or another are already allowed in some 20 States, primarily in the West, but also in the East on toll roads and turnpikes (see figures 3-3, 3-4, and 3-5). In some areas, and under restricted conditions, LCVs have been operating for as many as 30 years and traveled hundreds of millions of miles. According to State and industry data,[8] the accident record of LCVs equals or compares favorably with that of other trucks. Most States permitting LCVs bar their operations in inclement weather and restrict their use to Interstate highways and roads of high design standard in uncontested areas. At issue is whether existing Federal size and weight limits should be retained, or whether each State should be allowed to determine its own requirements, an eventuality that would almost certainly increase the number of States where LCVs operate.

REGULATORY BACKGROUND

Since States first placed limitations on trucking operations to protect their highways from being damaged by heavy axle weights, trucking companies have sought ways to

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[3] U.S. Department of Transportation, Federal Highway Administration, ***Highway Statistics 1989*** (Washington, DC: 1990).

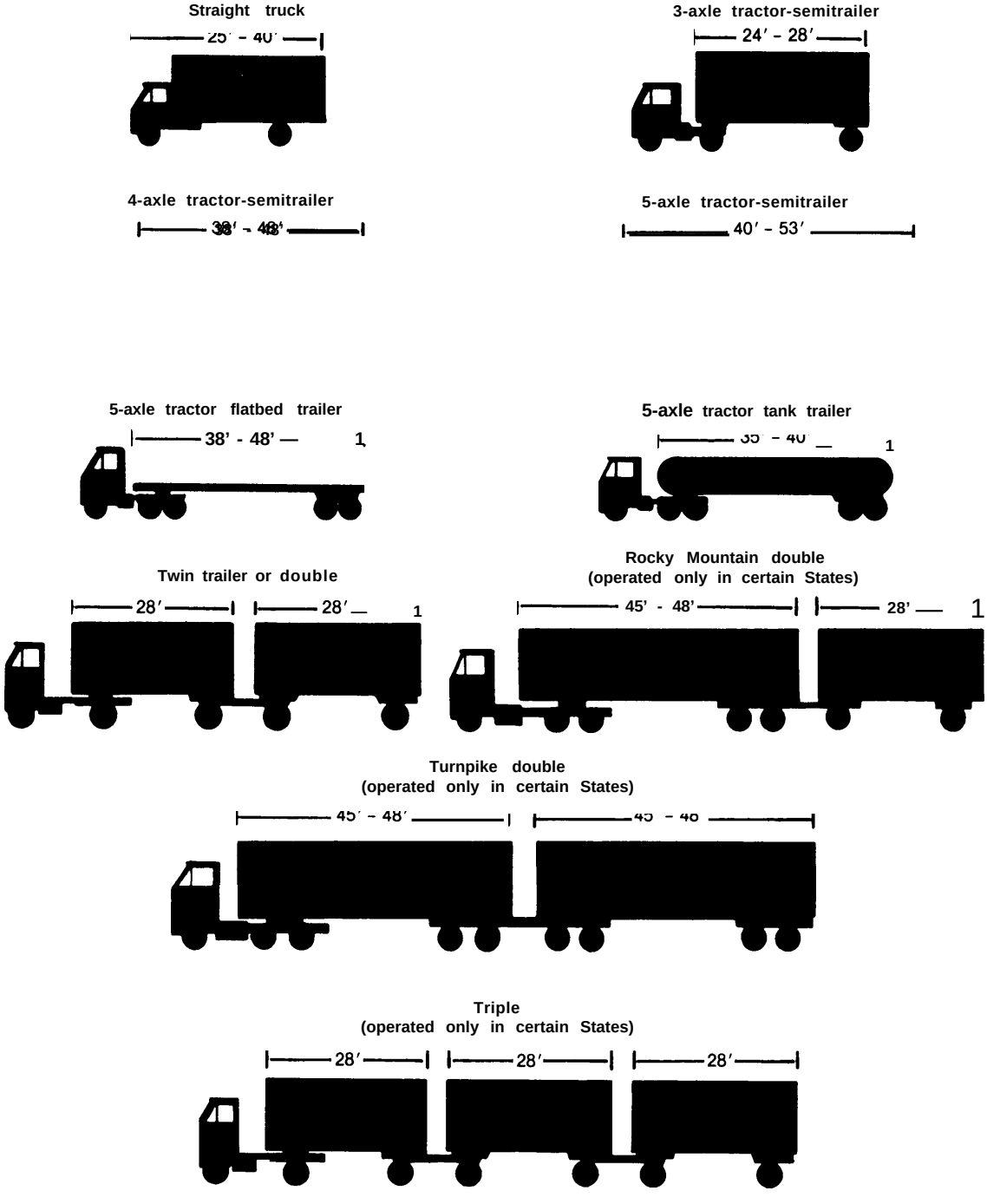
[4] For further information, see Office of Technology Assessment, op. cit., footnote 1, pp. 31-34.

5 Warren Hoemann, Yellow Freight System, Inc., personal communication, May 7, 1991.

[6] Robert Skinner, director, Special Projects, Transportation Research Board, personal communication, May 6, 1991.

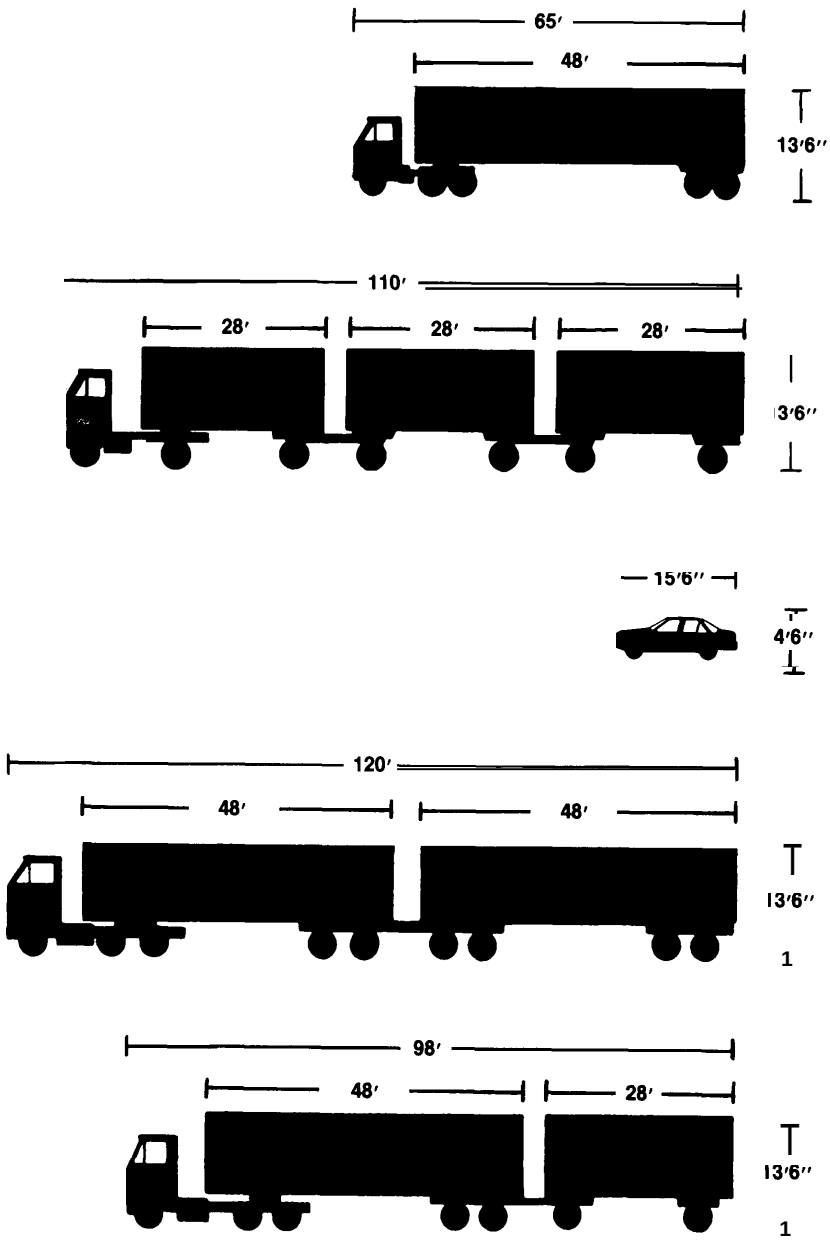
7 A fourth configuration, known as a Turner double, was proposed as part of a Transportation Research Board study and consists of one tractor hauling two 30- to 34-foot trailers and includes nine axles. However, no wide demand for this vehicle is

Figure 3-I—Heavy Truck Configurations



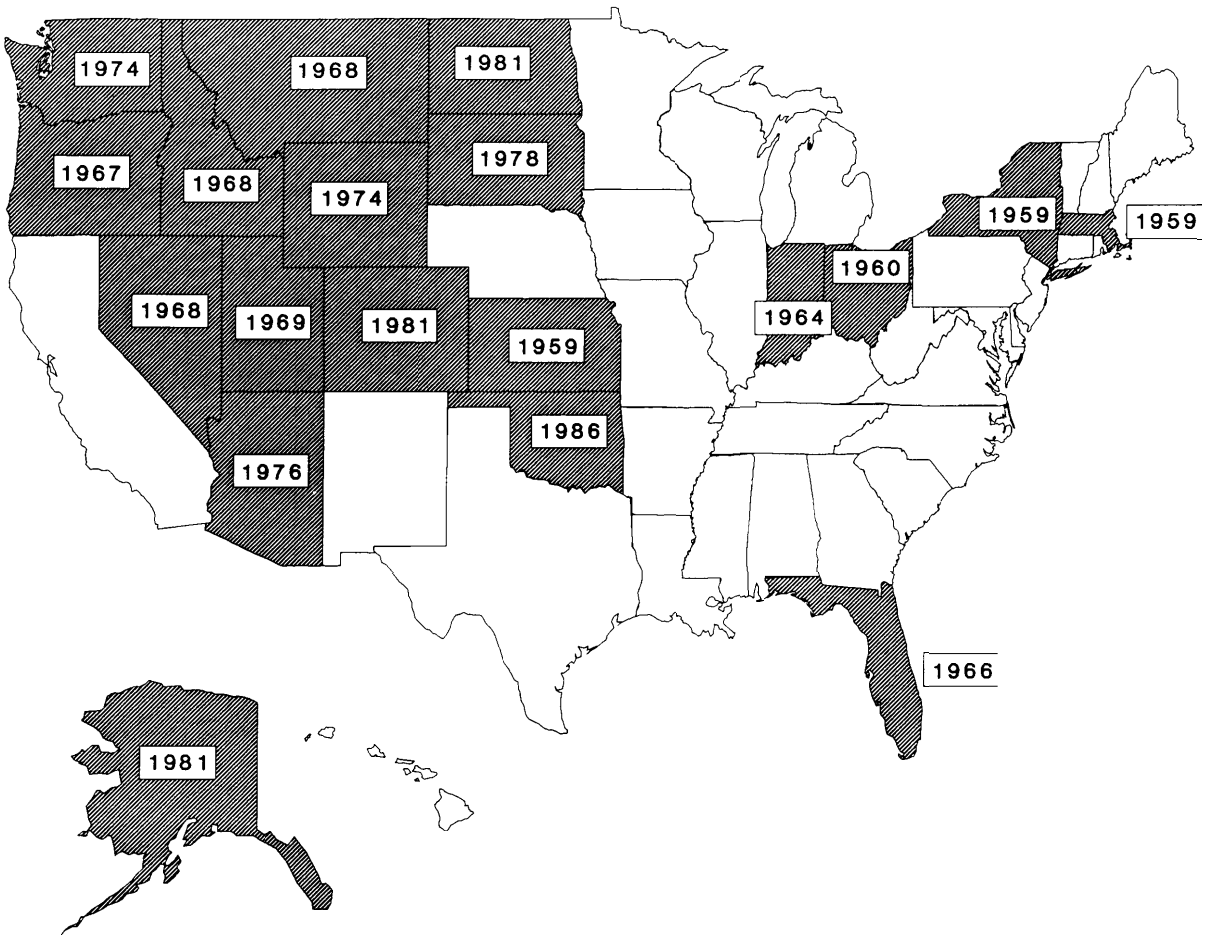
SOURCE: American Trucking Associations, Inc.

Figure 3-2—Vehicle Size Comparison



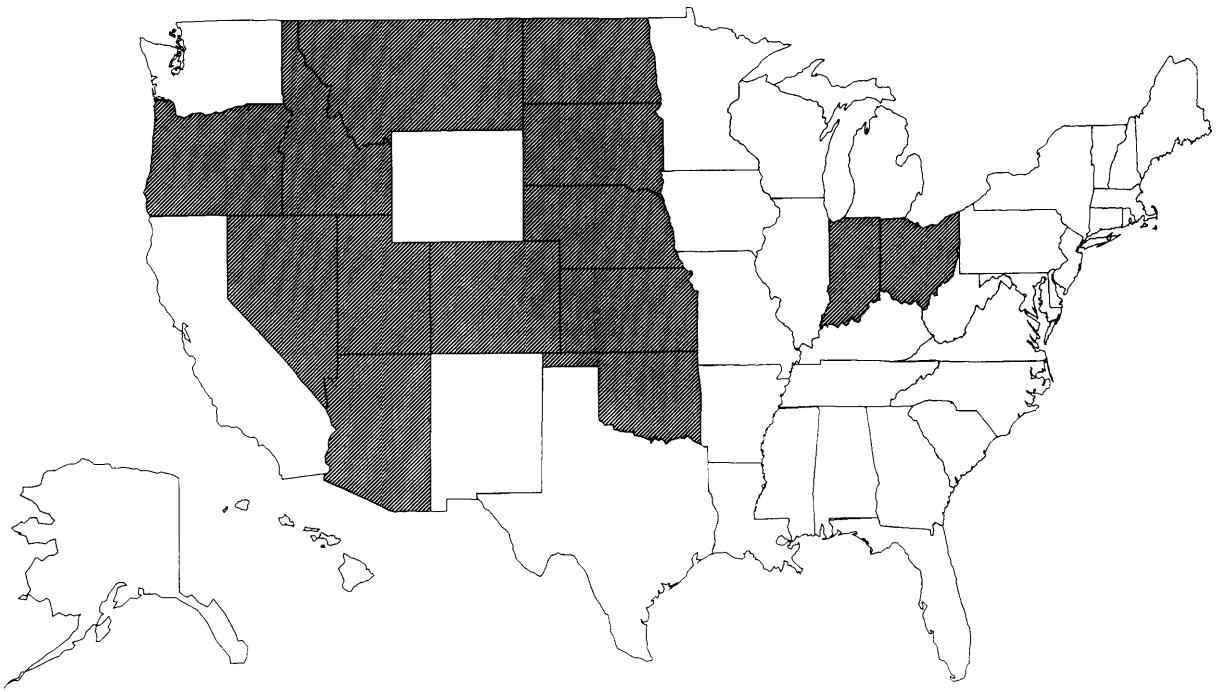
SOURCE: American Trucking Associations, Inc.

Figure 3-3—States Allowing Limited LCV Operations and Year First Allowed



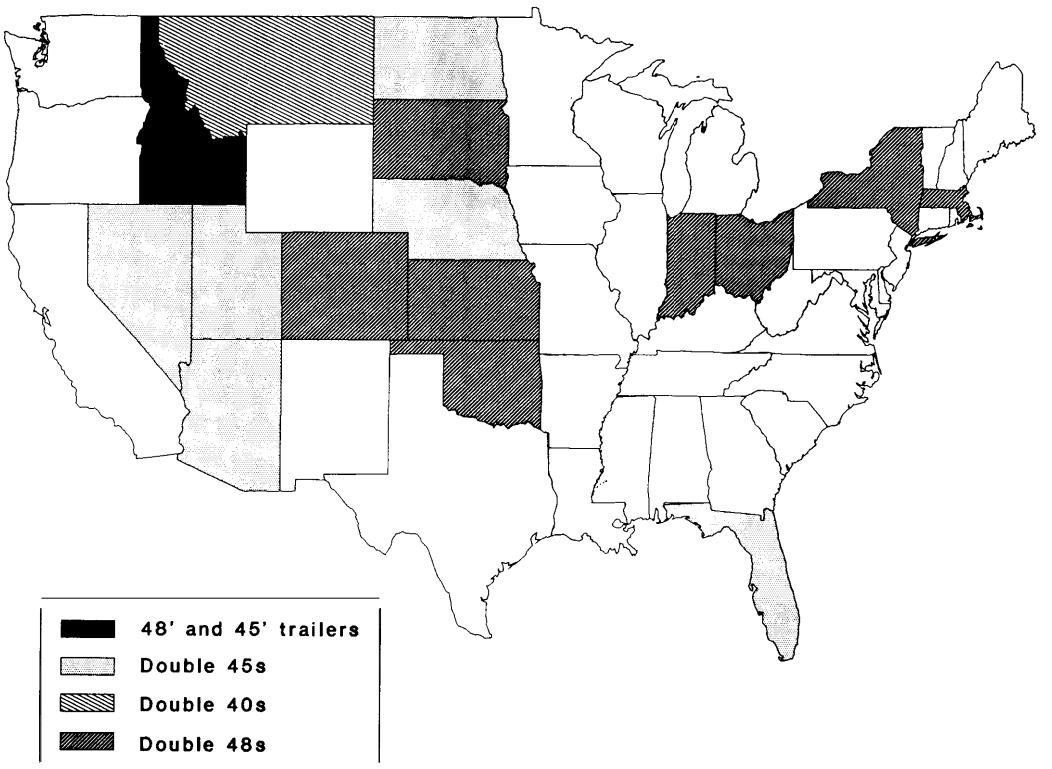
SOURCE: Office of Technology Assessment, 1991.

Figure 3-4—Triple-Trailer Operations



NOTE: Nebraska allows only the movement of empty trailers manufactured in the State.
SOURCE: Office of Technology Assessment, 1991.

Figure 3-5—Turnpike Doubles: States With Designated Routes and Weight Limits



NOTE: Nebraska allows only the movement of empty trailers manufactured in the State.
SOURCE: Office of Technology Assessment, 1991.

increase allowable vehicle sizes and weights. The first State laws regulating truck weight were adopted by Massachusetts and Maine in 1913, limiting gross vehicle weight (GVW) to 28,000 lbs. and 18,000 lbs., respectively. Pennsylvania later expanded on these regulations by placing a single axle limit of 18,000 lbs., a standard used on Interstate highways until 1974, and was the first State to establish a size restriction, requiring that all trucks on its roads be less than 90 inches wide. By 1933, all States had imposed total vehicle weight limits, and almost all States had adopted some sort of axle weight restrictions.[9]

Federal Standards

In response to State and industry concerns about the lack of regulatory uniformity between States, the American Association of State Highway Officials, now the American Association of State Highway and Transportation Officials (AASHTO), published a recommended program of uniform truck size and weight practices in 1946. The weight limits consisted of 18,000 lbs. for single axles, 32,000 lbs. for tandem axles, and 73,320 lbs. for GVW, although States could allow heavier trucks under special permits.

However, no Federal standards were set until 1956, with the passage of Federal legislation establishing the Interstate highway construction program.[10] At that time, the AASHTO axle and gross vehicle weight recommendations and a 96-inch width limit were included in the law, which applied only to Interstate highways. A grandfather clause allowed the continuing operation of wider or heavier trucks in those States where they were legal before the law's passage. The legislation also called on the Commerce Department to issue a report on the maximum desirable size and weight of trucks. The study, completed in 1964, recommended raising the weight restrictions to 20,000 lbs. for single axles, 34,000 lbs. for tandem axles, and 105,5oo lbs. for GVW.

The report also provided three different bridge formula programs, aimed at addressing the effects of heavy trucks on bridges built with Federal aid. One of the three, known as Bridge Formula B, was adopted. It allowed GVW to increase as axle spacing increased and established two main Federal classes of bridges. The HS-20 formula, used for bridges on most Interstate, allows axle weights that exceed design stress levels by 5 percent, while the H-15 model accounts for a possible 30-percent weight increase above optimum stress load.

For the HS-20, the hypothetical truck weighs 72,000 lbs. on three axles, 8,000 lbs. for the front axles and 32,000 lbs. for each of the two remaining axles. An H-15 bridge is designed to support trucks weighing 54,000 lbs. with a front axle weight of 6,000 lbs. and the remaining weight evenly distributed between the axles. The reasoning behind the more conservative formula for excess weight on the HS-20 was the bridge's predominance on the existing Federal-aid system roads and the greater amount of truck travel on these bridges.

Congress incorporated Bridge Formula B as part of amendments to the highway act in 1974.[11] The change in Federal weight regulations was made partly to offset industry concerns about possible reductions in trucking productivity resulting from legislation lowering the Federal speed limit to 55 miles per hour (mph).[12] The amendments also permitted States to raise GVW and single and tandem axle weight limits to the present limits of 80,000 lbs., 20,000 lbs., and 34,000 lbs., respectively.

Safety concerns registered at that time about wider use of larger trucks were countered by U.S. Department of Transportation (DOT) announcements that the trucks would be equipped with antilock brakes as required by new Federal Motor Vehicle Safety Standards and that new truck tire standards would soon go into effect.[3] However, the antilock brake requirements for trucks were later struck down in a court decision (see later discussion of antilock brakes) and no Federal standard for them has yet been promulgated.

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foreseen by the trucking industry, since it does not meet their market needs, and it is not discussed here.

8 However, a number of studies, including OTA's *Gearing Up For Safety (see* the first footnote in this chapter), have raised concerns about the accuracy and completeness of State accident reports and data.

9 National Research Council, Transportation Research Board, ***Truck Weight Limits: Issues and Options*** (Washington DC: 1990), p. 35.

10 70 stat. 374.

11 Public Law 93-643.

Although by the early 1980s, only three States did not allow 80,000 lbs. GVW and required lower axle weight limits on the Interstate system, these States were concentrated in the Mississippi Valley, a fact that had made coast-to-coast transport difficult. Western doubles (28-foot twins) were allowed in 70 percent of the States before enactment of the Surface Transportation Assistance Act (STAA), with nearly all of the States still prohibiting them located on the east coast.

The 1982 STAA[15] relaxed size and weight restrictions further, requiring all States to allow the weights permitted under the 1974 amendments to operate on the Interstate system. These allowances were a tradeoff for increases in Federal heavy vehicle fuel taxes and user fees imposed by the STAA. The width limit was increased as well, this time to 102 inches. The act also gave States control in deciding which trucks fell under the grandfather clause of 1956. In 1984, the Tandem Truck Safety Act[16] again eased restrictions, by requiring States to give broader access for single 28-foot-by-102-inch trailers and freer access for 102-inch trailers in general. Previously, the latter vehicles had been limited to roads with 12-foot-wide lanes.

Grandfather Clauses

The practical effect of the grandfathering of existing weight provisions in 1956 and 1974 has been to create a great deal of variation among the States in allowable truck sizes and weights, even on the Interstate system. Moreover, States can and do allow overweight trucks to operate at higher weights off the Interstate system under laws which vary widely from State to State (see detailed discussion later in this chapter). Two classes of vehicles currently operate on the Interstate system at weights in excess of the Federal axle and gross weight limits under grandfather clauses. One includes vehicles allowed to operate at weights in excess of 20,000 lbs. single axle and 34,000 lbs. tandem axle limits (or in excess of the Bridge Formula) in those States with higher limits before the passage of the 1956 and 1974 acts. This covers single-unit bulk haulers such as concrete mixers, dump trucks, garbage trucks, fire engines, and some local buses. The other class of heavier vehicles allowed on the Interstate system are the various combination vehicles which operate under special permits.

All States allow single or short-term permits for weights in excess of 80,000 lbs. for the movement of nondivisible loads. Furthermore, Federal law has been quite clear about the rights of States to issue single-trip or short-term permits for nondivisible loads.

In addition, 29 States now issue multiple-trip permits for divisible loads on certain highways and under specific operating conditions under the 1956 grandfather provision, an increase from 22 States in 1987. Some groups have argued that multiple-trip special permits for divisible loads should not have been covered by the grandfather provisions of the 1956 act. Extensive controversy has also surrounded the interpretation of State laws and State practices that were in effect in 1956. The amendment to the weight section in the STAA of 1982 was intended to clarify these arguments and provide that States' interpretations of their laws and practices in 1956 should prevail.

In recent years, some States that allow LCVs have substantially increased the numbers of special permits issued. This became necessary when shippers and their customers developed new markets made possible by the higher weights allowed under the permits. However, FHWA has become concerned that the grandfather clauses are being used to nullify Federal weight regulations in some States.

HANDLING AND SAFETY CHARACTERISTICS

Although the handling and stability characteristics of trucks depend greatly on the road geometry, pavement properties, equipment condition, number of axles, number, length, and weight of units, and how they are loaded and operated, any articulated vehicle is more difficult to drive safely than a straight truck or automobile. Some general comparisons can be made, however, between and among LCVs and conventional five-axle tractor-semitrailers. For example, triples have better low-speed maneuverability because of their short trailer

12 Transportation Research Board, op. cit., footnote 9, p. 36.

13 U.S. Congress, Senate Committee on Public Works, *The Federal-Aid Highway Amendment of 1974,* to accompany S. 3934 (Washington, DC:

wheelbases. Generally, low-speed *offtracking,* which occurs when the trailing axles of a vehicle migrate toward the center of a curve, is greatest for turnpike doubles, followed by Rocky Mountain doubles, conventional tractor-semitrailers, and triples. The greater the offtracking, the wider the road needs to be to accommodate turns. [17]

However, when multiple trailers are connected by conventional converter dollies, [18] *trailer sway,* especially in emergency maneuvers, is greatest for triples, followed by western doubles, Rocky Mountain doubles, turnpike doubles, and tractor-semitrailers. Articulated vehicles with more than one trailer experience strong side forces on the rear unit during rapid steering movements, such as those necessary to avoid an accident. The effects of the side forces are magnified between the tractor and rearmost trailer, often creating unstable behavior, such as trailer swing that can lead to rollover. [19] This rearward amplification is of particular concern with triple combinations, but rear trailer rollover occurs even with western (short) doubles.[20] The weight of each trailer and overall weight distribution also affect stability, making careful loading and trailer sequencing especially important. No Federal standards currently exist for trailer order or weight distribution.

Engine power and torque requirements to maintain minimum speed on grades increase with vehicle weight. Thus the most power and torque are needed for turnpike doubles, followed by triples, Rocky Mountain doubles, and tractor-semitrailers. Currently, no Federal requirements exist for engine power to ensure adequate minimum speeds, and such requirements would be difficult to enforce. However, State requirements for adequate performance and ability to maintain a minimum speed on grades could be enforceable and could help ensure adequate power.[21]

Braking power requirements also increase with vehicle weight, but braking distance depends on vehicle weight, tire and pavement characteristics, weight distribution, and the number of brake-equipped axles. In general, when each vehicle is comparably loaded and brakes are adjusted properly, *stopping distance* is essentially the same for all configurations. Under empty or partial loading, particularly when the rear part of any configuration is unloaded, braking distance will increase dramatically. Properly functioning antilock brake systems, discussed later, can greatly relieve this problem.

Safety-Enhancing Technologies

Using experienced, well-trained drivers that employ defensive driving techniques is an important means of avoiding accidents for articulated vehicles. Indeed, accident experience with LCVs thus far indicates that properly trained drivers operating in light-traffic-density, sparsely populated regions of the country can operate LCVs safely. However, even the best trucking companies complain that finding good drivers is difficult at present, and wider use of LCVs could lower the general skill level of LCV drivers and increase LCV exposure to dangerous situations. [22] If LVCs are operated in traffic mixes that increase the need for avoidance maneuvers, increases in crashes and rollovers can be expected.

A number of vehicle technologies are available or are being developed, however, to counter the handling difficulties of articulated trucks and make them safer and/or mitigate damage to the infrastructure. These include

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U.S. Government Printing Office, Aug. 20, 1974).

14 National Research Council, Transportation Research Board, ***Providing Access for Heavy Trucks*** (Washington, DC: 1989), p. 16.

15 Public Law 97-424.

16 Public Law 98-554.

17 U S Department of Transportation, Federal Highway Administration, ***The Feasibility of a Nationwide Network for Longer Combination Vehicles*** (Washington, DC: June 1985), p. III-3.

18 These are known as A-dollies, which have a single drawbar attaching to a pintle hook on the preceding trailer.

19 W.R.J. Mercer et al., ***Test and Demonstration of Double and Triple Trailer Combinations*** (Downsview, Ontario, Canada: Ontario Ministry of Transportation and Communications, August 1982), p. 17.

20 National Transportation Safety Board, recommendation H-90-7, 1990.

21 Larry Strawhorn, American Trucking Associations, personal communication, May 7, 1991.

22 OTA understands that companies with strong driver screening and training requirements, such as

antilock brakes, double-drawbar dollies for multiple-unit trucks, automatic slack adjusters, air suspension systems, and many others.

Brakes

Faulty braking systems are a contributing feature in a significant portion of truck accidents; they can contribute to accidents by not stopping the vehicle in time or causing wheel lockup, jackknifing, or trailer swing. Experts estimate that roughly one-half of all air-braked vehicles have at least one brake out of adjustment. The overall effect of recent fuel efficiency improvements, such as radial tires with lower rolling resistance, aerodynamic shields, and reduced friction engines, is roughly equivalent to increasing the slope of downgrades by 1 percent.[23] This places a much greater premium on properly maintained braking systems.

LCVs have more complex braking systems than conventional tractor-trailers, because the multiple trailers require more brake sets, each of which must be properly adjusted to ensure proper balance, timing, and torque. In addition, tractor and trailer brakes are certified separately, which places an especially large burden on those responsible for LCV maintenance to ensure compatibility between the tractor and various trailer brake sets. Often motor carriers do not control specification and maintenance of all the equipment used in their operations.

Adjustments must be made frequently during the life of a lining with manual adjusting brakes. *Automatic slack adjusters* can keep brakes in better adjustment, provide improved braking, and reduce maintenance costs. Though automatic slack adjusters are fairly standard on tractors, they are not consistently used on trailers, except by the larger fleets.[24] Recent National Transportation Safety Board inspections indicate that even automatic adjusters do not always ensure well-adjusted brakes and require some maintenance.[25]

A number of studies suggest that *antilock brakes* (known as ABS), particularly if introduced on all axles of a configuration, may be effective in reducing the frequency of jackknifing and loss of control due to braking. At present, the National Highway Traffic Safety Administration (NHTSA) is studying ABS on a cooperative basis with industry. Mandatory use of ABS was planned in the United States about 15 years ago, when Federal Motor Vehicle Safety Standard 121 was promulgated. However, ABS systems were unreliable at that time, and suffered from malfunctions caused by electromagnetic interference, among other problems. After a 1978 court decision eliminating the stopping distance requirement that resulted in the mandatory use of ABS, NHTSA proceeded *on* the basis of independent testing before making any decision on mandating ABS again. However, the trucking industry in the United States has remained skeptical about ABS because of their experiences in the late 1970s with systems that were not technically mature.

NHTSA is now conducting a test program with industry where 200 tractors have been placed in service with various ABS systems.[26] Fifty ABS-equipped trailers will be operational by June of 1991. Results of this program have been generally favorable and are expected to guide Federal regulatory efforts.

ABS is viewed by many safety experts as an important accident prevention tool, especially in avoiding trailer swing, jackknifing, or loss of steering control during braking. Although full benefits are achieved only if ABS is employed on all axles, some improvement in braking control can result from any set of ABS-equipped axles. According to a 1988 survey of foreign experience,[27] ABS systems used in Europe have many

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Yellow Freight Systems and United Parcel Service, will continue to use their most experienced and capable drivers for longer combination vehicles (LCVS). However, no such assurances pertain to the thousands of other potential operators of LCVs.

23 Ian S. Jones, Insurance Institute for Highway Safety, "Truck Air Brakes: Current Standards and Performance," proceedings of the 29th Conference of the American Society of Automotive Medicine, 1984, pp. 39-61.

24 Ron Roudebusch, Rockwell International Corp., personal communication, Mar. 8, 1991; and Jerry DeClair, Rockwell International Corp., personal communication, May 7, 1991.

25 James Kolstad, National Transportation Safety Board Chairman, unpublished remarks at the Motor Vehicle Manufacturers Association meeting, Feb. 18, 1991.

26 Transport Canada and Ontario Ministry of Transportation, "B-Train ABS Evaluation," working

checks and redundancies to ensure proper operation, and drivers report feeling safer with ABS and believe their vehicles can stop more quickly. Moreover, European experience with heavy truck and bus fleets indicates no interference problems with radios or other external electronic equipment. The systems require no routine attention aside from checks performed prior to and during required brake inspections, and the life of the ABS equals that of the vehicle. The only frequently mentioned concern is a problem with false alarm warning lights, which does not affect braking ability.

Trailer Connections and Suspensions

The *double-drawbar dolly (C-dolly),* used by some companies in Canada, couples trailers in a manner that eliminates one articulation point, improves roll stability, and reduces rearward amplification (see figure 3-6). It includes a self--steering axle to reduce high stress levels in the equipment due to tire scuffing in low-speed turns. The C-dolly also reduces low-speed offtracking because the axle is self-steerable.

Self-steering axles are vulnerable to unequal longitudinal forces acting through the wheels of the axle, such as when one side is on a paved road and the other is on a dirt shoulder or packed snow and ice. These weaknesses can be offset with the use of an appropriate centering force system. Self-steering axles also require locking mechanisms to immobilize the steering action of the axle when the vehicle moves in reverse. These mechanisms can be controlled from the tractor cab. The locking feature of the C-dolly yields greater vehicle maneuverability in trucking terminals and staging areas.[28] For example, the C-dolly enables multitrailer combinations to back up in a straight line for considerable distances. The C-dolly shows potential to reduce rearward amplification and trailer rollovers and to improve maneuverability for all multitrailer combinations with trailers less than 40 feet in length. This points to a need for large-scale fleet testing. Some Canadian provinces encourage the use of C-dollies over other hitching mechanisms by allowing vehicles equipped with them to carry greater maximum weight.

The *B-train hitch is* an alternative to the standard converter dolly used for multitrailer combinations. When B-trains are used, the towing trailers must have an extended frame with a fifth wheel for attaching the next trailer (see figure 3-6 again). The extended frame can be sliding, which allows the trailer to be backed flush to a loading dock, or fixed. B-trains with fixed frames are difficult to use in some operations because its protruding rear wheels prevent backing up the lead trailer flush to truck loading docks. Tests in Canada, where B-trains see significant use, indicate that they have superior stability, handling, and offtracking characteristics compared to conventional A-trains.*[9] As with the C-dolly, some Canadian provinces encourage the use of B-trains by allowing companies using them to carry greater weights.

Technologies can also be used to mitigate the effects of heavy trucks on pavements and bridges. For instance, *air suspensions* almost always produce lower dynamic loads than steel leaf suspensions. Tests conducted in the United Kingdom show that axle loads on bridges decrease by as much as 27 percent when air suspensions are used. Moreover, dynamic loads increase with speed more with steel leaf suspensions than with air suspensions. These findings point to less wear on roads and bridges when air suspensions are used. Air suspensions also reduce vibrations at the driver's position,[30] leading many drivers to prefer them, and can reduce equipment damage, particularly when a truck is traveling empty.

Despite the potential of these technologies to make driving LCVs safer and easier, manufacturers of such equipment have not found large

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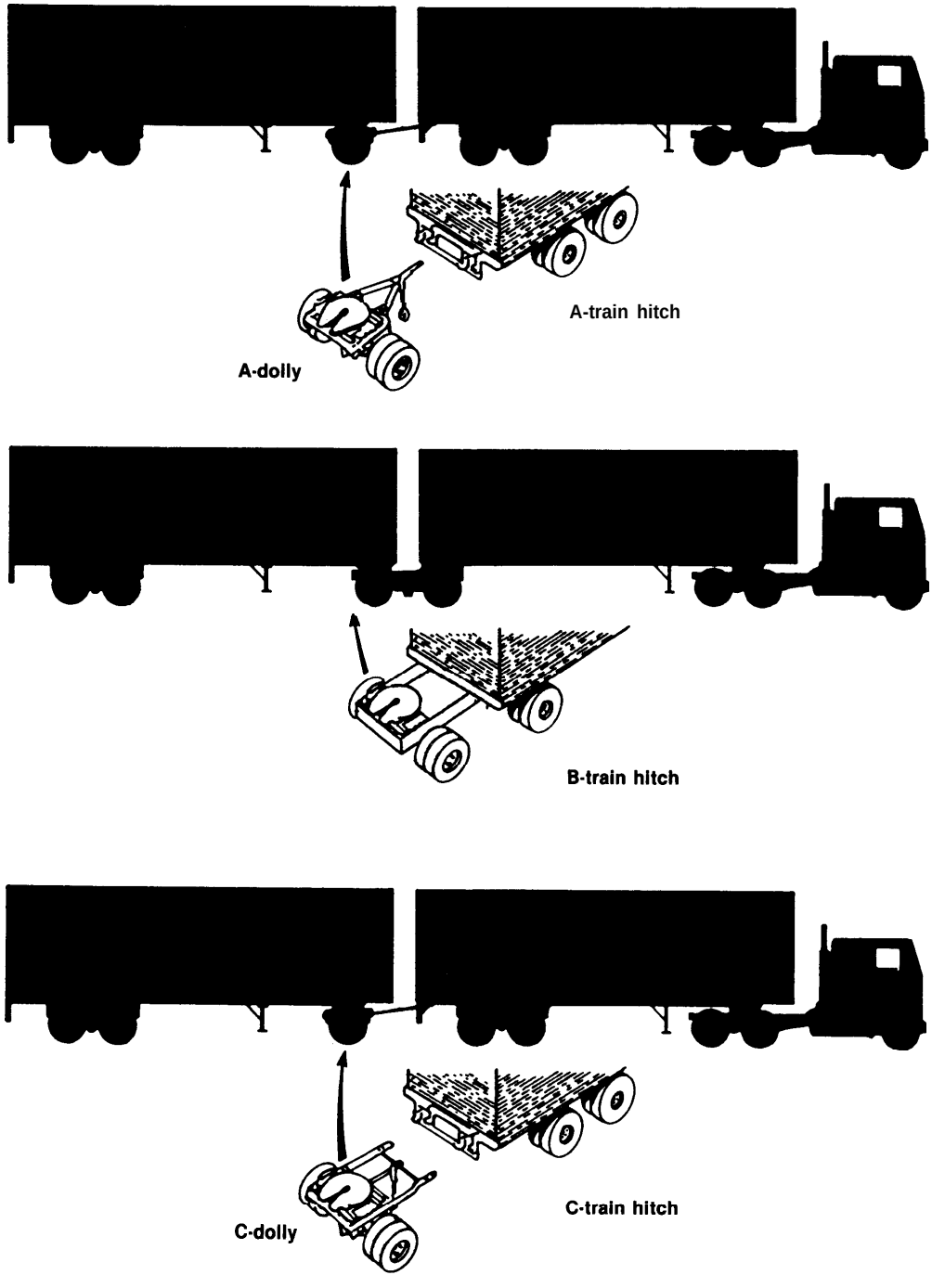
paper, May 1990, pp. 1-2.

27 Paul S. Fancher, Transportation Research Institute, University of Michigan, "European/Australian Experience With Antilock Braking Systems in Fleet Service," DOT Final Report No. DOT HS 807269 (Washington, DC: U.S. Department of Transportation, March 1988).

28 J. Woodroofe et al., Vehicle Dynamics Laboratory, National Research Council of Canada, "Development of Design and Operational Guidelines for the C-Converter Dolly," paper presented at the Second International Symposium on Heavy Vehicle Weights and Dimensions, Kelowna, British Columbia, Canada, June 18-22, 1989.

29 J.R. Billing et al., "Test of a B-Train Converter Dolly" (Downsview, Ontario, Canada: Ontario Ministry of Transportation and Communications,

Figure 3-6-Hitching Mechanisms for Twin-Trailer Trucks



SOURCE: Roads and Transportation of Canada, "Canadian Vehicle Weights and Dimensions Study," Technical Steering Committee Report, 1987.

markets for their products. Technological aids such as ABS and double-drawbar dollies show much potential to improve safety, particularly in emergency situations. Requirements for these, or similar technologies capable of providing controlled braking and reducing trailer sway, are essential to ensure low LCV accident rates. Congress could require DOT to implement standards for these technologies for companies using LCVs.

LCV Accident Records

Despite the handling difficulties of LCVsand the fact that the types of safety-enhancing technologies discussed above are not commonly used, most research and accident records indicate that LCV fatal and nonfatal accident rates per vehicle-mile traveled are equal to or better than those of other articulated trucks. However, most research also shows the accident rate of multitrailer trucks--most of which are western (twin) doubles, since they are allowed nationwide--to be higher than that of conventional tractor-semitrailers.[31] The reasons for the seeming contradictions are two-fold. First, recognizing the special skills required to operate LCVs safely, most carriers assign their most skilled and experienced drivers to LCVs.[32] No such precautions characterize the choice of drivers for western doubles. Second, because of State permitting requirements, LCVS generally travel over the safest roads and under the safest conditions. No such permitting procedures apply to conventional tractor-semitrailer and western doubles operations, accounting for their higher accident rates. Western doubles appear to have the highest accident rates of all articulated trucks.

However, previous LCV use and accident experience are simply inadequate to determine accurately the consequences of LCV use on a wider network. For example, most large national accident databases--those most likely to provide sufficient data to give statistically reliable information--have major limitations, including uneven levels of accident reporting, inaccurate exposure data, and insufficient level of detail. For instance, accident and truck-use databases do not clearly distinguish LCVs from other multitrailer combinations, because they do not include either trailer length or total vehicle length.

State and industry records on LCV operations show that triples have the lowest fatal accident rate, followed by turnpike doubles and Rocky Mountain doubles. Again, this ranking results not from inherent characteristics of each configuration, but from how much and where each vehicle is driven, and from driver selection procedures. For example, Rocky Mountain doubles see much more off-interstate use than other LCVs, and their drivers are less carefully screened than operators of turnpike doubles and triples. Triples operators appear to be the most carefully screened; it is not unusual for a company to require several years of accident-free doubles driving before allowing a driver to operate triples. Comparing inherent safety and vehicle handling characteristics is quite different than comparing how safely the vehicles are operated under present circumstances.

The lack of good data has hampered efforts to evaluate LCV accident experience. Researchers estimate that 1 billion vehicle-miles of travel would be required for reliably detecting a 10- to 20-percent difference in accident rates among different configurations under "clean" conditions (stable fleet composition, reliable data) .33 Such data are simply not available. Moreover, the task of acquiring enough data is daunting, because each LCV configuration has unique properties dependent on such various factors as wind, road geometry, choice of hitching mechanism, tire and suspension properties, trailer wheelbases, and trailer loading.

May 1983), pp. ii-iii.

30 C.G.B. Mitchell and L. Gyenes, Transport and Road Research Laboratory, United Kingdom, "Dynamic Pavement Loads Measured for a Variety of Truck Suspensions, " unpublished report, 1989.

31 For further information, see Office of Technology Assessment, op. cit., footnote 1, pp. 95-97; and a review of past studies in Forrest M. Council and William L. Hall, University of North Carolina Highway Safety Research Center, "Large Truck Safety in North Carolina, " unpublished report, October 1988, pp. 10-17.

32 U.S. Department of Transportation, Federal Highway Administration, ***Longer Combination Vehicle Operations in Western States*** (Washington, DC: October 1986), pp. 11-13-11-18.

33 Gordon A. Sparks, Department Of Civil Engineering, University of Saskatchewan, et al., "Safety Experience of Large Trucks: An Analysis

STATE PROGRAMS

State operating restrictions and permit practices for LCVs and other types of heavy vehicles vary widely because of the many different types of LCVs and the diverse ways and locations in which they are used. Most trucking operations are regional, and State highway officials, even in neighboring States, do not have uniform permitting requirements. For example, in Utah motor carriers must designate their LCV routes and have their safety programs certified, including guarantees that all LCV drivers are tested in accordance with Federal law. The tests at a minimum must include left-hand and right-hand turns, entering and exiting highways, operation in traffic, and operation on grades. Many, but not all, States and toll authorities that allow LCVs perform engineering evaluations to determine the impact on infrastructure, conduct demonstrations with test vehicles, and limit operations to selected carriers before authorizing operations by other qualified companies.[34]

Unstandard Standards

Fourteen States allow the operation of overweight vehicles[35] on Interstate without a special permit. Most of these States allow higher axle weights than permitted by Federal law, although Michigan and New Mexico both allow a GVW greater than the 80,000 lbs. Federal limit. Some States also allow single and tandem axle weights to exceed the Federal limit. In addition, States do not always apply Federal regulations to non-Interstates. The maximum GVW on some non-Interstates ranges from 73,280 lbs. in Illinois, Minnesota, and Missouri to 154,000 lbs. in Michigan.[36] Montana, Nevada, North Dakota, and Wyoming permit LCVs on the entire State highway network, while some other States restrict LCVs to a portion of the Interstate network.[37] Similarly, designated LCV highways may not be continuous from State to State, particularly for turnpike doubles and triples. Table 3-1 summarizes the variety of State regulations governing truck operations. (This table is revised every 6 months, with the next update scheduled for July 1991. Because State laws can change frequently, some information may be slightly outdated.)

The lack of consistent requirements across State boundaries is an obstacle to freer interstate transport that many would like to see addressed, and as a result of State and industry efforts,[38] some uniformity has been achieved in western States in laws governing LCV equipment and operations. However, this is less true for special permits, fees, and driver qualifications,such as minimum age and operating experience. Generally, States issue operating permits to carriers (not individuals) and require them to certify minimum levels of driver experience, insurance coverage, and vehicle safety and inspection standards. Typically, violations of permit conditions result in temporary suspension of the permit and removal of the individual tractor from operation. Carrier use of other LCV units, even by the driver of the suspended vehicle, is not necessarily prohibited. LCV driver experience and training requirements are where States differ the most from Federal regulations and each other. Although numerous safety studies have concluded that drivers less than 25 years of age have the highest accident rate, minimum age requirements for LCV drivers are the same as or below the Federal limit of 21 years of age in all but one State.

HUMAN FACTORS

As stated earlier, LCVs' relatively safe operating history is due in large part to the driver selection and training practices of the companies using them. It is not uncommon for a company to require accident-free driving before allowing a driver to operate an LCV.

Training

Training for companies with the safest LCV operating records includes an extensive on-the-road component. These operators believe that experience is essential in teaching drivers how to operate LCVs safely. Companies operating LCVs

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of Sample Size Requirements, " proceedings of the Second International Symposium on Heavy Vehicle Weights and Dimensions, Kelowna, British Columbia, Canada, June 18-22, 1989.

34 Warren E. Hoemann, Yellow Freight System, personal communication, Apr. 25, 1991.

35 Overweight refers here to weight limits in excess of those set forth in 23 U.S. C. 127.

36 Transportation Research Board, op. cit., footnote 9, pp. 45-47.

37 Federal Highway Administration, op. cit., footnote 32, p. II-1.

DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	LENGTH (FEET)									
	INTERSTATE AND DESIG. HWYS. (DES.)					STATE AND SUPP. HWYS. (OTHER)				
	STRAIGHT TRUCKS	COMBINATIONS		TRAILING UNITS		STRAIGHT TRUCKS	COMBINATIONS		TRAILING UNITS *	
		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER
ALABAMA	40	0	0	53	28.5	40	0	0	53	28.5
ALASKA	40	0	0	48	48	40	70	75	45	45
ARIZONA	40	0	0	57.5	28.5	40	65	0	51	28.5
ARKANSAS	40	0	65	53.5	28.50	40	0	65	53.5	28.5°
CALIFORNIA	40	B	B	B	B	40	B	B	B	B
COLORADO	40	0	0	57.33[D]	28.5[D]	40	0	0	57.33[D]	28.5[D]
CONNECTICUT	60	0	0	48	28	60	0	0	48	28
DELAWARE	40	0	0	53	29	40	60	60	NS	NS
DISTRICT OF COLUMBIA	40	0	0	48	28	40	55	A	NS	A
FLORIDA	F	0	0	5300	28	F	0	A	5300	A
GEORGIA	60	0	0	53[N N]	28	60[N N]	60[N N]	A[N N]	53[N N]	A[N N]
HAWAII	40	NS	NS	NS	NS	40	60	65	NS	NS
IDAHO	40	0	0	48	61[G G]	40	0	0	48	61[G G]
ILLINOIS	42	G	G	53[G]	28.5	42	G	G	53[G]	28.5
INDIANA	36	0	0	53[H H]	28.5	36	0	0	53[HH]	28.5
IOWA	40	0	0	53	28.5	40	60	60	NS	NS
KANSAS	42.5	0	0	53	28.5	42.5	0	0	53	28.5
KENTUCKY	45	D	0	53	28	45	55	A	NS	A
LOUISIANA	40	0	0	59.5	30	40	65	A	50	A
MAINE	45	0	0	48	28.5	45	65	A	48	A
MARYLAND	40	0	0	48	28	40	0	A	48	A
MASSACHUSETTS	40	0	0	48	28	40	60	A	48[B B]	A
MICHIGAN	40	0	59	5300	28.5	40	0	59	50	NS
MINNESOTA	40	0	0	53[EE]	28.5	40	65	E	48[EE]	28.5[EE]
MISSISSIPPI	40	0	0	53	30	40	0	0	53	30
MISSOURI	40	0	0	53	28	40	60	65	NS	NS
MONTANA	40	0	0	53	28.5	40	0	0	53	28.5
NEBRASKA	40	0	0	53	65[Y]	40	0	0	53	65[Y]
NEVADA	40	0	0	53[T]	28.5[T]	40	0[T]	O[T]	48[T]	28.5[T]
NEW HAMPSHIRE	40	N/S	N/S	48	28	40	0	0	48	28
NEW JERSEY	35	0	0	48	28	35	0	A	48	28
NEW MEXICO	40	0	0	57.5	28.5	40	65	65	NS	NS
NEW YORK	35	0	0	48	28.5	35	60[A A]	60	45[A A]	NS
NORTH CAROLINA	F	0	D	5300	28	F	60	A	NS	A
NORTH DAKOTA	50	0	0	53	53	50	75[U]	75[U]	53	53
OHIO	40	0	D	53	28.5	40	0	0	53	28.5
OKLAHOMA	45	0	0	C	C	45	0	0	59	29

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DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	HEIGHT (FEET)	WIDTH (INCHES)		WEIGHT (1 ,000 POUNDS)					
				SINGLE AXLE WEIGHT		TANDEM AXLE WEIGHT		GROSS VEHICLE WEIGHT	
		DES.	OTHER	INT.	OTHER	INT.	OTHER	INT.	OTHER
ALABAMA	13.5	102	L	20	20	34	40	80	84
ALASKA	14	102	102	20	20	38	38	K	NS
ARIZONA	13.5	102	96	20	20	34	34	80	80
ARKANSAS	13.5	102	102	20	20	34	34	80	80
CALIFORNIA	14	102	102	20	20	34	34	80	80
COLORADO	14.5	102	102	20	20	36	40	80	85
CONNECTICUT	13.5	102.36	102.36	22.4	22.4	36[w]	36[w]	80	80
DELAWARE	13.5	102	96	20	20	34	40	80	80
DISTRICT OF COLUMBIA	13.5	102	96	22	22	38	38	80	80
FLORIDA	13.5	102	96	22	22	44	44	80	80
GEORGIA	13.5	102	96	P	P	Q	37.34	80	80
HAWAII	13.5	108	108	22.5	22.5	34	34	80.8	88
IDAHO	14	102	102	20	20	34	34	80	105.5
ILLINOIS	13.5	H	H	20[e]	18	34[e]	32	80[e]	73.28
INDIANA	13.5	102	102	20	20	34	34	80	80
IOWA	13.5	102	96	20	20	34	34	80	80
KANSAS	14	102	102	20	20	34	34	80	85.5
KENTUCKY	13.5	102	96	20	20	34	34	80	J
LOUISIANA	13.5	102	96	20	22	34	37	80	80
MAINE	13.5	102	102	R	22.4	34	38	80	80
MARYLAND	13.5	102	96	z	z	z	z	80	80
MASSACHUSETTS	13.5	102	102	22.4	22.4	36	36	80	80
MICHIGAN	13.5	102	96	JJ	JJ	JJ	JJ	JJ	JJ
MINNESOTA	13.5	102	102	20	18	34	34	80	80
MISSISSIPPI	13.5	102	102	20	20	34	34	80[v]	80[v]
MISSOURI	14[kk]	102	96	20	18	34	32	80	73.28
MONTANA	14	102	102	20	20	34	34	80	80
NEBRASKA	14.5	102	102	20	20	34	34	80	95
NEVADA	14	102	102	20	20	34	34	80	M
NEW HAMPSHIRE	13.5	102	102	z	z	22.4	36	80	80
NEW JERSEY	13.5	102	96	22.4	22.4	34	34	80	80
NEW MEXICO	14	102	102	21.6	21.6	34.32	34.32	86.4	86.4
NEW YORK	13.5	102	L	20[11]	22.4	34[11]	36	80	80
NORTH CAROLINA	13.5	102	96	20	20	38	38	80	80
NORTH DAKOTA	13.5	102	102	20	20	34	34	80	105.5
OHIO	13.5	102	102	20	20	x	x	80	80
OKLAHOMA	13.5	102	102	20	20	34	34	80	90

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DES. = Interstates and federally designated state highways.
OTHER = All other state highways and supplemental routes

	LENGTH (FEET)									
	INTERSTATE AND DESIG. HWYS. (DES.)					STATE AND SUPP. HWYS. (OTHER)				
	STRAIGHT TRUCKS	COMBINATIONS †		TRAILING UNITS ‡		STRAIGHT TRUCKS	COMBINATIONS †		TRAILING UNITS ‡	
		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER
OREGON	40	Ø	Ø	53	N	40	N	N	N	N
PENNSYLVANIA	40	Ø	Ø	48[I]	28.5	40	60	A	NS	A
RHODE ISLAND	40	Ø	Ø	48.5	28.5	40	Ø	Ø	48.5	28.5
SOUTH CAROLINA	F	Ø	Ø	53[OO]	28.5	F	60	A	45	A
SOUTH DAKOTA	45	Ø	Ø	53	S	45	Ø	Ø	53	S
TENNESSEE	40	Ø	Ø	50[LL]	28.5	40	Ø	A	50[LL]	A
TEXAS	45	Ø	Ø	59	28.5	45	Ø	Ø	59	28.5
UTAH	45	92	92	48	61[Y]	45	Ø	Ø	48	61[Y]
VERMONT	60	Ø	Ø	48	28	60	65[MM]	A	45[MM]	A
VIRGINIA	40	Ø	Ø	53[L]	28.5	40	60	A	NS	A
WASHINGTON	40	Ø	Ø	48	60[Y]	40	Ø	Ø	48	60[Y]
WEST VIRGINA	40	Ø	Ø	48[L]	28.5	40	60	A	NS	A
WISCONSIN	40	Ø	Ø	53[FF]	28.5	40	60	A	48	A
WYOMING	60	Ø	Ø	60	CC	60	Ø	Ø	60	CC

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NOTE: No state shall prohibit the use of trailers or semitrailers of such dimensions as those that were in actual or lawful use in such state on Dec. 1, 1982. Neither shall any state prohibit the use of existing trailers or semitrailers of up to 28.5 feet in length in a truck tractor-semitrailer-trailer combination if those trailers and semitrailers were actually and lawfully operating on Dec. 1, 1982, within a 65-foot length limit in any state.

TOLERANCES:
ALABAMA - 10% weight tolerance on other roads
CALIFORNIA - 200 lbs. on Platform Scales, or 2% of scale wt. on Portable Scales.
CONNECTICUT - 2% tolerance if below 73,000 lbs.
DISTRICT OF COLUMBIA - 1,000 lbs. tolerance on GVW.
HAWAII - 5% weight tolerance on state and supplemental routes only.
KENTUCKY - 5% tolerance on length.
MARYLAND - 1,000 lbs. tolerance on GVW.
MISSISSIPPI - None on federal highways, 5% on tandem and 2% on gross on selected other highways.
MISSOURI - If on hwys. other than Interstate, can exceed axle and gross wt. limitations up to 2,000 lbs.
MONTANA - Up to 5% (7% for livestock). $10 trip permit fee charged.
NEW HAMPSHIRE - 5% tolerance below 80,000 lbs. on supp. hwys. only.
PENNSYLVANIA - 3% on axle weight except when weighed on stationary scales on Interstate highways.
VERMONT - On other highways only - 10% on axles, 5% on gross.

· Only tractor-semitrailer and tractor-twin-trailer combinations are considered here. For other combinations, contact state agency.

‡ Semitrailer in tractor-semitrailer combination, and trailer in tractor-twin-trailer combination.

ᵥ No overall length restrictions imposed.

NS. Not specified.

L. Not allowed (allowed in some states by permit).

1. **On any hwy.** tractor-semitrailer combo. 65' (distance between kingpin and rearmost semitrailer axle must be 40' or less; single axle semitrailer kingpin dimension is limited to 38 feet).

On federally designated hwys., no overall combination length limitation or kingpin restriction if semitrailer is 48' or less. Or, semitrailer may be 53 feet if kingpin to centerline of rearmost axle of tandems is no longer than 40 feet, single rear axle is limited to 38 feet.

Twin-trailer combinations 65' on all hwys. if either trailer exceeds 28.5'; 75' on non-designated hwys. if neither trailer exceeds 28.5', and unlimited length on federally designated system if neither trailer exceeds 28.5'.

A. No limit on interstate or 4-lane highways, otherwise 59-foot semitrailer and 29-foot twin trailers.

B. Combinations with semitrailers or twin-trailers in excess of limits may not exceed 70'.

C. On class I, II, and III hwys.

E. 2 axles, 35'; 3 axles, 40'.

G. Any semitrailer operated on any hwy. whose length exceeds 48', is limited to maximum distance of 42'6" from kingpin to center of rearmost axle. **On class II, and non-designated hwys.**, maximum tractor-semitrailer wheel base, 55'. **Class II hwys.**, maximum tractor-twin-trailer wheel base, 65'. **On class III and non-designated hwys.**, maximum combination vehicle length, 60'.

H. 102" on class I and II hwys.; 96" on class III and non-designated hwys.

I. 53' long, 8' wide trailer also legal if total length does not exceed 60'.

J. 80,000 lbs. on class AAA hwys.; 62,000 lbs. on class AA hwys.; and 44,000 on class A hwys.

K. GVW is governed by Bridge Formula.

M. 53' trailers permitted if distance between last axle of tractor and first axle of semitrailer does not exceed 37 feet.

M. Uncapped Federal Bridge Formula.

N. **Tractor-semitrailer combo.** 60' for Group 1 hwys.; 50' for groups 2 and 3 hwys. **Semitrailers** not specified for group 1; 40' for group 2; and 35' for group 3. **Tractor-twin-trailers** 75' for group 1; 65' for group 2; and 50' for group 3. **Trailers** 40' for group 1; 35' for groups 2 and 3.
On interstate and designated hwys., no semitrailer or trailer in a twin-trailer combo. may exceed 40'; both trailing units together measured from the front of the 1st to the rear of the 2nd may not exceed 68'.

O. 28'6" if trailer was manufactured prior to December 2, 1982; 28' if trailer manufactured after December 1, 1982.

P. 18,000 lb. + 13%.

Q. 34,000 lb. Exception: If vehicle is less than 55 feet long and gross weight is less than 73,280 lb., will allow 40,680 lb.

R. **Single Axle** 22,000 lbs. if GVW is less than 73,280 lbs.; and 20,000 lbs. if GVW is more than 73,280 lbs. but less than 80,000 lbs.

S. 28½ feet on each trailer unit operating in a road tractor-trailer-trailer combination if the towbars do not exceed 19 feet and the overall length of the trailer-trailer including towbars does not exceed 80 feet. The maximum length of semitrailer or semitrailer-trailer combination, excluding the length of the tractor, is 81½ feet provided the maximum length of either unit does not exceed 45 feet. If the towbar length exceeds 19 feet, the towbar shall be flagged during light hours and lighted at night. The weight of the second unit may not exceed the weight of the first unit by more than 3000 pounds.

T. 70 feet overall limit if semitrailer is over 53 feet on network (48' on other roads) or twin trailers are over 28.5 feet.

U. 2, 3, and 4-unit combos., 110' on 4-lane divided hwys.

V. 80,000 lbs. or 57,650 lbs., depending on highway classification.

W. 4 axles of tandem are less than 6' apart.

X. Two successive axles spaced 4' or less, 24,000 lb.; axles spaced more than 4' to 10', 34,000 lb. & 1,000 lb. for each foot or fraction thereof over 4'.

Table 3-I—Vehicle Sizes and Weights: Maximum Limits, Jan. 1, 1991-Continued

DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	HEIGHT (FEET)	WIDTH (INCHES)		WEIGHT (1 ,000 POUNDS)					
				SINGLE AXLE WEIGHT		TANDEM AXLE WEIGHT		GROSS VEHICIE WEIGHT	
		DES.	OTHER	INT.	OTHER	INT.	OTHER	INT.	OTHER
OREGON	14	102	102	20	20	34	34	80	80
PENNSYLVANIA	13.5	102	96	22.4[Z]	22.4[Z]	36Z	34Z	80	80
RHODE ISLAND	13.5	102	102	22.4	22.4	44[RR]	44[RR]	80	80
SOUTH CAROLINA	13.5	102	96	20	22	35.2[W]	39.6	80	80.6
SOUTH DAKOTA	14	102	102	20	20	34	34	80	K
TENNESSEE	13.5	102	102	20	20	34	34	80	80
TEXAS	13.5	102	102	20	20	34	34	80	80
UTAH	14	102	102	20	20	34	34	80	80
VERMONT	13.5	102	102	22.5	22.5	36	36	80	80
VIRGINIA	13.5	102	96	20	20	34	34	80	80
WASHINGTON	14	102	102	20	20	34	34	80	80
WEST VIRGINA	13.5	102	96	20	20	34	34	80	65[DD]
WISCONSIN	13.5	102	102	20	20	34	34	80	80
WYOMING	14	102	102	20	20	36	36	80	80

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As measured from front of 1st trailing unit to rear of second

When **GVW** is 73,280 **lbs**. or less, single axle may not exceed 22,400 lbs and tandem, 36,000 lbs, if **GVW** exceeds 73.280 **lbs**., single axle may not exceed 20,000 lbs and tandem 34,000 lbs

Tractor-semitrailer combo. 60' if semitrailer is 45' or less Tractor-semitrailer combo. 55' if semitrailer is greater than 45' and less than 48'

If have 54' between first tractor axle and last trailer axle, plus overall length not over 60'

48' 1st semitrailer, 40' 2nd trailer, but combined length of the two may not exceed 80', including connecting devices Other combinations not shown, 85'

73,500 on some roads

If over 48', kingpin to rear axle cannot exceed 41 Tractor-twin trailer combinations allowed on state designated routes only

Provided distance between kingpin and center of rearmost axle group is 41 feet or less

Combination of trailers can be 61 feet including tongue, or 75 feet overall

Kingpin to rearmost axle cannot exceed 405 feet, if the semitrailer was manufactured before January 1, 1985, the kingpin to rearmost axle distance shall not exceed 42 feet 6 inches A semitrailer, regardless of when it was manufactured, that is longer than 48 feet 6 inches and that has a distance between the kingpin and rearmost axle of 43 feet or less may be operated on the Interstate system and have 10 miles of access

II. If GVW is below 71,000 lb , single axle weight may be 22,400 lb , tandem axle weight may be 36,000 lb

JJ. Variable, contact the Michigan Department of Transportation

KK. 14' on Interstate and designated system only, otherwise 135 feet

LL. Measured from point of attachment (kingpin) to end of trailer or load If the semitrailer (or trader) length limit exceeds 48 feet, the distance between the kingpin and the rearmost axle or a point midway between the two rear axles, if the two rear axles are a tandem axle, shall not exceed 41 feet

MM. A 48' trailer and a 60' overall length is also legal

NN. 53' semitrailer must have maximum of 41 from center of kingpin to center of rear tandem on trailer or center of rearmost axle in the case of a single axle or "stretch tandem" trailer, 67 5' semitrailer combinations and twin trailer combinations, allowed on state designated system

00. 41 maximum from kingpin to center of rear axle assembly If the semitrailer is longer than 48 feet, it must be equipped with a rear underride guard

PP. If gross weight is more than 75,185 lb , legal tandem weight is 34,000 lb

Cm. Semitrailer can only have 2 axles Kingpin to center of tandem axle can't exceed 405 feet + 5 feel

RR. Eff 4-1 91 decreased to 34,000 lbs

SOURCE: *Vehicle Sizes and Weight Manual,* "Vehicle Sizes and Weights Chart," supplement (Neenah, WI: J.J. Keller & Associates, Inc.).

point to a number of other factors contributing to safe driver performance. For example, their drivers often operate close to home and spend a majority of their nights at home. As a consequence, drivers are familiar with the routes they travel, and management supervision is present at both origin and destination.

One trucking company contends that its driver training programs are analogous to those of an airline;[39] each vehicle has unique characteristics, and drivers need specialized training for each configuration just as airline pilots need to log hours in different types of aircraft. However, such a claim overlooks the fact that training requirements and standards for aircraft pilots are set by the Federal Government. No special Federal standards or requirements exist for truck drivers of any type of heavy vehicle, including LCVs. Development of Federal driver standards and rigorous Federal driver training requirements for heavy vehicle drivers is overdue and should be a top priority for DOT[40]*

Should LCVs be more widely allowed, a number of safe operating practices could disappear because the vehicles would operate on a far broader scale. Without adequate equipment, driver training, and other requirements, typical LCV operating practices are likely to resemble western doubles operations, for which many drivers receive little or no special training.[41]

Driver Error

Heavy vehicle drivers must continuously process and react to a variety of information, and even momentary lapses in concentration can cause an accident. Human error is involved in over 60 percent of motor carrier accidents.[42] The same factors affect performance of all truck drivers: attitude, coordination, vision, caution, and fatigue associated with stress, exhaustion, or sleep deprivation.

However, the mental demands of driving can differ among different vehicle types and characteristics. Drivers of doubles and triples report greater tiredness after 8-hour hauling sets than they do with conventional tractor-semitrailers.[43] Though noise and cab vibration may contribute more directly to fatigue and are common to all truck configurations, the additional mental strain from driving multiunit combinations probably stems from concerns about trailer sway and instability caused by a greater number of articulation points on combinations hitched together by A-dollies. Drivers contacted by OTA verify the additional driver concerns from driving multitrailer combinations hooked by conventional A-dollies.[44] Using a double-drawbar dolly increases driver confidence and decreases mental strain and fatigue. Testing and study are needed to determine the possibly differing effects on drivers of various combination lengths, hitching mechanisms, and number of trailing units. Ongoing FHWA/industry fatigue studies could be expanded in scope to provide valuable driver fatigue comparisons between western doubles and conventional tractor-semitrailers.

Sharing the Road With Motorists

Since trucks share the highways with the motoring public, attention to the interaction between automobiles, trucks, and drivers is crucial to any examination of LCV issues. Such concerns as roadway visibility and behavior of nearby passing and oncoming traffic are particularly acute because of the wide disparity in scale between LCVs, automobiles, and motorcycles. (Trucks can be four to six times as long as automobiles and are three times as high--see figure 3-2 again.) For instance, trucks often

38 Groups such as the Western Highway Institute and the Western Association of State Highway and Transportation Officials have promoted uniform size and weight standards with some success.

39 Jerry Hughes, Roadway Express, Inc Q, presentation at Professional Truck Driver Institute of America public forum, Sacramento, CA, Feb. 26, 1991.

40 office of Technology Assessment, op. cit., footnote 1, pp. 12-13.

41 National Transportation Safety Board, op. cit., footnote 20.

42 Office of Technology Assessment, op. cit. ? footnote 1, p. 137.

43 *Overdrive*, July 1987, p. 43.

44 Jim Johnston, Owner-Operators Independent Drivers Association, personal communication, March 1991; and truck driver interviews, unedited footage of Saskatchewan LCV operators produced by University of Michigan Transportation Research

block motorists' view of other traffic and signs, a phenomenon that would likely worsen with greater use of longer vehicles.[45] Even minor trailer sway concerns motorists, who associate it with the possibility of loss of control of the truck. The continuous small steering corrections employed by some drivers to stay in a traffic lane can cause a wave action down through the vehicle, which can be augmented by curves in the road, uneven pavement, and wind. Even though such motions may not result in instability, the impact on motorists' attention to other driving tasks and general behavior has not been rigorously examined.

Surveys of automobile drivers show almost universal opposition to any increased use of longer trucks and indicate that the trucks already on the road overwhelm motorists.[47] Such concerns will become increasingly important in the coming decades, particularly as the population of older drivers grows. A substantial portion of older drivers shows poorer perceptual capabilities--such as reaction time, peripheral vision, sharpness of vision, decisionmaking--than the rest of the driving public. In addition, research and survey and accident data suggest that older drivers have relatively more difficulty interacting with trucks and have the strongest negative reactions to them.[48]

INFRASTRUCTURE IMPACTS

Although LCVs can carry heavier loads than conventional trucks, recent studies by the Transportation Research Board and other organizations find that LCVs cause less pavement damage per unit of freight moved. This is because they have more axles over which the weight is distributed and because fewer trips are necessary to move the same amount of freight. An industry study[49] estimates the annual reduction in pavement costs would be between $16 million to $55 million if LCVs were allowed on a national basis and significant amounts of freight shifted from conventional trucks to LCVs. *Such a shift would occur almost exclusively in States not now allowing* LCVs. Precise impact estimates are difficult because they depend greatly on traffic shifts, vehicle mixes, tires and suspensions used, and other factors.

Although pavement damage might decrease, highway tax payments used to maintain and repair pavements would also decrease if freight shifts from conventional trucks to LCVs. FHWA finds that in general, State permit fees for overweight vehicles do not cover the cost of administration and highway damage.[50] In addition, the reality of lax weight enforcement on the highways and more (often overweight) marine containers traveling on the road network could outweigh any pavement benefits where turnpike doubles are allowed to operate from ports.

The generally poorer offtracking of LCVs (except for triple combinations, as described earlier in this chapter), longer length, and greater gross weight point to a need for redesign and reconstruction of significant portions of the roads where they are used, especially interchanges and bridges. Lane widening, increased turning radii, and provision of climbing/passing lanes will be necessary in some areas to accommodate longer vehicles with poorer off tracking or climbing ability.

Longer Buses

A legislative proposal by the intercity bus industry seeking permission for nationwide operations of 45-foot over-the-road motor coaches is discussed in box 3-A. Coach manufacturers claim that the turning radius of their proposed design is within the design limits of current highways.

Bridges

For States to allow LCV operations and comply with the Bridge Formula as well would mean upgrading many bridges to higher design

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Institute under NHTSA contract, 1991; and Nick Patch, Mayflower Elite Fleet, personal communication, Mar. 12, 1991.

45 Neil D. Lerner et al., Comsis Co w. ! "Older Drivers' Perceptions of Problems in Freeway Use, " unpublished report, March 1990, pp. 32-34.

46 W.R.J. Mercer et al., op. cit., footnote 19, p. 69.

47 American Automobile Association, survey of members, October 1989 and December 1990.

48 Neil D. Lerner et al., Op. cit., footnote 45, pp. 12-13, 32-34.

49 The Urban Institute, 'Pavement and Bridge Impacts of Longer Combination Vehicles, " study prepared for the Trucking Research Institute, The

Box 3-A--Greater Productivity Through Longer Buses

The average length of intercity buses increased from 35 feet to 40 feet in the late **1940s and early 1950s, as vehicle dimension regulations changed. With** the passage of **1956** highway legislation came a set of grandfather provisions unique to intercity buses. States that permitted 45-foot transit buses prior to 1956 were allowed to approve 45-foot intercity buses as well. Currently, 45-foot coaches can be operated legally in 15 States and the District of Columbia (see figure 3-A-l).

The main advantage of longer coaches is increased productivity. A lavatory-equipped 40-foot coach carries 46 or 47 passengers and has 319 cubic feet of baggage space. A similarly equipped 45-foot coach carries 55 passengers, a 20-percent improvement, and has 410 cubic feet for baggage, a 29-percent improvement. One company estimates that this longer vehicle could save 32 million bus-miles each year and 5.5 million gallons of fuel.[1]

No data exist to show whether the 12-percent greater length of 45-foot coaches over 40-foot coaches brings about significant changes in safety and handling, although the manufacturer's computer models indicate it does not. Bus accident data do not include vehicle length, so present 45-foot coach operations cannot be compared with other intercity bus operations. Some, but not all, 45-foot coaches have turning radius, rear swingout, and axle weight distribution characteristics that are equivalent to those of 40-foot coaches and within existing Federal and State limitations. Both transit and intercity buses, when fully loaded, can violate Federal axle and gross weight limits and have significant pavement impacts. Nonetheless, axle and gross weight limits are rarely enforced for these vehicles.[2]

1 Motor Coach Industries, "Background Information on 45-Foot Coaches, " informational document, April 1991.

2 John Pearson, director of research, Western Highway Institute, personal communication, May 8, 19919

loads or replacing load deficient bridges. Even bridges not requiring immediate strengthening could impose an indirect cost because of reduced service life. A trucking industry study,[51] using a similar methodology to that used in the TRB studies, found total bridge costs (not including user costs associated with time delay and additional fuel consumed) associated with national use of LCVs to be on the order of $6 billion.[52]

Other subsequent studies on the rural[53] and urban bridge[54] networks used a similar TRB methodology, enhanced to include estimates of user-borne costs. Moreover these studies used a different bridge rating based on the results of a survey **of** 49 State **highway agencies in calculating bridge replacement costs .55 Estimates for the total bridge costs on the rural and urban Interstate system using this methodology are on the order of** $30 **billion, comprised of $14 billion replacement costs (1989 prices) and $16 billion associated user-borne costs. Bridge impact estimates of the ability to carry LCVs are sensitive to how highway agencies rate their bridges' condition, truck loads and configurations, and construction and material costs. If user borne-costs are considered to reflect total costs more completely, the value of time and additional fuel consumed must be included, and the final total can double original replacement cost estimates.**

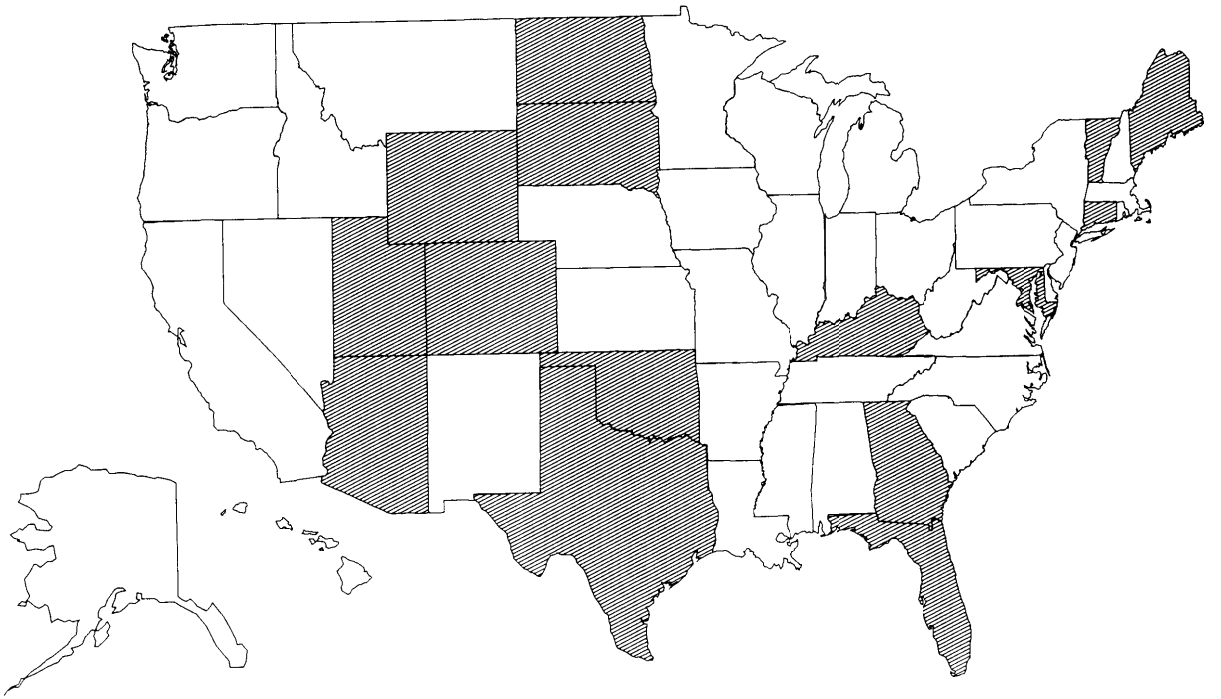
ATA Foundation, June 30, 1990.

50 U S Department of Transportation, Federal Highway Administration, "Overweight Vehicles: Penalties & Permits, " unpublished report, 1987, p. vii.

51 The Urban Institute, op. Cit., footnote 49.

52 As in the Transportation Research Board studies, a discount rate of 7 percent and infinite term for amortizing capital costs were assumed in order to

Figure 3-A-1—States Allowing 45-Foot Coaches



SOURCE: Office of Technology Assessment, 1991.

Costs for bridges are particularly important because these improvements must be made before heavy trucks are allowed to travel on them and require up-front public expenditures. Changes in funding mechanisms are also needed to reflect more accurately the true infrastructure costs incurred by heavy trucks and pay for necessary bridge and road maintenance. Because of these concerns, AASHTO has taken a strong stand against any efforts to allow wider use of LCVs, maintaining that most of the Nation's highways have yet to be reconfigured to standards that accommodate the increases that occurred during the 1980s in truck sizes and weights.

ECONOMIC IMPACTS

The economic impacts of a wider LCV network depend on many factors: which and how many States allow them, future fuel prices and tax rates, the cost and extent of infrastructure upgrades, and responses from various sectors of the trucking, and railroad industries, and many others. Thus, it is impossible to make reliable predictions of the economic impacts of greater LCV use.

However, some studies have suggested[57] that allowing LCVs on a national scale would probably lead to productivity benefits for the trucking industry and the shippers it serves, perhaps on the order of $2 to $4 billion annually, because increased weights and dimensions would enable a given amount of freight to be carried in fewer trips, reducing the per ton-mile cost of each movement. For example, the addition of a single 28-foot trailer to a double 28-foot combination allows 50 percent more product to be hauled at little additional cost and increases flexibility. In addition to the pavement and bridge impacts discussed earlier, other predicted impacts, discussed later, include changes in trucking operations, shifts in freight traffic from rail to trucking, and provision of staging areas. Box 3-B describes the effects that changing truck weight restrictions can have on a State's economic development.

LCVs Advocates

Many shippers support wider use of LCV. Generally, long-haul carriers and some short-haul carriers with high freight volumes between endpoints will benefit the most from turnpike doubles and triples. Short-haul carriers, carriers serving lowdensity freight corridors, and carriers with proportionately greater operations on urban streets will benefit less from LCVs since they are less able to capitalize on the economies these vehicles afford. Each configuration is attractive to various types of carriers.

Truckers most enthusiastic about wider use of triples tend to be large parcel and nationwide Less than Truckload (LTL) carriers. They would like to be able to operate more efficiently over long hauls (or short hauls with high volumes of freight) in more parts of the country. Many of these carriers are already set up to use western doubles for their linehaul movements, and the ability to operate triples in all States would probably lead to substantial savings for these companies. Regional LTL carriers, which use both western doubles and conventional semitrailers for their linehaul operations, could benefit from either triples or turnpike doubles.

Only some truckload (TL) carriers are enthusiastic about LCVs, because many operate on already slender profit margins. Moreover, TL rates are likely to drop more than LTL rates if wider LCV use is allowed, since LTL rates include pickup and delivery charges and tend to be more competitive due to the smaller shipments involved. General commodity TL carriers face additional hurdles in taking advantage of LCVs because few serve a pair of shippers (one at each endpoint) that can consistently offer balanced freight in both directions. Consequently, TL movements tend to be treated on a one-by-one basis with a driver moving a truckload to a receiving dock and then being routed elsewhere for the next load.

Efficient use of turnpike doubles for TL movements would require a reorganization into pickup and delivery operations (using single

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estimate an annual cost. OTA converted annual costs to total costs.

53 Jose Weissmann and Rob Harrison, Texas Research and Development Foundation, "The Impact of Turnpike Doubles and Triple 28s on the Rural Interstate Bridge Network," paper presented at the 70th Annual Meeting of the Transportation Research Board, Washington, DC, January 1991.

54 Rob Harrison and Jose Weissmann, Texas Research and Development Foundation, "Urban

trailers) and linehaul operations between staging areas (using the doubles) that large fleets would be most likely to afford. Small TL carriers would be less likely to take advantage of the longhaul efficiency of turnpike doubles and could suffer in an environment where large firms are able to operate more efficiently over long-haul corridors.

Single commodity TL carriers could benefit from LCVs. Many of these operations are local, and some might need to operate extensively off the Interstate, where the greater maneuverability of triples would be useful. Carriers that make proportionately greater use of Interstate would probably opt for the greater volume of turnpike doubles.

Both weigh-out and cube-out traffic will benefit from more LCVs.[59] Carriers of bulk commodities, such as chemicals, petroleum products, wood pulp, and gravel, are affected mainly by weight restrictions, and weigh out before they cube out. Consequently, turnpike doubles, which can carry the greatest weight, would be likely to see more bulk use. LTL carriers are more likely to need the flexibility of triples. It is unclear how rapidly trucking companies would adapt to any changes in size and weight restrictions. Some, especially large carriers, would simply couple one more trailer to existing combinations, thereby reaping considerable productivity benefits while incurring few capital investment costs. Others would buy new equipment immediately, while some would wait for existing equipment to wear out. No analysis to date has considered the costs to companies that would result from technology requirements or new safety and driver training programs.

LCV Opponents

As noted above, not all trucking companies will benefit from wider use of LCVs. Since some overcapacity still exists in both the TL and LTL sectors, weaker companies now struggling to make a profit would be unlikely to survive if LCVs were widely permitted. Small TL firms, lacking the capital, traffic volumes, and sophisticated management systems needed to exploit LCVs, will lose out to larger, better financed TL competitors, who will be in a position to convert more quickly to LCVs.[60] Other small companies and independents are likely to suffer as well, since they cannot capitalize on economies of scale to purchase equipment.[61] On grounds of both employment and safety, the Teamsters oppose any expansion of LCVs beyond those States where they are presently allowed. Experience of Teamster locals in those States convinces the Union that those LCVs could not be operated as safely in areas with more traffic.[62]

Railroads are concerned about LCVs because of a loss of traffic due to lower trucking costs and rates as well as a potential loss of revenue on traffic for which they would have to lower their rates to meet increased trucking competition. These concerns are particularly acute for railroads in truck competitive markets, such as lumber, chemicals, automobiles, and pulp and food products as well as intermodal container traffic, where significant freight diversion to turnpike doubles can be expected in all regions of the country. Though LTL traffic is not a large portion of overall railroad business, their LTL operations would also be affected, primarily by triples. Rail corridors sensitive to increased use of triples include Chicago, St. Louis, Houston, and Kansas City to the Pacific Northwest and Chicago to Philadelphia. Because they allow combining TL and LTL traffic, Rocky Mountain doubles might reduce rates somewhat, since higher revenue from the 28-foot (LTL) trailer would permit a lower rate for the 48-foot (TL) trailer.[63]

Contrary to assertions that most opposition to LCVs has been orchestrated by their industry

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Interstate Bridges: Turnpike Doubles and Triple 28 Costs," unpublished report, May 1991.

55 Rob Harrison et al., Texas Research and Development Foundation, "Operating Rating or Inventory Rating: A Multi-Billion Dollar Difference," unpublished report, February 1991.

56 Hal Rives, president, American Association of State Highway and Transportation Officials, written communication with six Senators and Congressmen, Feb. 19, 1991.

57 The Trucking Research Institute has sponsored research on potential longer combination vehicle productivity benefits and infrastructure costs, and the Transportation Research Board has conducted studies on heavier (but not longer) trucks and Turner trucks.

58 Paul Roberts, "The Politics of Longer Combination Vehicles," paper submitted to the

Box 3-B--Calculating the Costs of Economic Development in Wyoming

A truck weight study conducted by the Wyoming State Highway Department[1] found that changing truck size and weight regulations could affect economic development. Wyoming is highly dependent on truck transportation, but unlike most western States, did not qualify for the grandfather clause allowing trucks to operate on Intestates beyond the 80,000 lbs, gross weight limit. According to the study, because trucks in other States could haul more cargo, their transportation costs were significantly lower, making Wyoming products more expensive in comparison. Moreover, some vehicles bypassed the State in favor **of** neighboring States that permitted heavier vehicles. (To determine the effect of the ban on trucking productivity, the Wyoming State Highway Departmmt had earlier gained permission from the Federal Government to conduct a 2-year study on heavy truck operations.)

The study showed that almost 26,000 fewer trips werer made when the heavy trucks were utilized than under previous conditions, saving an estimated 700,000 gallons of feul. Reductions in tranportation costs were observed for several commodities, and some Wyoming firms **opened new markets because** they could compete with companies in Montana and Canada.

However, the report did not examine truck accident data or calculate the costs of infrastructure impacts. Thus, no estimates of these public sector costs were used to offset the trucking industry benefits. After the study and at Wyoming's request, a provision allowing the State to permit the operation of trucks weighing greater than 80,000 lbs. on the Interstate system through December 31, 1991, was included in a Federal appropriations bill.[2]

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1 Wyoming State Highway Department, "The Wyoming Weight Study: Increasing the Gross Vehicle Weights on Wyoming Interstate Highways," unpublished report, January 1988.

2 Public Law 101-56.

opponents, public opinion surveys and **OTA staff interviews show an overwhelmingly negative public reaction to increasing truck dimensions.[64] Moreover, in recent trucking industry surveys, 76 percent of the executives from TL carriers polled indicated they would not be willing to trade higher user taxes for a size increase.[65] Professional truck drivers felt triples and turnpike doubles were less safe than conventional tractor-trailer combinations by over 80 percent, and 60 percent said they would feel less safe sharing the road with triples and turnpike doubles if they were operated everywhere. (However, more than 90 percent of the drivers interviewed indicated they had never driven an LCV.)[66]**

CONCLUSIONS

The number and variety of State grandfather clauses and permit programs governinglonger, heavy trucks make clear that the United States does not have uniform truck size and weight requirements, even on Interstate highways. Some State officials contend that the Federal Government has "dropped the ball" on the issue,[67] and that States do not have adequate resources to ensure that their permitting programs are sufficient to guarantee highway safety.

Although not comprehensive, existing accident data do indicate that LCVs are operated safely in those States that allow them under special permit restrictions. These generally include specifications of road type, climate, time-

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Federal Highway Administration, n.d.

59 Freight cubes out when trailer capacity is reached before weight limits are exceeded; it weighs out when the opposite occurs.

60 'Longer Combination Vehicles: A Trucking D i saster, " ***Competitive Policy Reporter,*** AAR/Intermodal Policy Division Report, vol. 2, No. 5, Mar. 15, 1991.

61 Jim Johnston, Owner-Operator Independent Drivers Association, Inc., personal communication,

of-day restrictions, driver qualification, loading, hill-climbing ability, and maximum speed. Such State permit programs, when enforced, have been a key ingredient in promoting the safety of LCV operations to date. The success of these permitting programs raises the possibility of developing Federal safety requirements, especially for driver training, for western double and conventional tractor-trailer operations, since they share many, but not all, of the operating difficulties of LCVs and account for over 99 percent of all tractor-trailer accidents.

Being able to use LCVs on a wider network would bring productivity benefits to a number of motor carriers and could promote economic development in some States. However, many States are not enthusiastic about having more LCVs on their roads and would like the Federal Government to take a more active role in curbing proliferation of LCV operations.[68] Moreover, the trucking industry is not unanimous in its support of LCVs. Each configuration is suited to different industry segments, and some sectors do not favor any changes in the types of vehicles allowed to operate. The benefits of any changes to Federal size and weight laws will accrue to different industry sectors to varying degrees. Some operations, primarily owner-operators and other small outfits, are likely to lose market share if wider use of LCVs is permitted, and they vigorously oppose this idea.[69] Parcel and nationwide LTL carriers would use triples, large TL carriers would use turnpike doubles, and some regional LTL carriers could use either configuration.

While LCVs promote increased productivity and fuel efficiency for trucking companies, wider LCV use is likely to divert some rail traffic to trucks, reducing the overall fuel efficiency of the freight transportation system, under most circumstances. Moreover, permits for overweight vehicles generally do not cover the cost of administration and highway damage, and estimates of the total costs to upgrade bridges to accommodate LCVs range from a low of $6 billion up to at least $14 billion. When broader public interests and costs such as these are taken into account, they may outweigh the productivity benefits (estimated at $2 to $4 billion annually) to the industry.

Mar. 22, 1991.

62 Vernon McDougal, Safety and Health Division, International Brotherhood of Teamsters, personal communication, Apr. 2, 1991.

63 Association of American Railroads officials, personal communications, Feb. 13, 1991.

Accident Data

Accident data are insufficient to evaluate the safety impacts of wider use of LCVs. Congress may wish to consider requiring DOT to develop a database for tractor-trailers and LCVs that includes travel data by type of road, road class, geographical data, type of truck (including length of units, speed restrictions, and loading condition), and fatal and nonfatal truck accidents. A collaborative effort for information gathering between NHTSA, the Office of Motor Carriers in FHWA, and the States would be essential. In the future, information from such a database could help DOT develop guidelines for special LCV permitting and for determining routes based on highway geometry, traffic flow, bridge characteristics, traffic densities, vehicle mixes, and grades.

Federal Safety Requirements

In 1988, OTA suggested that Congress consider Federal training standards and requirements for tractor-trailer drivers. Information gathered since indicates that many companies take no steps to prepare drivers for the transition between conventional tractor-semitrailers and vehicles requiring more skill (such as western doubles and LCVs). The relationship between rearward amplification and trailer sway on multiunit combinations and mental strain and fatigue on drivers is not clear and needs empirical testing. Current FHWA driver fatigue research could be expanded to include analysis of double- v. single-unit combinations and provide valuable, preliminary insight into LCV driver fatigue and how it might differ between combinations.

Given the current high rate of driver turnover in some segments of the trucking industry and the considerable training expenses faced by operators, the public has a right to expect that stringent Federal safety equipment and training requirements and stricter operating regulations will be implemented before any change in Federal policy on LCVs. It is time to address a major loophole in Federal highway safety

programs and for Congress to require DOT to develop training standards and requirements for tractor-trailer and LCV drivers, under the Commercial Drivers' License program. Although some industry segments remain opposed to Federal standards, acceptance of the concept has grown substantially over the past several years.[70]

Performance standards are needed for braking efficiency (particularly for unloaded vehicles), rearward amplification, rollover threshold, minimum grade-climbing ability, low- and high-speed offtracking, steering sensitivity, and vehicle suspension. Congress should require DOT to develop and implement appropriate studies and inservice fleet testing of safety enhancing technologies on LCVs, including antilock brakes, double-drawbar dollies, and sufficiently powerful engines. Vehicles from existing LCV operating fleets could be used for such a test.

On completion of the appropriate studies and operational tests, Congress may wish to require DOT to mandate adequate control measures to mitigate the handling problems and/or infrastructure impacts of LCVs. The use of antilock brakes on all axles, double-drawbar dollies for trailers less than 40 feet in length, air suspensions, and automatic slack adjusters on trailers as well as tractors, or equivalent systems, could be required or encouraged through weight or other incentives. Heavier trailer forward requirements should also be mandated to improve control. Such test programs and development and implementation of Federal standards must precede any changes to Federal laws applicable to heavy vehicle operation to ensure nationwide highway safety.

LCVs and Infrastructure Improvements

Each configuration of LCV needs to be considered against the sort of uniform performance standards discussed above. The infrastructure implications of turnpike doubles are quite different than those of triples. The safety concerns of triples could be addressed by technologies identified in this paper, whereas the infrastructure demands of turnpike doubles involve upgrading substantial portions of the highway network. Taxes and fees for heavy trucks must be set at levels adequate in order to cover their impact on the infrastructure.

Automobile Drivers and LCVs

The overwhelming opposition of motorists to large, heavy trucks is, and should continue to be, a major concern for the trucking industry. It is possible that motorists' discomfort with even conventional truck configurations is so great that the industry will be unable to counter the strong negative public reaction to longer ones. Since the issue of the public's reactions to longer trucks has disturbed the industry in the recent past, trucking companies may want to weigh the costs in goodwill of proposed productivity improvements.

Just as truck drivers need adequate special instruction in operating their equipment safely in mixed truck and car traffic, automobile drivers need special instruction in sharing the road with trucks. Congress could consider requiring DOT to develop guidelines on this for automobile driver training courses and instruction materials, in cooperation with State motor vehicle administrators.

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64 The 1989 Legislative Survey Composite Report prepared by the American Automobile Association's (AAA) Department of Market Analysis and Research found that 89 percent of AAA members are strongly opposed to increasing truck lengths. A 1990 poll conducted by the Frederick/Schneiders Inc. yielded similar results.

65 Memorandum of Interstate Truckload Carriers Conference, Feb. 11, 1991.

66 "A Study of the Operating Practices of Extra-Long Vehicles," *Transportation Research and Marketing,* December 1990, p. 48.

67 Norm Lindgren, director of motor carriers, Utah Department of Highways, personal communication, May 3, 1991.

68 See Rives, op. cit., footnote 56; and ibid.

69 Jim Johnston, executive director, Owner-Operators Independent Drivers Association, Inc., personal communication, May 3, 1991; and Rita Bontz, Independent Truck Drivers Association, personal communication, May 7, 1991.

70 Jim Johnston, Owner-Operators Independent Drivers Association, Inc., and Ed Kynaston, Professional Truck Drivers Institute of America, personal communications, May 1991.

Appendix A
Supplementary Tables

Table A-l—impact on States of Change in Bridge Program Federal Match
(based on 1991 program apportionment)

State	Current State matching share at 20 percent (millions of dollars)	Hypothetical State matching share at 25 percent (millions of dollars)	State	Current State matching share at 20 percent (millions of dollars)	Hypothetical State matching share at 25 percent (millions of dollars)
Alabama	$7.2	$9.7	Montana	1.8	2.4
Alaska	0.9	1.1	Nebraska	4.2	5.7
Arizona	0.9	1.1	Nevada	0.9	1.1
Arkansas	4.5	6.0	NewHampshire	1.9	2.5
California	11.1	14.8	New Jersey	15.3	20.4
Colorado	3.2	4.2	New Mexico	1.1	1.5
Connecticut	17.2	23.0	New York	34.1	45.4
Delaware	1.0	1.3	North Carolina	6.9	9.2
District of Columbia	2.4	3.2	North Dakota	1.2	1.6
Florida	6.0	8.0	Ohio	10.4	13.9
Georgia	6.7	8.9	Oklahoma	7.3	9.7
Hawaii	0.9	1.2	Oregon	2.0	2.6
Idaho	0.9	1.1	Pennsylvania	30.7	41.0
Illinois	9.9	13.1	Rhode Island	0.9	1.1
Indiana	5.7	7.6	South Carolina	2.6	3.5
Iowa	6.3	8.4	South Dakota	1.6	2.2
Kansas	6.2	8.3	Tennessee	8.7	11.6
Kentucky	6.8	9.1	Texas	12.9	17.2
Louisiana	7.0	9.3	Utah	0.9	1.1
Maine	2.1	2.8	Vermont	1.9	2.5
Maryland	4.2	5.6	Virginia	7.7	10.2
Massachusetts	19.3	25.7	Washington	8.5	11.3
Michigan	7.5	10.0	West Virginia	9.5	12.6
Minnesota	4.3	5.7	Wisconsin	5.8	7.8
Mississippi	4.8	6.4	Wyoming	0.9	1.1
Missouri	13.4	17.9	Total	339.7	452.9

NOTE: The hypothetical State matching share marks a 33-percent increase from the current matching share.
SOURCE: Office of Technology Assessment, 1991, based on Federal Highway Administration, *Highway Statistics 1989* (Washington, DC: 1990).

Table A-2-States Receiving Matching Share Reductions for Federal Lands and Proposed Low-Density Bonuses

State	Federal lands matching share reductions (1991) (millions ofdollars)	Proposed low-density bonus (1992) (miiliins ofdoilars)	Total (millions ofdollars)	State	Federal iands matching share reductions (1991) (millions ofdollars)	Proposed low-density bonus (1992) (millions ofdollars)	Total (millions ofdollars)
Alaska	$22.7	$35	$57.7	Nevada	2.2	28	30.2
Arizona	9.9	no	9.9	New Mexico	4.3	34	38.3
California	21.4	no	21.4	North Dakota	no	26	26.0
Colorado	3.2	no	3.2	Oregon	4.5	no	4.5
Hawaii	0.5		0.5	South Dakota	1.2	26	27.2
Idaho	6.7	24	30.7	Utah	5.7	20	25.7
Montana	2.3	35	37.3	Washington	1.9	no	1.9
Nebraska	no	24	24.0	Wyoming	3.8	28	31.8

The State matching share requirements for major Federal highway programs are reduced for those 14 States with large Federal land holdings. The reductions are calculated on a sliding scale depending on the size of the Federal holdings.
SOURCE: Office of Technology Assessment, 1991.

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