TRANSPORTATION STATISTICS

Annual Report

1994

Bureau of Transportation Statistics

U.S. DEPARTMENT OF TRANSPORTATION

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U.S. DEPARTMENT OF TRANSPORTATION

Federico Peña, Secretary

BUREAU OF TRANSPORTATION STATISTICS

400 Seventh Street, S.W., Room 2104
Washington, D.C. 20590

Main Number: 202-366-DATA
Fax: 202-366-3640
Statistical Information: 800-853-1351

T.R. Lakshmanan, Director

Robert A. Knisely, Deputy Director

Rolf R. Schmitt, Associate Director for Analysis and Data Development

Philip N. Fulton, Associate Director for Data User Services

Lorelei S. Evans, Administrative Officer

Elizabeth V. Ellis, Secretary

Lonn Henrichsen, Senior Technology Advisor (Acting)

Terry Feinberg, Managing Editor

Rolf R. Schmitt	Editor-in-Chief
Terry D. Feinberg	Managing Editor

Major Contributors:

Kathleen M. Bradley	Volpe National Transportation Systems Center
Shih Miao Chin	Oak Ridge National Laboratory
Stacy C. Davis	Oak Ridge National Laboratory
Douglas C. Frechtling	George Washington University
John W. Fuller	University of Iowa
Philip N. Fulton	Bureau of Transportation Statistics
David L. Greene	Oak Ridge National Laboratory
Patricia S. Hu	Oak Ridge National Laboratory
Alan Pisarski	Consultant
Michael A. Rossetti	Volpe National Transportation Systems Center

Other Contributors:

Philip Barbato	Office of the Secretary of Transportation
Patricia Beardsley	Federal Aviation Administration
Louann M. Hall	National Highway Traffic Safety Administration
Bruce D. Spear	Volpe National Transportation Systems Center

EXECUTIVE SUMMARY

The Transportation Statistics Annual Report is a summary of the state of the transportation system and its consequences, the quality of statistics used to characterize the transportation system, and planned efforts by the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS) to improve the quality of the statistics. BTS was established by Congress to compile, analyze, and make accessible information on the nation's transportation system; to collect information on intermodal transportation and other related areas as needed; and to enhance the quality and effectiveness of the Department of Transportation's statistical programs through research, the development of guidelines, and the promotion of improvements in data acquisition and use.

The State of the Transportation System

Transportation is a pervasive component of daily life and a significant share of the national economy. Travel consumes roughly an hour of an average person's day, and roughly one-sixth of household expenditures. American households, businesses, and governments spend over $1 trillion to travel 3.8 trillion miles and to ship goods 3.5 trillion ton miles each year. When adjusted to formal definitions of the National Income Product Accounts, transportation accounts for 12 percent of Gross Domestic Product.

Passenger travel and freight movements continue to increase. Passenger-miles per person and the ratio of passenger-miles to Gross Domestic Product have both grown steadily over the past three decades. Ton-miles per person have also increased, although the ratio of ton-miles to Gross Domestic Product has declined.

The transportation system includes 190.4 million automobiles, vans, and trucks operating on 3.9 million miles of streets and highways; 103,000 transit vehicles operating on those streets, as well as more than 7,000 miles of subways, streetcar lines, and commuter railroads; 275,000 airplanes operating in and out of 17,500 airports and landing fields; 18,000 locomotives and 1.2 million cars operating over 113,000 miles of railroads; 20 million recreational boats, 31,000 barges, and over 8,000 U.S. ships, tugs, and other commercial vessels operating on 26,000 miles of waterways, the Great Lakes, and the oceans; and 1.5 million miles of intercity pipelines. The numbers and use of vehicles, vessels, and aircraft generally continue to grow, while the infrastructure over which they operate has not expanded significantly in extent or capacity. Both the infrastructure and the fleets operating over the infrastructure are aging, and placing greater demands on maintenance and reconstruction.

The performance of the transportation system from the user's perspective is not improving on the passenger side as it did in past decades. Large gains in speeds have ended as the Interstate System has reached completion and become increasingly congested, and as airlines shift from nonstop flights to hub-and-spoke operations. In contrast the freight system shows major gains through innovations in intermodal service, through the growth in parcel express delivery, and in the shift of businesses to just-in-time delivery systems. Both passenger travel and freight movements were disrupted temporarily by the 1993 Midwest floods, which closed over 1,600 miles of navigable waterways, 3,764 miles of mainline railroads, over 380 miles of major highways, and 34 airports.

Spending on the transportation system by households, businesses, and governments has increased eight-fold in current dollars over the past three decades. Some of the increase is due to the replacement of inventories by just-in-time transportation. Some of the increase in transportation spending is due to a shift to higher quality service, as illustrated by the enormous growth in both household and business use of overnight delivery services. Government spending has not increased at the same rate as household and business spending; in constant dollars, state and local government spending on transportation facilities and services has increased modestly in the past decade while federal spending has been flat.

The price we pay for transportation is not limited to direct monetary costs. Transportation accounts for half of all accidental deaths in the U.S. Although the number of fatalities and the fatal accident rate have shown significant improvement in the past decade, transportation accidents took more than 42,000 lives in 1992 alone. Other costs include energy consumption and environmental quality. Improvements in fuel economy over the past decade are leveling off or declining for most forms of transportation, and show little potential for significant improvement in the near future. As a result, we can expect petroleum use by transportation to increase in step with passenger travel and goods movement. Impacts on air quality, global warming, and other environmental issues are much harder to monitor, but show past improvement and potential for further gains.

The State of Transportation Statistics

While many conditions and trends have been characterized, a better understanding of the performance of the transportation system and the potential for its improvement requires both better coverage and increased quality of existing data, and the design and implementation of better measures to transform existing and new data into useful information.

New or significantly expanded data collection is needed on: location, condition, and physical performance of transportation services and facilities provided by the private sector, and intermodal connections provided by both public and private sectors; quantity, geographic distribution, and cost of commodity and passenger movements; expenditures and revenues of passenger transportation companies and selected providers of freight transportation services; inventory and use of transportation resources controlled by establishments that are not primarily in the business of for-hire transportation; and fuel consumption and fuel economy based on real-world experience rather than laboratory conditions.

More reliable, comparable, or detailed information is needed on: location, condition, and physical performance of transportation services and facilities provided by the public sector; balance of trade related to transportation services and international travel; characteristics and travel behavior of foreign visitors in the U.S. and of U.S. travelers abroad; business travel; motor vehicle miles of travel by vehicle type; safety (particularly with respect to definitions of terms); and environmental conditions affected by transportation.

Better measures or analytical methods to transform data into useful information are needed on subjects such as: congestion; productivity of the transportation sector; the contribution of transportation activity and infrastructure investments to economic growth, employment, and competitiveness; relationships be-tween environmental quality and the use of vehicles, vessels, and aircraft; and the transportation needs of disadvantaged groups.

BTS is directing its near-term energies toward three areas to improve the effectiveness of transportation statistics and to serve as a foundation for future editions of the *Transportation Statistics Annual Report*. The first area is to complete the Commodity Flow Survey now underway and to initiate a similar survey of passenger travel to determine how many people and how much cargo move between regions of the country, and by what means. The second area is to obtain geographic and other information on transportation facilities and intermodal connections. The third area of BTS activity is reconsideration of basic measures of transportation, such as congestion and productivity, to make sure that transportation statistics relate to concepts that are useful to decisionmakers and the public.

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ACRONYMS/ ABBREVIATIONS

AAR	Association of American Railroads
ADA	Americans with Disabilities Act
AMFA	Alternative Motor Fuels Act of 1988
APTA	American Public Transit Association
ATSF	Atchison, Topeka and Santa Fe Railroad
ATS	American Travel Survey
ATV	Accurate Traffic Volume
AVI	Automated Vehicle Identification
BTS	Bureau of Transportation Statistics
Btu	British Thermal Unit
CAAA	Clean Air Act Amendments of 1990
CD-ROM	Compact Disk-Read Only Memory
CFC	Chlorofluorocarbon
CFS	Commodity Flow Survey
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COE	Corps of Engineers
COFC	Container-on-Flat-Car
CPI	Consumer Price Index
CRLIND	Civil Rail Lines Important to National Defense
CTPP	Census Transportation Planning Package
dBA	Decibel
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DRI	DRI/McGraw-Hill
ECPC	Economic Classification Policy Committee
EDI	Electronic Data Interchange
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act of 1992
EV	Electric Vehicle
FAA	Federal Aviation Administration

FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FRA	Federal Railroad Administration
GBF/DIME	Geographic Base File/Dual Independent Map Encoding
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GNP	Gross National Product
GPS	Global Positioning Systems
HPMS	Highway Performance Monitoring System
ICC	Interstate Commerce Commission
IPD	Implicit Price Deflator
IRI	International Roughness Index
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITAB	Intermodal Transportation Advisory Board
LNG	Liquefied Natural Gas
LOS	Level of Service
LPG	Liquefied Petroleum Gas
LTL	Less-Than-Truckload
M85	85 Percent/15 Percent Unleaded gasoline
MLC	Military Load Classification
mpg	Miles Per Gallon
mph	Miles Per Hour
MSA	Metropolitan Statistical Area
N_20	Nitrous Oxide
NPIAS	National Plan of Integrated Airport Systems
NPTS	Nationwide Personal Transportation Studies
NSDI	National Spatial Data Infrastructure
NTS	National Transportation System
O_3	Ozone
OMB	Office of Management and Budget
PPI	Producer's Price Index
PSR	Present Servicability Rating
RCRA	Resource Conservation Recovery Act
rpm	Revenue Passenger Mile
SIC	Standard Industrial Classification
Smpg	Seat Miles per Gallon
SO_x	Sulfur Oxide
STCC	Standard Transportation Commodity Classification
STOL	Short Take-off and Landing
TDC	U.S. Travel Data Center
TEU	Container Equivalent
TIA	*Transportation in America*
TIUS	Truck Inventory and Use Survey
TL	Truckload
TOFC	Trailer-on-Flat-Car
TP	Total Particulate Matter
TCIC	Technical Committee on Industrial Classification
USTTA	U.S. Travel and Tourism Information Association
VMT	Vehicle Miles Traveled
VNTSC	Volpe National Transportation Systems Center
VOC	Volatile Organic Compounds
VTS	Vessel Traffic Service
WATS	Survey of Motor Freight Transportation and Public Warehousing
WIM	Weigh-in-Motion

PREFACE

The *Transportation Statistics Annual Report* is the keystone publication of the Bureau of Transportation Statistics (BTS). BTS is the newest operating administration of the U.S. Department of Transportation (DOT), and is responsible for compiling, analyzing, and making accessible information on the nation's transportation systems; collecting information on intermodal transportation and other areas as needed; and enhancing the quality and effectiveness of the statistical programs of DOT through research, the development of guidelines, and the promotion of improvements in data acquisition and use.

In this inaugural edition of the *Transportation Statistics Annual Report,* BTS provides information on the many eclectic topics identified by Congress in Section 6006 of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, and suggests future directions for research and data development. BTS endeavors to provide a comprehensive assessment of the nation's transportation system, continuing a tradition that started with the Gallatin Report of 1808. This tradition of comprehensive assessments across all forms of transportation has been practiced only sporadically by the federal government since DOT's creation in 1966.

Discussions of transportation in publications such as the *Transportation Statistics Annual Report* are organized around concepts such as industries, modes, markets, and corridors. These terms are typically used without precise meanings, often leading to misunderstandings and wrong conclusions. Popular concepts and the definitions of professional analysts often diverge; even definitions among various academic disciplines can vary.

For purposes of this report, the *transportation industry* is recognized to be those establishments or parts of establishments that build transportation facilities and equipment; operate transportation facilities; provide for-hire transportation services for individuals, households, businesses, or government agencies; provide in-house transportation for a business or government agency; arrange transportation services for individuals, households, businesses, or government agencies; provide supporting services necessary to the provision of transportation services; or administer transportation programs. This definition includes a diverse cross section of the economy, such as automobile manufacturers, railroads, travel agents, school district bus operators, port authorities, gas stations, and the trucking fleets of major grocery chains. As discussed in several chapters of this report, more restrictive definitions are required for some accounting systems. The broad definition is useful, however, in understanding the pervasiveness of transportation to the nation's economy and way of life.

Transportation planners, analysts, and decisionmakers refer to the means of transportation as *modes*. The transportation community's historic emphasis on individual modes is being supplanted by an emphasis on *intermodalism*, typically used in three contexts. Most narrowly, it refers to containerization, piggyback service, and other technologies that provide the *seamless* movement of goods and people by more than one mode of transport.

More broadly, intermodalism refers to the provision of connections between different modes, such as adequate highways to ports or bus feeder services to rail transit. In its broadest interpretation, intermodalism refers to a holistic view of transportation in which individual modes work together or within their own niches to provide the user with the best choices of service, and in which the consequences on all modes of policies for a single mode are considered. This view has been called *balanced*, *integrated*, or *comprehensive* transportation in the past.

Congress and others frequently use the term intermodalism in its broadest interpretation as a synonym for *multimodal* transportation. Most precisely, multimodal transportation covers all modes without necessarily including a holistic or integrated approach.

BTS accepts the broad interpretation of intermodalism in its philosophy, but prefers the middle ground in its use of the term. The Bureau collects and reports information on multimodal transportation systems, including both individual modes and intermodal combinations.

While BTS embraces an intermodal philosophy, the Bureau does not adhere to the current convention of categorizing the transportation system into *markets*. The markets most typically identified—intercity passenger, intercity freight, international, urban, and rural—have more variation within each category than between categories. For example, international transportation between New York and Montreal has more in common with intercity transportation between New York and Chicago than with intercontinental transportation. Urban transportation is very different between the largest metropolitan areas and small cities. A more effective classification would require a substantially larger number of categories to reflect common sets of supply and demand attributes.

Corridors are a more meaningful concept than the five markets. Corridors come in all sizes, from the North Atlantic corridor between North America and Europe to the Northeast Corridor between Boston and Washington, D.C. to the Route 50 corridor in the Washington suburbs. Corridors are the key units for capturing the geographic and temporal variations that are central to understanding transportation problems. Unfortunately, very little transportation data exist even for multistate corridors. Until the multimodal commodity and passenger flow studies now underway are completed, this report must be limited to national and statewide aggregates.

The range and integration of topics in this first edition of the *Transportation Statistics Annual Report* is a significant accomplishment for an agency that is just one year old; however, the report's authors recognize that this document is a beginning rather than a conclusion. Many topics requiring further analysis and data acquisition are highlighted throughout the volume. A number of improvements, such as the full integration of metric measures into the report and the development of innovative thematic maps, are planned for subsequent editions. BTS encourages the reader to provide comments on this inaugural effort so that future issues of the *Transportation Statistics Annual Report* can be made more useful to both decisionmakers and the transportation community.

TRANSPORTATION *and the* NATION

Transportation activity consumes vast quantities of the nation's wealth and resources, along with the time of its citizens. Because it is always defined as a means to an end rather than as an end in itself, it is difficult to explain what transportation is and why it must be valued highly. Here, we provide a sense of transportation's size and pervasiveness. We also define transportation's role in the economy of the nation and in our daily lives. This overview attempts to answer the basic question: Why do we care about transportation?

Transportation and Society

America is perhaps the world's most mobile society. We have become so because of the vast expanses of our nation, because of the need to move raw materials long distances to processing sites or world markets, and because of that "something" in the American people that continuously suggests movement. Transportation throughout our history has been the main tool of knitting together a nation.

To capture the rich interplay between transportation and the society it serves in statistical terms is an attractive and daunting responsibility. One of the great challenges is to structure measures of transportation productivity in ways that effectively transmit the real value of the "thing produced" by transportation in something other than the most rudimentary measures of tons moved or people carried.

The pleasure of motion is reflected in many social activities of the nation, e.g., recreational bicycling, flying, boating, and traveling scenic byways. Most statistical treatments of transportation, including this one, fail to recognize properly the social and recreational aspects of transportation. A number of years ago a presidential commission studying Americans' outdoor activities identified "taking a ride" as the number one outdoor recreation activity for Americans.[1]

About one-sixth of the expenditures of American households go to transportation goods and services. Americans make nearly a thousand trips per year per person, covering about 15,000 miles annually.

Perhaps a more significant statistic, in a society where time increasingly is becoming a more precious commodity than money, is the fact that they spend at least one hour per day in travel. (See table 1-1.) The average journey to work is 45 minutes round trip on work days. In addition, an extraordinary number of people make their living either using or providing transportation services. It is interesting to speculate at any one moment in the day what proportion of the population is in motion—driving a car, riding in a bus, piloting a plane or riding in one. Whatever the actual number, a substantial part of the population values very highly the services they receive from the transportation system.

TABLE 1–1

Weekly Time in Travel by Trip Purpose for Persons 16 and Older

Trip Purpose	Time Spent (Hours)
To or From Work	1.76
Work-related Business	.16
Shopping	.85
Other Family or Personal Business	1.30
School/Church	.36
Doctor/Dentist	.08
Vacation	.12
Visiting Friends/Relatives	.70
Pleasure Driving	.05
Other Social and Recreational	1.04
Other	.05
Total Time Per Week	6.47

How People Value Transportation

It is a measure of the value that Americans place on mobility that they spend such a large share of their incomes on transportation. In fact, only expenditures for housing exceed that for transportation in the typical household budget. Over time household transportation expenditures have tended to remain at a relatively stable level of about one-sixth of consumer spending, although the long-term trend indicates a declining share of income going to transportation. (See figure 1-1.) “Vehicle Purchases” refers to spending for new and used vehicles; “Other Vehicle Expenses” includes insurance, vehicle repairs, and financing costs; “Gas and Oil” and “Purchased Transportation” refer to vehicle leasing as well as all transportation that is not self-operated, e.g., taxis, urban transit, bus, rail, and air travel. (Note: Some caution must be exercised in reviewing a single year’s data.)

History has shown that transportation expenditures—especially vehicle purchases—can be quite volatile from year to year. The long-term trend in most elements is for transportation to consume a smaller share of total household expenditures. Of significance was the continuing decline in the share of total spending represented by gasoline expenditures. The percentage of household expenditures devoted to gasoline and oil in 1991 was almost precisely half what it was in 1980.

Despite indications that the share of household income spent on transportation is on the decline, it is nevertheless true that society still places high value in mobility. This view is supported by the fact that the percentage of spending going to transport tends to rise with increasing incomes, only declining in share of spending for the highest income groups. This fact suggests that as their discretionary income rises the public chooses to

FIGURE 1–1

Total Consumer Spending Shares by Major Category: 1991

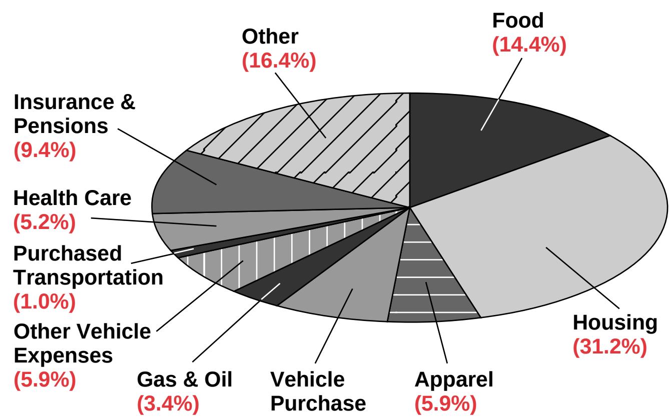


FIGURE 1 – 2

Transportation Purchases By Income Quintiles 1991

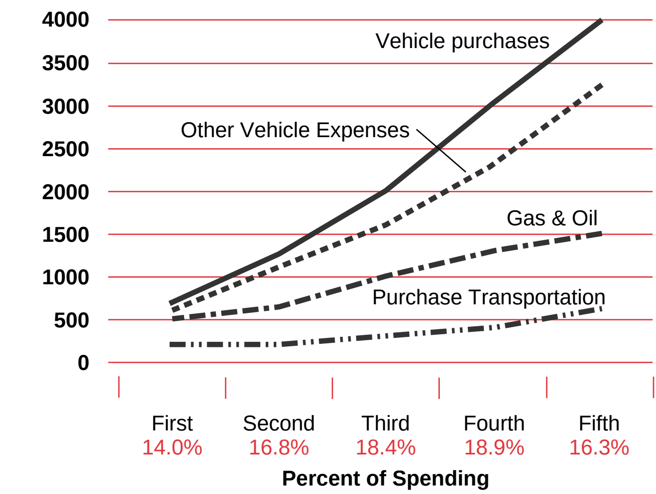
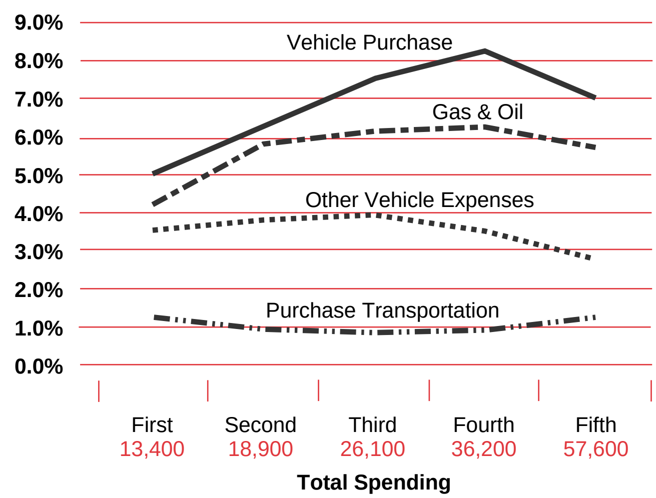


FIGURE 1 – 3

Percent of Purchases for Transportation By Income Quintiles 1991



use much of it for transportation purposes. Of course, the amount of spending also increases, rising from about $1900 per year for the lowest incomes to almost $9500 for the highest, approaching twice the national average figure of $5200, according to the Consumer Expenditure Survey of the Bureau of Labor Statistics.

If the nation's households are divided into five groups, or quintiles, and the transportation spending of each group is evaluated, one can learn a great deal about spending behavior. (See figures 1-2 and 1-3.) As expected, vehicle purchases and repairs increase as incomes do; gas and oil expenses rise too, but at a much slower pace. Also, purchased transportation expenditures rise only moderately until spending for air travel begins to have an effect. An examination of spending as a percentage of income terms clearly indicates that shares of spending rise and then fall with incomes except for purchased transportation.

Examining consumer transportation spending in detail reveals that roughly 93 percent of all spending is related to the acquisition, operation and upkeep of motor vehicles. The remainder goes to purchased intercity travel, which accounts for about 5 percent of transportation spending; local transit, which amounts to about 1 percent; and miscellaneous purchases and rentals, which also amount to about 1 percent. (See figure 1-4.) Changes in the distribution across income groups are not substantial, with lower income groups spending proportionately less on intercity travel and vehicles purchases, and proportionately more on gasoline.

When these data are distributed across national regions, a few surprises emerge. (See figure 1-5.) As expected, gasoline purchases are higher in the South and the West due to greater auto availability and use. The data for vehicle purchases and expenses are modified by the West's characteristics, which include lower spending on new cars, more spending on leasing, and greater costs for insurance, registrations,

FIGURE 1 – 4

Detailed Consumer Spending For Transportation: 1991

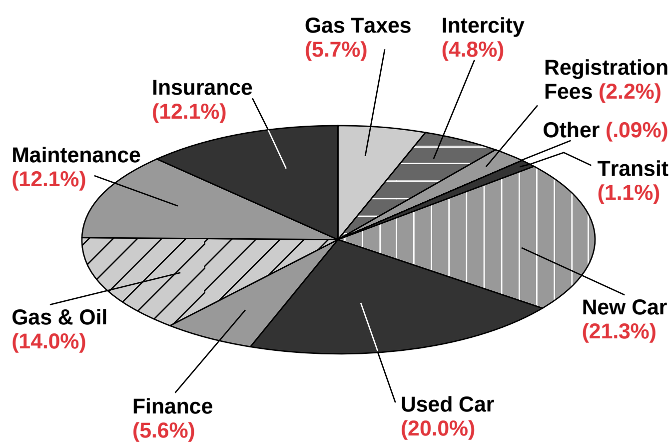
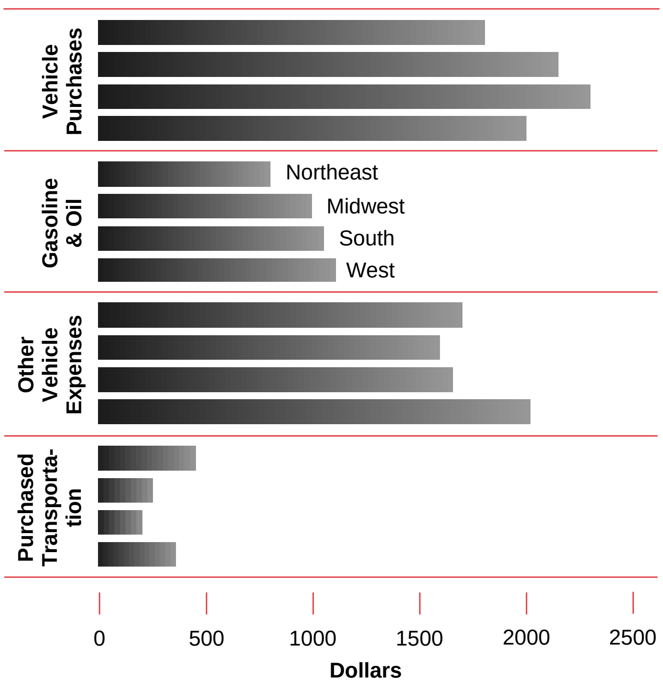


FIGURE 1–5

Transportation Spending By Type of Spending By Region: 1991



and fees. The behavior of the "Purchased Transportation" category is revealing. The East is higher because of greater transit spending; while the West is higher because of greater air travel expenditures.

Transportation and the National Economy

The relationship between transportation and the economy can be viewed in a number of ways. If official economic statistics are consulted (these statistics apply the formal industry-based definition of transportation employed in the national product accounts) transportation as explicitly defined is almost a minor facet of the economy, accounting for less than 4 percent of the Gross National Product (GNP) (3.67 percent in 1980 and 3.78 percent in 1990). This definition of transportation focuses exclusively on those industries that provide transport services for hire, i.e., common carriers of freight and passengers. It excludes vast components of what we normally mean by transportation in America (e.g., automotive vehicle manufacturing and services), which would add almost 2 percent to transportation's share of the GNP. If a transportation construct is assembled to approximate all transportation activities, either from the production or consumption side, an *industry* can be defined that aggregates 12-13 percent of GNP.

Among the future challenges for transportation statistics is the delineation of a rigorous and viable definition of transportation consistent with the National Income and Product Accounts.[2] This may require special studies to disaggregate elements of the accounts or the creation of *shadow accounts* that re-aggregate existing data in new ways.

There are other ways to describe transportation's scale relative to the economy and they will be traced in subsequent sections of this report. One way is to identify the total capital stock of transportation investments and trace the scale and condition of that stock. This has been done only on a piecemeal basis in the past, but it will become a fundamental element of an ongoing statistical system. For instance, the U.S. road vehicle fleet—which consists of cars, trucks and buses—approaches 200 million vehicles; however, its value is unknown, and can only be estimated in

GNP Versus GDP

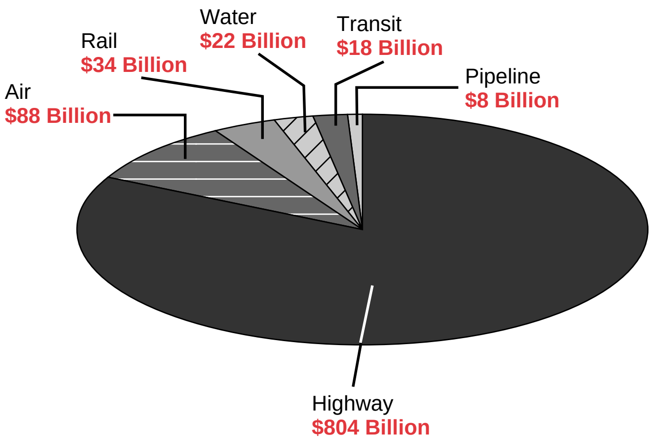
Gross National Product (GNP) is a commonly used, traditional measure of total output of goods and services for a country. GNP includes output attributable to all labor and property supplied by the country's residents.

Gross Domestic Product (GDP) has been used by the Bureau of Economic Analysis since December, 1991, as the preferred measure of total output. GDP is the total output produced by labor and property within the country's borders, valued at market prices, and conforms to United Nations guidelines for monitoring and analysis of national economies.

GNP equals GDP plus the value of production by U.S. labor and property abroad, less the value of production by foreign labor in the U.S. GDP for the U.S. in 1991 was $5,677.5 billion, while GNP was $5,694.9 billion. The $17 billion difference is less than one-third of 1 percent of the $5.7 trillion U.S. economy.

FIGURE 1–6

National Transportation Expenditures, Freight & Passenger: 1991

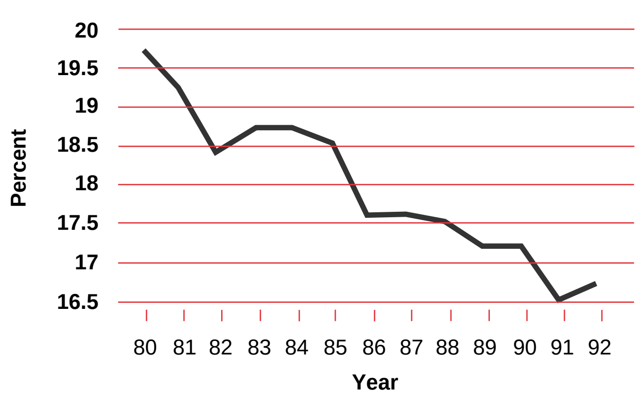


the coarsest fashion. At $10,000 per vehicle, the volume reaches $2 trillion.

If total transportation-related transactions or spending are considered as a measure of economic activity for transportation, then a total figure is obtained for 1992 that for the first time reached a level above $1 trillion.[3] Although this figure is not consistent with Gross Domestic Product (GDP) definitions, it can be useful in tracking total spending related to transportation. When described in a ratio to GNP it amounts to a value in the range of 17 percent of the GNP. When that ratio is disaggregated into its modal elements, highway-related spending accounts for the lion's share. (See figure 1-6.) As a rough rule of thumb, highway-related spending accounts for about 80 percent of transportation spending and aviation about 10 percent; everything else sums to the remaining 10 percent.

FIGURE 1–7

Transport Spending/GNP Ratio: 1980–1992

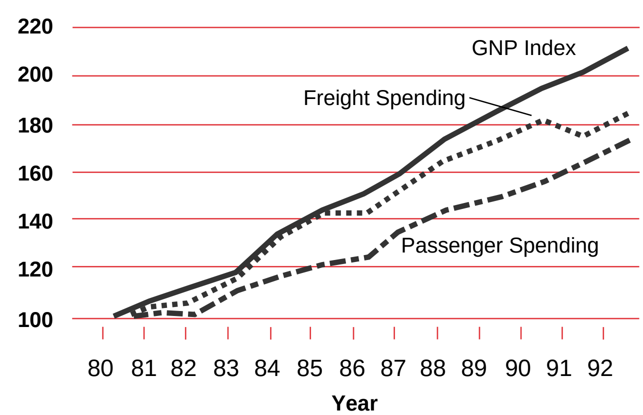


Although the dollars spent on transportation are higher than ever, when the long-term trend in these values is examined it becomes clear that the transport share has been declining relative to GNP since at least 1980. (See figure 1-7.) For most of the 1960s and the 1970s, the transportation spending/GNP ratio was higher than 20 percent.

An examination of the nature of the decline indicates that both passenger and freight spending—most notably freight spending—have declined relative to total GNP. (See figure 1-8.) This relative decline in freight share might possibly be attributed to the shift of the economy toward services, the increased reliance on imports for manufactured goods, the relative downsizing of products in the economy, and improvements in freight transport productivity after deregulation. Less complex explanations are also possible.

FIGURE 1–8

National Transportation Spending Trend: 1980–1992

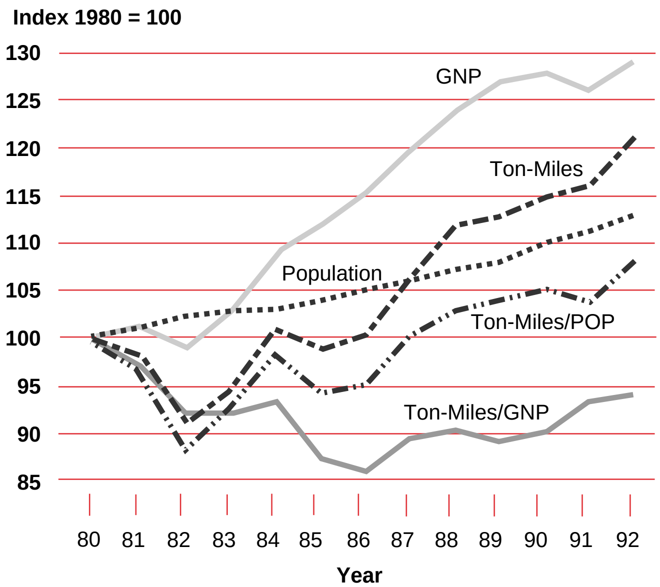


For example, because petroleum movements represent such a large share of freight transport, improvements in overall fuel efficiency or shifts in petroleum sources could substantially shift total patterns. Further analysis of the data would help shed some light on this question.

Examination of freight transportation trends provides further information: It appears that ton-miles per capita have shown some growth since the sharp decline in the 1982 recession.(See figure 1-9.)

FIGURE 1–9

Freight Transportation Trends: 1980–1992

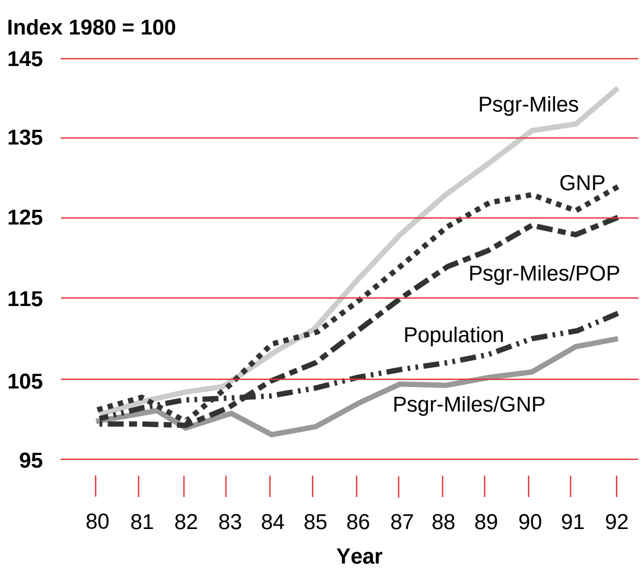


However, ton-miles per unit of GNP has remained below 1980 levels, indicating that actual number of ton-miles required to produce a unit of GNP has declined.

On the other hand, passenger mile trends indicate that on both a per-capita and a per-unit-GNP basis, passenger miles of travel increased in the 1980s. (See figure 1-10.) In fact, the passenger share of the total transport bill has grown substantially in recent years. (See figure 1-11.) It must be noted, however, that the data on which this statement is based represent intercity passenger miles only.[4]

FIGURE 1–10

Passenger Transportation Trends: 1980–1992

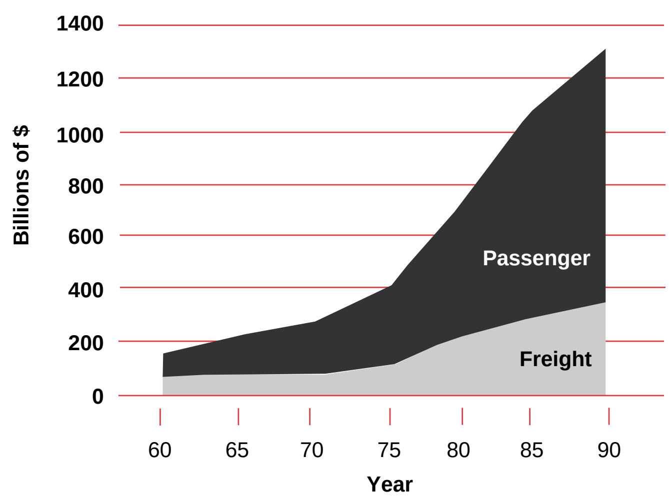


Transportation and Gross Domestic Product

Gross Domestic Product (GDP) is a measure of the total value of goods and services produced for final demand within the United States during a specified period of time, most often a year. One way to arrive at this measure is to sum the final demands for output of consumers, business firms, governments, and foreign entities. The concept of GDP emphasizes final demand, net of intermediate goods and services. These latter goods and services include business purchases of freight transportation and passenger transportation for employees, because these are inputs to the production of business firms' products.

FIGURE 1–11

National Transportation Spending Passenger vs. Freight: 1960–1990



It is traditional to view personal consumption expenditures, gross private domestic investment, government purchases of goods and services, and net exports of goods and services as the GDP major components. Adopting this convention, we can try to distinguish the portions of each of these components that are related to transportation activity.

The sum of personal expenditures on transportation, business investment in transportation equipment and transportation companies' investment in plant and equipment, government purchases of transportation-related goods and services, and net exports of transport goods and services grew to $728 billion in 1992. (See table 1-2.) This transportation expenditure comprises a fairly steady proportion of GDP measured in current dollars over the last four years: about 12 percent. A comparison of transportation-related GDP in constant dollars to total GDP, also indicates that transportation appears to comprise about 12 percent of the nation's real output over this period. (See table 1-3.)

There are convincing reasons to believe that transportation activity is undervalued in these types of comparisons. (Tables 1-2 and 1-3.) Time has not permitted detailed investigation of the U.S. Department of Commerce National Income and Product Accounts beyond published tables. Consequently, certain categories of transportation-related activity have been left out. These include government purchases of transportation equipment (as opposed to labor and construction output), consumer spending on

TABLE 1–2

Gross Domestic Product Attributable to Transportation Demand
(In Billions of Current Dollars)

	1989	1990	1991	1992
Personal Consumption of Transportation	437.3	453.9	434.6	463.1
User-operated transportation	399.6	414.0	395.5	423.9
Purchased local transportation	8.1	8.9	9.1	9.2
Purchased intercity transportation	29.5	30.9	30.0	30.0
Gross Private Domestic Investment in Transportation	156.1	173.5	173.1	185.4
Purchases of structures by transportation-related organizations	3.0	3.0	3.2	4.0
Private purchases of producers' transportation equipment	153.1	170.5	169.9	181.4
Net Exports of Goods and Services	–33.1	–25.5	–15.2	–13.2
Exports	72.1	84.0	92.3	102.2
Civilian aircraft, engines and parts	26.6	32.2	36.4	37.7
Automotive vehicles, engines and parts	34.9	36.5	40.0	47.1
Passenger fares	10.6	15.3	15.9	17.4
Imports	105.2	109.5	107.4	115.0
Civilian aircraft, engines and parts	9.6	10.5	11.7	12.6
Automotive vehicles, engines and parts	87.4	88.5	85.7	91.8
Passenger fares	8.2	10.5	10.0	10.9
Government Purchases	73.5	78.8	84.2	92.8
Federal Government Transportation-related Purchases	9.6	10.4	11.8	12.7
State and Local Government Transportation-related Purchases	63.8	68.4	72.3	80.1
Gross Domestic Product Attributable to Transportation Activity	633.7	680.7	676.7	728.1
Gross Domestic Product	5,281.0	5,546.0	5,723.0	6,039.0
Transportation Share of Gross Domestic Product	12.0%	12.3%	11.8%	12.1%

TABLE 1–3

Gross Domestic Product in Constant Dollars Attributable to Transportation Demand (In Billions of 1987 Dollars)

	1989	1990	1991	1992
Personal Consumption of Transportation	407.5	403.1	373.6	389.0
User-operated transportation	373.8	369.1	340.2	356.2
Purchased local transportation	7.6	7.9	7.6	7.3
Purchased intercity transportation	26.0	26.2	25.8	25.4
Gross Private Domestic Investment in Transportation	148.0	159.8	152.3	158.9
Purchases of structures by transportation-related organizations	2.8	2.8	2.8	3.5
Private purchases of producers' transportation equipment	145.2	157.0	149.5	155.4
Net Exports of Goods and Services	–28.6	–23.4	–13.1	–11.5
Exports	68.8	76.7	81.7	88.5
Civilian aircraft, engines and parts	25.5	28.6	31.0	30.9
Automotive vehicles, engines and parts	33.4	34.1	36.4	41.9
Passenger fares	9.9	14.0	14.3	15.7
Imports	97.4	100.2	94.9	100.0
Civilian aircraft, engines and parts	9.0	9.3	10.0	10.3
Automotive vehicles, engines and parts	80.7	81.4	75.8	79.7
Passenger fares	7.7	9.5	9.1	10.0
Government Purchases	67.7	69.7	72.1	77.6
Federal Government Transportation-related Purchases	9.0	9.3	10.1	10.5
State and Local Government Transportation-related Purchases	58.8	60.4	62.0	67.1
Gross Domestic Product Attributable to Transportation Activity	594.6	609.2	584.8	614.0
Gross Domestic Product in Constant Dollars	4,838.0	4,897.0	4,861.0	4,986.0
Transportation Share of Gross Domestic Product	12.3%	12.4%	12.0%	12.3%

postal and delivery services, and international visitor spending on transportation within the U.S. and similar U.S. spending within foreign countries, international freight transportation receipts and payments, and related insurance and fuel. Other relevant items may have also been excluded. It is hoped that research effort will be devoted to filling in these gaps to provide a more accurate description of transportation's contribution to GDP.

There is a larger sense in which these figures fail to indicate transportation's proper role in our economy. We, as consumers, business operators, and government officials, depend on transportation to provide access to most of what we need to function. Virtually all of the goods and services we consume as final demand or use as inputs in our productive processes are either delivered by transport services or secured through our own travel. In short, we all have a stake in improving our understanding of how transportation facilitates so much of the economic activities on which we have come to depend.

Transportation and Employment

Transportation employment, not surprisingly, follows the economic trends described earlier. Using the expansive *Transportation in America* (TIA) definition[5] as the basis of determining transportation employment, total transportation employment in 1990 amounted to slightly more than 10 percent of all national employment, or roughly 12 million out of the 118 million employed Americans. (See figure 1-12.) Just like the trend in shares of GNP, the employment share of transportation has declined in recent years, from about 13.5 percent of all employment in 1960 to its present share. Yet, total employment in the industry increased by about 35 percent from a base of 8.9 million in 1960, as total output measured as passenger-miles and ton-miles more than doubled. This growth in transport employment is contrasted to average growth of all employment (i.e., 78 percent) in the same period. The growth in jobs that occurred between 1960 and 1990 came predominantly in the industries *related to* transportation, typically automotive services wholesaling and retailing, but there was also some increase in delivery and freight handling personnel.[6]

The transportation service sector, which consists of carriers of freight and passengers, grew only slightly in the period, adding about 600,000 employees over 30 years. But, that net change masked dramatic shifts. For instance, in that period rail services lost more than 600,000 employees while trucking gained 700,000. Air transport services also gained more than 500,000 employees, an increase of over 300 percent.

The transport equipment manufacturing sector exhibited limited growth, increasing slightly in the period. All component activities of the sector, e.g., aircraft manufacturing, motor vehicles, and shipbuilding, exhibited parallel weak growth trends. All other sectors, including government, have declined in share over the 1960–1990 period with the exception of the transport-related sector which expanded to a majority of transport employment. (See figure 1-13.) In recent times, 1990 was the peak period for total employment in the transport sector, reaching 12.3 million. By 1992, however, total employment had slipped to just below 12 million.

The occupational mix of those with specialized transport skills is significant. Of the 8.6 million persons identified in 1990 as transport specialists, almost 2.7 million were truck drivers. Another 1.4 million were automotive mechanics and body repair specialists, and almost .5 million were bus operators.

If the narrower definition of transport is used—comparable to that applied in the GNP statistics—transport employment amounted to 3.1 million in 178,000 establishments.[7] This is according to the *1990 County Business Patterns* reports of the U.S. Bureau of the Census.[8]

Examination of the *County Business Patterns* reports on the distribution of jobs among these establishments—with their accompanying levels of employment and payroll—by the separate modal elements of the industry indicates that almost 60 percent of employment is in the area of trucking and warehousing. (See table 1-4.) However, these data are based on firms that participate in unemployment security programs; therefore, certain types of entities are excluded (most notably railroads, which have a separate system, as well as employees on oceangoing vessels and the

FIGURE 1–12

Transportation Employment Trend: 1960–1990

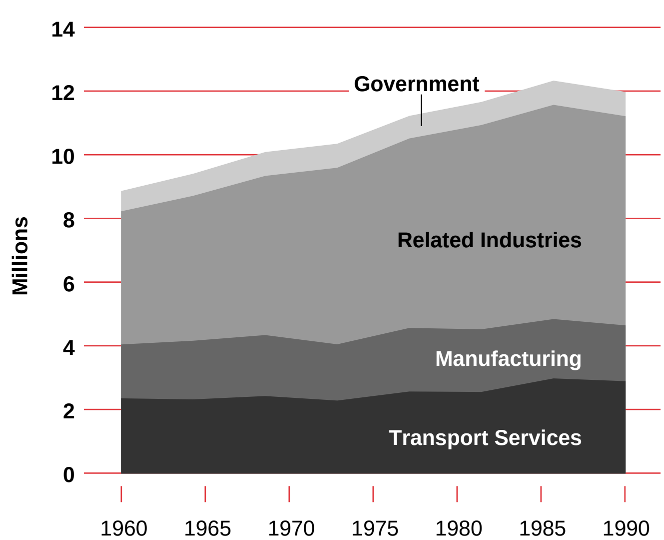
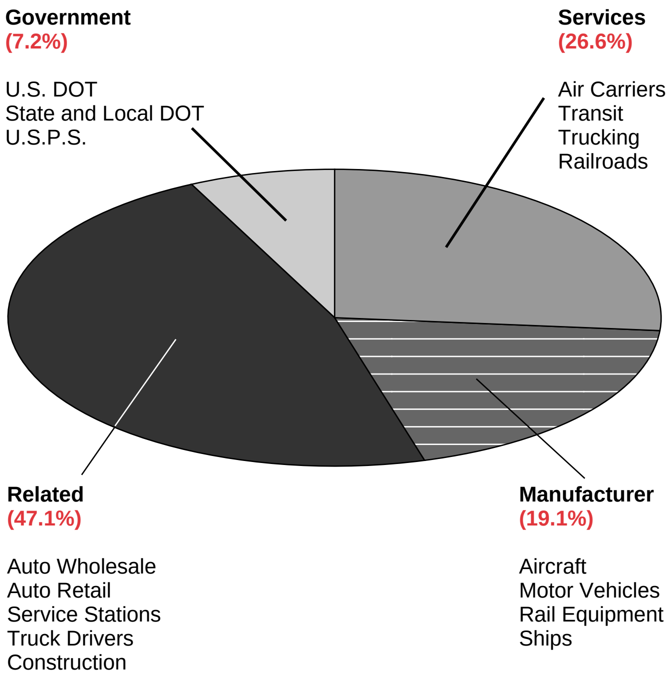
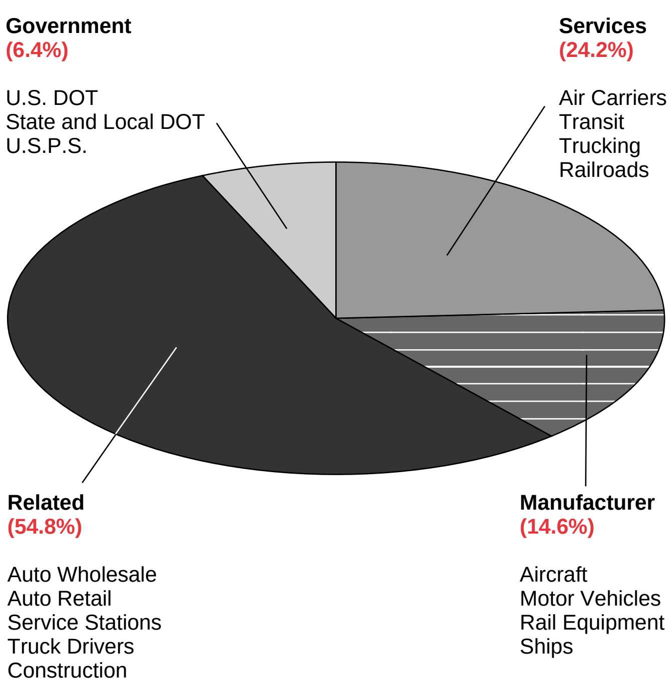


FIGURE 1–13

Transport Employment Industry Shares: 1960



Transport Employment Industry Shares: 1990



self-employed). In 1992, the railroad industry reported 197,000 employees in the 12 Class I railroad organizations with a payroll of nearly $9 billion.[9] Total employment in all railroads in 1992 was estimated at 275,000. Both total and Class I rail employment have shown dramatic decreases over the years.[10]

Despite incomplete coverage, the *County Business Patterns* reports are useful because they provide a highly detailed annual data source that permits an assessment of employment by area by industry by size of establishment. The 1990 reports show the distribution of covered transport employment by Standard Industrial Classification by size of establishment. (See figure 1-14.) The reports indicate that the transportation field contains large numbers of organizations and employees in every size category. The services industry, which includes freight forwarders, travel agents, and tour operators, is the most concentrated at the small end of the employment distribution while the airline industry seems to be the most concentrated in the more-than-1000-employees category. Trucking appears to be the industry most uniformly distributed across all size categories with substantial numbers of employees in all groupings.

The Domestic Impact of International Travel

Forecasted expenditures by international visitors in 1994 on U.S. air carriers and while in the country will substantially exceed the $71 billion in receipts from visitors in 1992, and double the 1988 figures. This amount, the highest level of travel receipts by any country, more than offsets the deficit impact on our balance of payments of the $51 billion spent by Americans outside the country in 1992, also the highest amount of tourism spending by any country. Thus foreign tourism made a $20 billion contribution to balance of payments. Recent data systems changes make confirmation and refinement of these data crucial to future understanding of balance of payments impacts of tourism.

Foreign visitors to the U.S. historically have applied about 15 percent of their

TABLE 1–4

Employment by Transport Industry Sector: 1990

Industry Sector Standard Industrial Classification (SIC)		Number of Establishments	Number of Employees	Total Annual Payroll (In Millions of Dollars)
SIC 41	Transit	15,126	329,040	$ 4,665
SIC 42	Trucking & Warehousing	103,269	1,574,833	38,501
SIC 44	Water Transportation	7,088	158,031	4,810
SIC 45	Air Transportation	9,631	674,058	21,393
SIC 46	Pipelines	660	15,310	644
SIC 47	Transport Services	42,520	370,094	8,183
TOTAL		178,294	3,121,366	$78,196

travel expenses to transportation, indicating about a $10 billion domestic market. According to past U.S. Travel and Tourism Information Administration surveys, about half of all overseas visitors use domestic air travel during their stay, 6 percent use Amtrak, 18 percent intercity bus, and 36 percent rental cars. Also, almost 36 percent use the autos of friends and relatives while here. The likelihood of using different modes varies by visitor nationality and trip purpose. Those visiting for business purposes—about 46 percent of all visitors—use air and car rental more extensively than other travelers. Vacationers, students, and those visiting friends and relatives are more likely to use bus, rail and private cars. Almost two-thirds of Canadian arrivals are by personal auto.[11]

The effects of foreign travel on the balance of payments have two components: the balance of expenditures on the ground in the countries visited and the travel payments balance. The ground expenditures balance varies primarily by changes in the ratio of foreign visitors to citizens departing, while the travel payments balance is more a function of consumer preferences for certain carriers independent of nationality. In the past, the U.S. balance with other nations generally suffered because foreign citizens tended to use their national carriers more than did U.S. citizens. In the late 1980s, however, this began to change, and in 1987 this situation was nearly in balance; the deficit had been reduced to a few hundred million dollars, representing a dramatic improvement of the typical deficits in the range of $1 to $3 billion in the early 1980s. In 1992, travel receipts from foreign visitors exceeded payments by U.S. citizens to foreign carriers by almost $6 billion. This radical change is the result of sharp improvements in the market penetration of U.S. flag carriers with both U.S. citizens and foreigners.[12]

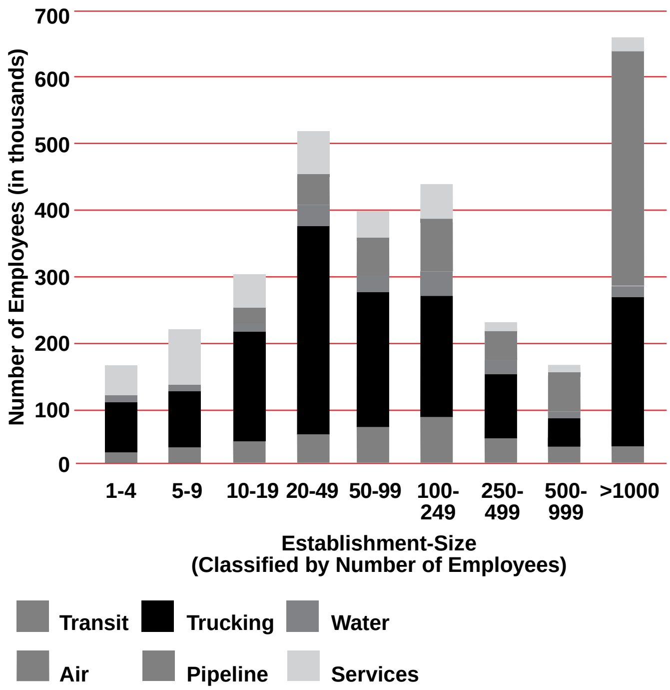
The ground expenditures balance remained at about $2.5 billion in 1988, but by 1989 it had crossed over and receipts exceeded payments. By 1992 the surplus amounted to more than $12 billion.

Transportation and the Nation: What More We Need to Know

Several conceptual problems, as well as detailed statistical issues, need to be resolved in regard to transportation's relationship to the society and the economy. There are answers needed for a better understanding of the role transportation provides in a society where the mobility of persons and goods is highly valued. This is more than amply demonstrated by the amount of time and money expended on it willingly by citizen, government, and business. But, there is no statistical underpinning to this inference. The product of transport, and what it does for society, has not been adequately described in terms that permit effective measures of productivity. Especially in an era in which trade-offs are critical between transport mobility and other values such as air quality and

FIGURE 1-14

Transportation Employment by Employment-Size Class



energy conservation, it is crucial to know what value to place on mobility.

More specifically, the need to link transportation into the national economic accounts, in a way that permits a full understanding of transportation, is a crucial part of the Bureau of Transportation Statistics' (BTS) program for the future. This will entail the delineation of a rigorous and viable definition of transportation consistent with the National Income and Products Accounts, and the restructuring of the Standard Industrial Classification system to be consistent with that redefinition. Development of these capabilities may require special studies to disaggregate elements of the existing accounts or the creation of *shadow accounts* that reaggregate existing data in new ways. Analyses of the relationship of freight trends to the GDP and determination of the relative contribution of the many factors involved in the decline in ton-miles per GDP could pay huge dividends in understanding the role of transportation in the current economy and in forecasting future trends.

Productivity measurement lags in transportation even in the simplest forms; labor-hours data are difficult to obtain as are adequately detailed ton and ton-mile estimates. Passenger-mile measures in air and rail seem to be better organized. But, the decline in the bus statistics needed to permit a continued series on bus productivity is an example of the government's limited capability. The ability to take into account changes in value of goods moved so that a *value-miles* concept can be incorporated in productivity calculations will be a crucial future step.

Sources

Figures

Figures 1-1through 1-5: Consumer Expenditure Survey.

Figures 1-6 through 1-13: *Transportation in America*. Lansdowne, VA: Eno Transportation Foundation, Inc., 1993.

Figure 1-14; U.S. Bureau of the Census, *County Business Patterns, 1990*, U.S. Report CBP-90-1 (Jan 1993) GPO.

Tables

Table 1-1: *National Personal Transportation Survey, 1990*. Note: Times are averaged over all persons, including workers and non-workers.

Table 1-2: Personal Consumption: U.S. Department of Commerce, *Survey of Current Business*, August 1993, Table 2.4, p. 64; Gross Private Domestic Investment: U.S. Department of Commerce, *Survey of Current Business*, August 1993, Table 5.4 and 5.6, p. 82 and 83; Net Exports of Goods and Services: U.S. Department of Commerce, *Survey of Current Business*, August 1993, Table 4.3, p.7 and September 1993, Table 2, p. 122; Government Purchases: U.S. Department of Commerce, *Survey of Current Business*, September 1993, Table 3.16 and 3.17, pp. 33 and 34.

Table 1-3: Personal Consumption: U.S. *Department of Commerce, Survey of Current Business*, August 1993, Table 2.5, p. 65; Gross Private Domestic Investment: U.S. Department of Commerce, *Survey of Current Business*, August 1993, Table 5.5 and 5.7, pp. 82 and 83; Net Exports of Goods and Services: U.S. Department of Commerce, *Survey of Current Business*, August 1993,

Table 4.4, p. 79 and September 1993, Table 2, p. 122. (Source data adjusted by federal nondefense and state and local implicit price deflators.) Government Purchases: U.S. Department of Commerce, *Survey of Current Business*, September 1993, Table 3.16, p. 33.

Table 1-4 :U.S. Bureau of the Census, *County Business Patterns, 1990*, U.S. Report CBP-90-1 (Jan 1993) Government Printing Office.

Endnotes

1. Final report of the National Commission on Americans Outdoors, 1989.
2. The National Income and Product Accounts (NIPA) summarize the entire income, output, and interactions of the U.S. economy. NIPA is essentially a double-entry bookkeeping system that tracks the economy as if it were a large company. NIPA measures the volume, composition, and use of U.S. output in dollars, and is used to monitor both long term trends and current fluctuations in the economy. NIPA includes over 130 tables and about 5,100 line items. NIPA information is published by the Bureau of Economic Statistics in various issues of the *Survey of Current Business* and in *An Introduction to National Income Accounting* (NTIS, PB 85-247567, 1985).
3. This concept, known as the *Transportation Bill*, compiles all spending for transportation in both passenger travel and freight. It has proven useful because of its direct statistical links to the individual industries that comprise transportation. For instance, it includes spending for trucking and business use of autos by industries that would otherwise be counted in the individual industry. This concept, developed by the Transportation Industry Association in its series titled *Transportation Facts and Trends*, is now maintained by the Eno Transportation Foundation in its report series, *Transportation in America*. This series has been in continuous production for more than 25 years under the guidance of Mr. Frank Smith.
4. Passenger-miles of travel and ton-miles are the traditional measure of transportation output: the movement of a person or a ton of freight for 1 mile. These measures are calculated by multiplying the number of people or weight of cargo times the length of trip.
5. Transportation employment can be defined narrowly as the employees of establishments primarily engaged in for-hire transportation or operation of transportation facilities, or broadly as the employees of establishments that provide for-hire transportation, that produce transportation equipment, and that provide supporting retail services such as gas stations. The narrower definition is used in the Standard Industrial Classification (SIC) system. Employment statistics in this chapter are based on *Transportation in America,* which uses the broader definition.
6. Truck drivers appear here and in the services sector as well. Truck drivers in this sector are typically working for a firm that moves its own products. Those in services are truckers for hire to haul the goods of other people.
7. As in the case of transportation employment, the transportation industry for GNP and GDP estimates is limited to the SIC definition rather than the broader view of *Transportation in America*.
8. U.S. Bureau of the Census *County Business Patterns, 1990*, U.S. Report CBP-90-1 (Jan 1993), GPO.
9. Railroad class distinctions are determined by the Interstate Commerce Commission. *See* chapter two in this report for additional information.
10. *Railroad Facts*: 1993 Edition. Association of Railroads, 1993.
11. U.S. Travel and Tourism Administration, *Impacts of Foreign Travel on U.S. Industries,* series published 1988-1989.
12. U.S. Travel and Tourism Administration, *International Travel to and from the United States: 1994 Outlook*, October 1993.

The TRANSPORTATION NETWORK

Millions of motor vehicles, vessels, and aircraft operating on a variety of networks comprise the nation's transportation systems. These systems range in geographic extent from the near ubiquity of highways to the very constrained reaches of navigable waterways. The vehicles, facilities, operators, and other components of these systems vary in number, age, condition, and other factors that affect the cost and effectiveness of transportation to shippers and the traveling public. The extent of public knowledge also varies among systems from a complete inventory of aircraft and airports to the scattered and incomplete data on school buses.

Transportation Inventory and Condition

The transportation inventory consists of a number of elements for each form of transportation: *facilities,* such as highways and waterways; *vehicles and equipment,* such as rail cars and aircraft; and *operators,* such as pilots and drivers. All these elements, plus such supporting activities as maintenance and administration, are needed to produce transportation services.

Individuals can produce transport services as they pilot their own aircraft or drive their own automobiles. They can also obtain services from transportation businesses that supply rail, motor carrier, freight forwarder, warehousing, and a great variety of other transportation services on a for-hire basis to business and individual users. Similarly, businesses that are not primarily in the transport field employ the elements of transportation to obtain transportation services for their own consumption and in fact, these private transportation services are sometimes also sold to others on a for-hire basis.

The inventory of vehicles, labor, and other resources needed to provide all the transport services consumed within the United States and sold to other countries is immense. Most are readily categorized into one of six modes of transportation: highway, air, rail, urban and rural transit, water, or pipeline. Others are intermodal. (See table 2-1.)

Highway Transportation

In the United States, highways provide the most pervasive form or mode of transportation. This mode encompasses: (1) vehicles—automobiles, motorcycles, bicycles, trucks, truck-tractors and trailers, and buses; (2) drivers—both employed drivers and individuals who drive their own vehicles—plus other highway-related workers; and (3) the highway infrastructure—roads, streets and highways, together with their associated bridges, traffic control devices, and other facilities.

TABLE 2–1

Principal Transportation Modes

Mode	Major Defining Elements
Highways	Public roads and streets; automobiles, vans, trucks, motorcycles, and buses (except local transit buses) operated by transportation companies, other businesses, governments, and households; garages, truck terminals, and other facilities for motor vehicles.
Air	Airways and airports; airplanes, helicopters, and other flying craft for carrying passengers and cargo.
Rail	Freight railroads and Amtrak.
Transit	Commuter trains, heavy-rail (rapid rail) and light-rail (streetcar) transit systems, local transit buses, taxis
Water	Navigable rivers, canals, the Great Lakes, St. Lawrence Seaway, Intercoastal Waterway, ocean shipping channels; ports; commercial ships and barges, fishing vessels, and recreational boating.
Pipeline	Crude oil, petroleum product, and gas trunk lines.

The Highway Inventory

The country has an extensive network of some 3.9 million miles of roads and streets.[1] These highway facilities are owned, operated, and maintained by governments at every level—federal, state, and local—and even in some cases by private entities. This report describes only the public road inventory, because data are lacking on facilities under private control.[2]

Some 3.1 million miles of the total highway inventory, or about 81 percent, are in rural areas. The rest of the network, 19 percent—or about 740,000 miles—is located in urban areas.[3]

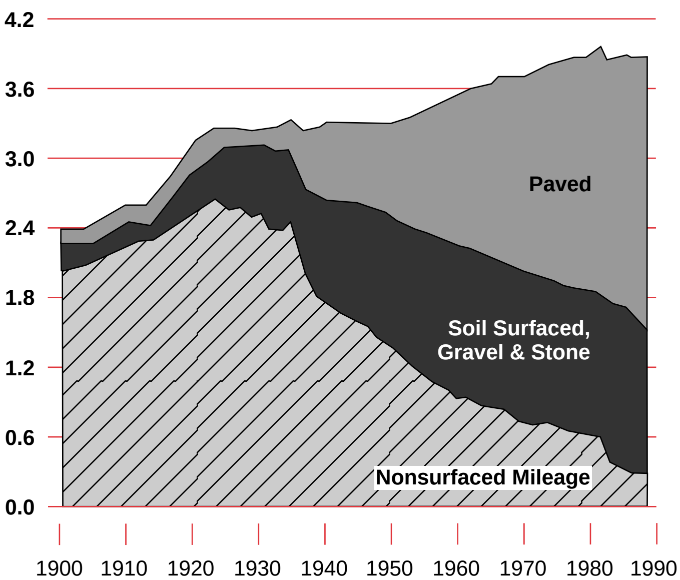
Although the road network is extensive and pervasive, when measured in terms of roads in relation to area, the U.S. ranks low compared to such developed countries as France, Great Britain, and Japan—each of which has at least twice as many kilometers of road per unit area of land as exist in the U.S. However, if road expanse is viewed in relation to population, those countries have relatively less road than does the U.S., with its lower population densities and tremendous continental expanse. The French, for example, with about 100 persons per square kilometer of land, have 1.5 kilometer of road per square kilometers of area; the U.S. has about 20 persons per square kilometer and about 0.7 kilometers of road—less than half of France's roads for every unit of land area, but with only one-fifth the population density.[4] The higher ratio of roads to population in the U.S. reflects a need to connect the country's more widely dispersed communities and economic activity. Moreover, this means that as there are more roads per person, there is a higher per-person cost for maintaining roads in the U.S. than the residents of other countries.

The size of the U.S. highway system has been relatively static for many years, but the proportion of the system consisting of roads with higher service levels has increased.(See figure 2-1.)[5] Far more miles of road are hard-surfaced today than in past years, and the system contains a greater proportion of multiple-lane facilities serving higher volumes of traffic.[6] The number of bridges on public-use roads (bridges are defined as structures more than 20 feet long, totaling some 575,000 in 1991)[7] has changed little over the years.[8]

Highway Functions. U.S. highways are classified according to the function they are intended to perform. There are three key functional systems: arterials,

FIGURE 2-1

Total Road And Street Mileage in the United States by Type of Surface: 1900–1989



collectors, and local roads.[9] The functional road systems relate to the trip purposes of the traffic they are designed to serve, such as local land access traffic for local roads and streets, and higher-speed, higher-volume, and often longer-distance traffic for arterials. The U.S. inventory of Interstate highways, a 43,500 mile network, includes many of the nation's highest-function arterials.(See figure 2-2.) The Interstate System, authorized by Congress in 1956, was designed to connect major population centers throughout the United States.

National Highway System. In December 1993, Secretary of Transportation Federico Peña recommended a National Highway System (NHS) of arterial facilities to Congress.[10] NHS is to include all Interstate highways and will approximate 157,000 miles of facilities. Other nationally recognized systems of highways exist as well, such as the National Network for Trucks, (consisting of some 211,000 miles or 5.4 percent of all U.S. public road mileage),[11] for the operation of larger truck-tractor combination vehicles.[12]

Highway Jurisdictions. Although the federal government plays important roles in funding and managing the U.S. highway system, state and local governments control almost all the roads and bridges in the United States. Local governments have jurisdiction over about 74 percent of the system (2.9 million miles), while the states own and maintain 21 percent (800,000 miles).[13] Only about 6 percent of the mileage is under the direct jurisdiction of the federal government (consisting of facilities open to public use on federal lands, such as national parks and monuments).

The Highway Vehicle Inventory

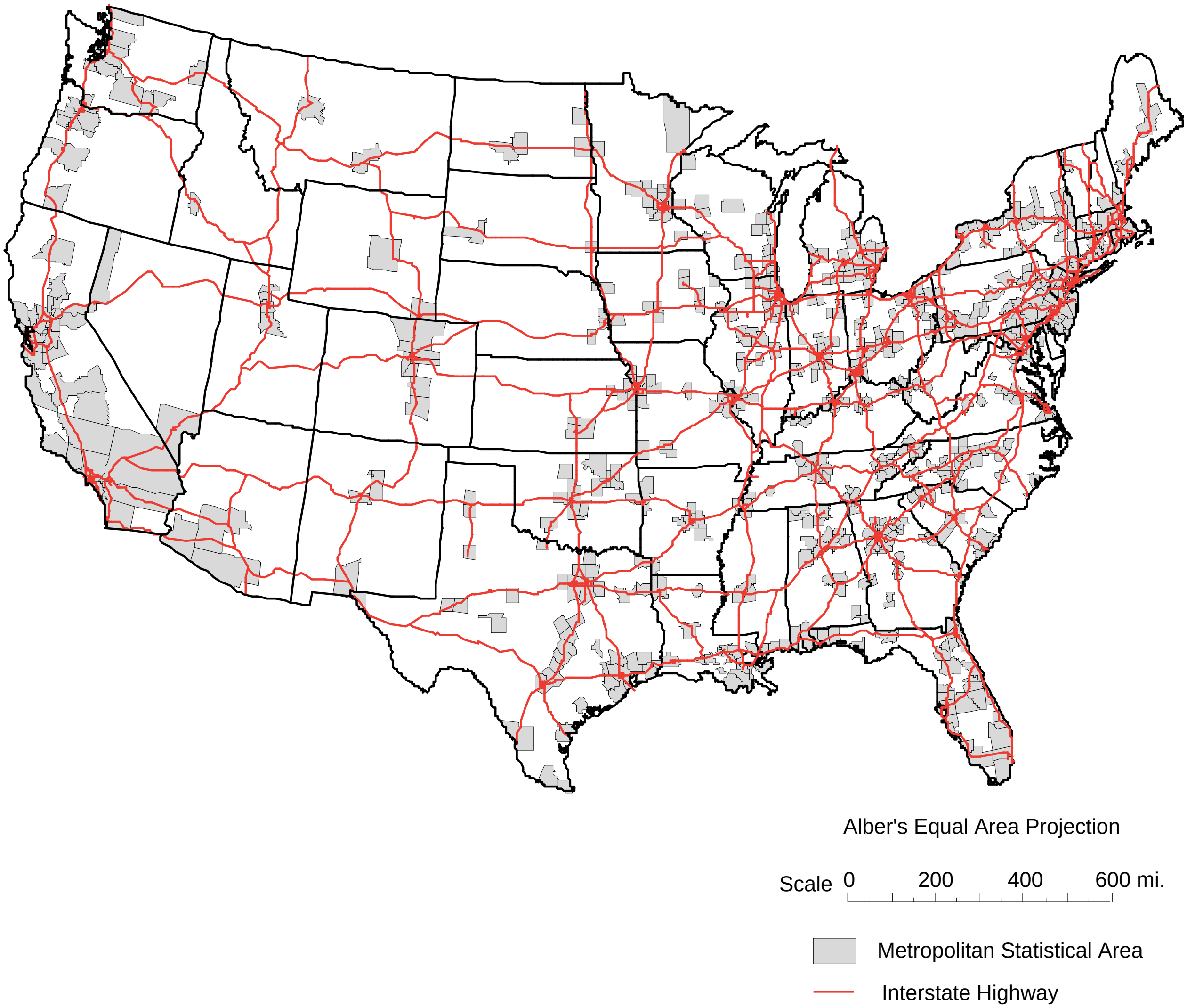
There are some 190.4 million registered motor vehicles in the United States, operating over the 3.9 million miles of highways, streets, and roads.[14] That comes to about 57 automobiles for every l00 persons in the country, and 77 vehicles (including trucks, buses and motorcycles) for every 100 people.[15] With 173 million drivers in 1992 and 190 million vehicles, the U.S. registers more vehicles than there are licensed drivers.[16] In comparison, Canada (which is the country ranking second highest to the U.S. in vehicle population per capita) has far fewer—47 cars and 64 vehicles per 100 persons. Still, many other countries contain more vehicles per kilometer of road than the U.S. figure of 25: Switzerland has about 40, Japan nearly 50, and Hong Kong—with its tremendous population density—tops the list with more than 220.[17]

Truck Inventory. The U.S. supply of trucks and truck-tractors is about 45 million units; however, data show that 1.7 million of these are registered as farm vehicles, which typically do not operate to the same extent as other trucks, on public roads. Some 38 million are classified as *light* (meaning 10,000 pounds gross weight or less); another 1.3 million private vehicles are truck-tractors, which carry the largest loads and pull the 3.8 million commercial trailers registered in private use, as well as the nearly 200,000 that are publicly owned.[18] The greatest growth in number of trucks has been occurring with small vehicles—used much like passenger cars—and with the largest truck-tractor combinations.

Bus Inventory. The stock of buses (most of which are school buses) has been growing, totaling some 645,000 in 1992,[19] compared with 397,000 in 1971 and 544,000 in 1981.[20] By far the majority of these (369,000 in 1992) are publicly

FIGURE 2-2

Interstate Highway Network



owned, almost entirely by non-federal governments.[21]

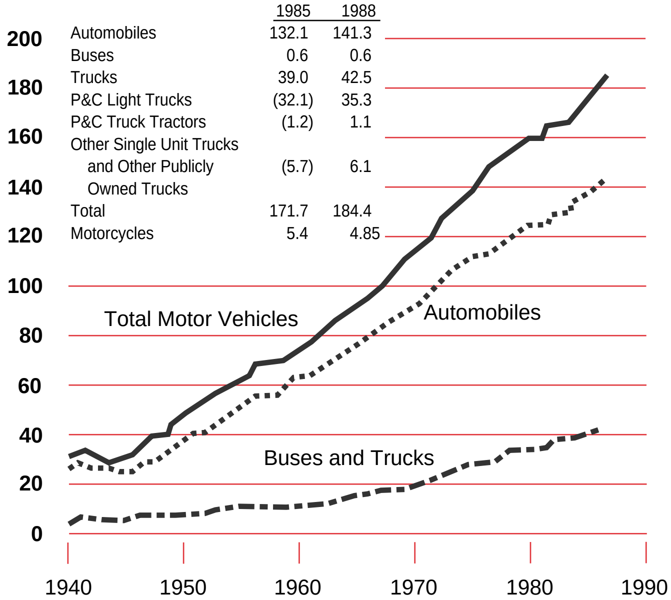
Overall Vehicle Inventory Trends. Large though the number of vehicles may be, the total dipped slightly in 1991 (down 426,000, or 0.2 percent, from 1990) before rising again in 1992.[22] Of all the vehicles that data show to be registered for use on the highways, only those categorized as motorcycles and recreational vehicles appear to have been declining over time to any major extent in the U.S. motorcycle registrations fell from 5.7 million in 1980 down to 4.2 million in l991, while recreational vehicles declined from 354,500 in 1990 to 300,500 in 1991.[23] The key trend has been the increase in the proportion of trucks in the vehicle fleet (primarily light, off-farm vehicles, or pickups)—from 16 percent in 1960 to 24 percent in 1991.[24] (See figure 2-3.)

Inventory of Highway Vehicle Operators and Related Employees

Drivers.[25] For every 1,000 persons resident in the U.S. there are 679 licensed drivers.[26] As there are 885 persons in the driving-age population for every 1,000 persons resident in the country, the great majority of those who are capable of operating a vehicle—and can afford to do so—are already licensed. At one time drivers were preponderantly male (until 1965

FIGURE 2–3

Motor Vehicle Registration: 1940 to 1988



some 60 percent of licensed drivers were male),[27] but the proportions are now roughly equal (51 percent male in 1992).[28]

Of the 173 million drivers in the U.S., an estimated two million of them were commercial truck drivers and delivery personnel in 1992.[29] Most drivers, however, operate their own vehicles for work, shopping, and a variety of personal business trips.

Highway Transportation Employees. It is estimated that 4.2 million employees work in the field of highway transportation and another 4.4 million supply motor freight services; 1.6 million in trucking and truck terminals; 2.1 million as truck drivers and delivery personnel, and, 610,000 as Class I intercity motor carriers of property.[30] Some 139,000 work as employees of commercial intercity and school bus companies (which have 275,000 private and commercial buses registered).[31] Federal, state, and local governments, which own and operate almost 369,000 additional nonprivate-sector buses—mostly school buses typically operated by part-time drivers—are estimated to employ 405,000 full-time-equivalent employees.[32] Finally, 580,000 persons work as state and local government highway employees, 219,000 work in highway and street construction,[33] and 4,000 are employed by the Federal Highway Administration (FHWA).[34] Total figures suggest overall employment in highway transportation (not including vehicle manufacture and assembly or the U.S. Postal Service) of nearly 10 million.(See table 2-2.) To put this employment figure in perspective, 9 percent of the civilian labor force is employed in highway transportation.[35]

Inventory of Motor Carrier Services

Motorists use highways, but so do operators of many other vehicles, including trucks (long- and short-haul truckers), buses (transit, school and intercity), public service and utility vehicles (ambulances, police cars, fire engines, sanitation trucks, etc.), taxicabs, bicycles, and vans. Some of these operators serve passengers, others serve freight demands, and a few provide joint services (for example, intercity buses jointly produce package freight and passenger services; taxicabs occasionally carry packages, as well as passengers and their luggage or parcels). Overall, it is calculated that more than 75 percent of the value of all goods and services produced in

TABLE 2–2

Highway Transportation Employment by Sector: 1991

Sector	Estimated Employment
Truck drivers and delivery personnel	2,148,000
Auto dealers and service stations	1,996,000
Trucking and truck terminals	1,609,000
New and used car dealers	886,000
Auto repair services and parking	882,000
Class I intercity motor carriers of property	610,000
State and local government highway agencies	580,000
Motor vehicle parts and supplies	446,000
Public-sector transit and school buses	405,000
Highway and street construction	219,000
Commercial intercity and school buses	139,000
Taxicab drivers	32,000
Federal Highway Administration	4,000
TOTAL	9,956,000

the U.S. is carried by truck, and most passenger traffic moves over the highways.[36] (It has been estimated that 80.5 percent of intercity passenger travel is highway transport[37] and 91 percent of journey-to-work trips are taken by auto and truck.)[38]

Industrial Structure of Highway Carriers. The Interstate Commerce Commission (ICC) reports the existence of more than 50,000 for-hire motor carriers of property (of which more than 48,000 are small, Class III carriers with less than $1 million annually in operating revenue).[39] As a general matter, these figures suggest that major transport markets contain many motor carriers, although some carriers specialize in certain types of hauls and markets. For example, the average size of LTL (less-than-truckload) carriers, which specialize in smaller shipments, is greater than the size of TL (truckload) carriers.[40]

Full information about how many carriers serve each market, and with what kinds and frequencies of service, is not available.[41] The number of businesses in highway freight transportation appears to have grown since partial deregulation of the motor carrier industry occurred upon passage of the Motor Carrier Act of 1980, although the number categorized as larger Class I carriers has fallen.[42]

Passengers. The ICC reports 30 Class I motor carriers of passengers (i.e., with $5 million or more in annual revenue), and 4,573 other bus companies (with revenue less than $5 million).[43] Bus carriers transport packages as well as passengers, and some carriers engage in charter operations as well as, or instead of, regular-route services. Although there are many bus carriers, the largest by far is Greyhound, which is the only bus company to offer nationwide service. Overall, more than 5,000 locations are currently served by intercity buses, this represents a 52 percent decline in service from the almost 12,000 places served in 1982.[44]

Other Highway Carriage. Many additional businesses have a role in facilitating highway transport. For instance, some 7,600 brokers exist to match freight shippers with carriers.[45] Moreover, it is entirely possible that the majority of freight carried on the highways is transported by private carriers;[46] it has been estimated that 26 percent of all intercity freight tonnage for 1992 was carried by non-ICC regulated trucks, compared with the 17 percent moved by the regulated carriers.[47]

Joint Use of Highways. The highway system is used jointly by all of these operators and by individual motorists. In only a few cases are roads and highways restricted in service to just certain users. Examples of special use roads include high-occupancy lanes on urban freeways, transit-only lanes and streets, logging roads for the use of large trucks, or minor rural roads limited to light vehicles during spring thaw periods.

Motor Carrier Terminals. Motor carriers also use truck and bus terminals in their operations, as locations to gather, distribute, or transfer freight and passengers. Some of these terminals are intermodal, for example, intercity bus terminals that provide connections to local transit service, and freight facilities where containers are transferred from rail cars or ships to trucks. Very few data exist about terminals and their characteristics, so no inventory can be given of terminal size, location, capacity, throughput, capital stock, or degree of intermodal connection. About the only descriptor known on a national basis is the number of persons employed in trucking and truck terminals; as noted earlier, according to the Bureau of Labor Statistics about 1.6 million people worked in these facilities in 1991, and 1.5 million in 1992.[48]

The Condition of Highway Transportation

For many years, the condition of highways has been studied and measured far more extensively than the condition of any other mode of transportation. It stands to reason, therefore, that more is known about the condition of highways than about the elements of the highway transportation system.[49]

Rating Systems and Findings. Highways are rated according to the levels of service (LOS) they provide on a scale from A (best operating conditions) to F (poor: stop-and-go driving).[50] Highway pavement condition is rated according to a present serviceability rating (PSR), which is measured from 5 (very good—typical of new, smooth pavements) to 1 (deteriorated, reduced speeds, ride discomfort). Bridges are rated according to several criteria to determine structural and functional adequacy.[51] Eligibility for federal funding is then determined by application of bridge sufficiency ratings developed by FHWA.

According to FHWA, the following is true:

- Pavement condition improved throughout the 1980s and continues to do so in the 1990s. The mileage of "poor" pavement continues to decline; however, some 234,500 miles of arterials and collectors remain rated "poor" or "mediocre."
- Highway performance, as measured by various indicators of congestion, declined marginally between 1989 and 1991 on the higher-function urban systems and improved slightly on the lower-function systems.
- More than half the urban peak-hour congestion occurs in the urban areas larger than one million population. In 50 of the most populous urban areas, the cost of congestion (including delay and fuel consumption) was estimated to exceed $39 billion.
- Bridge conditions have stabilized and show a reduction in the number of structurally deficient bridges.[52] Some 118,500 of the nation's 575,000 bridges were structurally deficient in l992, compared with 134,100 in 1990. The number of structurally deficient nonlocal bridges is less than 15 percent of the total.[53]

Performance Indicators. Other highway performance measures that are reported (and relate to system condition) include vehicle speed, trips made, and miles traveled. Speeds, which dipped sharply in 1973 with imposition of a nationwide 55 mile-per-hour limit, have since increased to levels just a bit below those of earlier years. Average daily traffic figures show approximately 4 percent annual growth over the past 20 years, but truckload traffic has increased at about an 18 percent annual rate.[54] The average annual numbers of vehicle trips and vehicle miles of travel have grown from decade to decade, for example, in 1983, trips per household equaled 1,486 covering 11,739 miles, while in 1990 there were 1,702 trips and 15,101 miles of travel.[55]

Capital Stock and Condition. Capital outlay data for the highway mode are available, but capital stock figures for the public sector generally are not. (See chapter five.) The condition of the investment in highway transportation (including depreciation and remaining life expectancy) is not calculated, so the current value of highway investment cannot be given; nor, is it possible to determine how much it would cost to replace or replicate the capital stock. Stock data are difficult to gather as the condition of the information is inexact, and quality changes have occurred. However, data are available on a few components of highway capital, for example, figures show that the average age of passenger cars in use was 8 years in 1991, compared to 7.6 years in 1985 and 6.0 years in 1980.[56] The U.S. Department of Commerce produces statistics illustrating the current-cost gross stock of transportation-related fixed private capital. Among the elements of that stock that are clearly highway-related are motor vehicles and equipment; trucking and warehousing; and auto repair, services, and parking. (See table 2-3.)

TABLE 2–3

Transportation-Related Private Capital Stock: 1992 (In Billions of Dollars)

Industrial Category	Gross	Net
Manufacturing:		
Motor vehicles and equipment	124.8	64.7
Other transportation equipment	104.2	60.8
Transportation:		
Railroad transportation	244.4	106.3
Local and interurban passenger transit	12.3	5.9
Trucking and warehousing	101.3	44.2
Water transportation	56.2	22.4
Transportation by air	107.1	53.4
Pipelines, except natural gas	41.3	20.0
Transportation services	44.8	20.3
Services:		
Auto repair, services, and parking	164.4	95.8
TOTAL	1,000.8	398.0

Condition of Human Capital. In contrast with the extensive body of information available about the physical condition of the highway infrastructure, and lesser amounts of information on capital condition, very little appears to be known about the condition of the highway workforce. Concern is expressed about the supply of truck drivers, in part because training costs are viewed as higher than in the past, making rapid turnover expensive for trucking firms;[57] and in part because of the age distribution of state highway engineers and other experienced workers.[58] Also at issue is the skill level of older drivers and the ability of the highway system to accommodate increasing numbers of older motorists.[59] Despite these questions raised about workforce change, statistical series on qualitative change are not maintained.

TABLE 2–4

Number of U.S. Airports

	1986	1988	1992
Public-Use Airports	5,775.0	5,680.0	5,545.0
% with Lighted Runways	69.2	70.2	72.3
% with Paved Runways	66.6	69.2	71.7
Private-Use Airports	10,807.0	11,647.0	12,301.0
% with Lighted Runways	8.8	7.7	7.6
% with Paved Runways	28.1	30.0	36.6
Certificated Airports	711.0	646.0	n/a
General Aviation Airports	15,871.0	16,681.0	n/a
Airports with FAA Towers	416.0	398.0	400.0
TOTAL AIRPORTS	16,582.0	17,327.0	17,846.0

Air Transportation

The elements of the air transportation system are: airports; airways; aircraft, pilots and other personnel; and the suppliers of air passenger and freight services. Some air service users are recreational flyers; other users include a variety of business operations. In addition, a number of for-hire passenger and freight carriers operate over the air transport system.

Inventory of Airports

There are more airports in the United States than in the rest of the world combined. In all, the U.S. had some 17,500 airports in 1990, up from 15,200 as recently as l980.[60] These include the 3,285 public and private airports that are included in the National Plan of Integrated Airport Systems (NPIAS)[61] and thereby are eligible to receive federal aid.[62] But the total also includes other private paved and unpaved landing strips (only 44 percent of the nation's airports have paved runways), other public and public-use airports, heliports, and short take-off and landing (STOL) ports.[63] (See table 2-4.)

Although the U.S. holds a large number of airports, most of them (12,245 in 1992)[64] are not open to the public, and more than half of all commercial passengers pass through only 25 airports. Still, air transport in the U.S. is far more active than elsewhere in the world; of the world's 50 busiest airports, 31 are located in the U.S. [65]

Airport Classification. Airports, like highways, are classified in various ways. Scheduled air passenger service is provided at about 800 airports, and some 570 (those airports with 2,500 or more enplanements annually) are classified as commercial service airports. Commercial service airports that enplane 0.01 percent or more of total U.S. air passengers are classified as primary airports. In 1990 the U.S. held 396 primary airports, and eight additional airports were proposed for this status. Primary airports account for more than 99 percent of air passenger enplanements on certified air carriers, and at least 95 percent of air passenger enplanements on all scheduled domestic air carriers, including commuter airlines.[66]

Hub Airports. The U.S. contains 26 large hub airports. Large hub airports are defined as primary airports handling 1 percent or more of total air passenger enplanements. Together the large hubs accounted for 71 percent of all commercial air passenger traffic in 1992. NPIAS identifies 285 reliever airports—smaller airports located near a congested hub or primary airport—and proposes the development of 71 more by the year 2000.[67] There are also some 233 military airfields in the United States, and 24 currently permit civil aviation operations.[68]

Airways and Air Traffic Control

Airways are a system of electronic navigation aids and air traffic control procedures designed to keep aircraft safely separated and to help them avoid dangerous weather conditions. Performance of the airways system is measured by the number of aircraft handled by Federal Aviation Administration (FAA) Air Route Traffic Control Centers and Towers. In 1992 that system handled more than 98 million aircraft.[69] Airway system mileage consists of 185,600 miles of low-altitude air routes and 150,496 miles of high-altitude jet routes.[70]

There are 20 air route traffic control centers in the continental U.S. plus four offshore facilities located in Anchorage, Alaska; Honolulu, Hawaii; San Juan, Puerto Rico; and Guam. The FAA operates air traffic control towers at 401 public-use airports.[71] Other elements of the airport and airways system include 201 airport surveillance radar and 118 air route surveillance radar sites, plus 26 beacon-only sites; 934 FAA-operated radio navigation sites; and 728 nondirectional radio beacons.[72]

Inventory of Aircraft

The U.S. aircraft fleet consists of some 275,000 civilian planes (most of which have single-engines), helicopters, gliders, blimps, and balloons.[73] It is estimated that 4,580 aircraft were available for air-passenger-carrier service in 1991. Of these, 3,782 were flown by major air carrier operators), 582 were employed by national carriers, and regional carriers flew 214 aircraft.[74] One important trend has been a decline in the number of smaller single-engine aircraft, from 168,600 in 1980 to 154,500 in 1991.[75]

The total number of commercial for-hire large aircraft in operation (turbojet, turboprop, and piston) reported by all U.S. air carriers (domestic, international, supplemental/scheduled, and cargo carriers) reached 4,695 in 1991.[76] Commuter air carriers and on-demand air taxis reported 1,359 small aircraft in operation that year—two turbojet, 1,143 turboprop, 203 piston, and six rotary.[77]

Pilots and Air Carrier Employees

In 1990 there were 703,000 active pilot certificates held—an increase from the recent low point of 694,000 in l988, but still down from 764,000 in 1981.[78] Some 492,000 nonpilot certificates were in existence (mainly mechanics—344,000), up from 383,000 in 1981.[79] It has been estimated that 97,000 persons were employed as pilots and navigators, 133,000 as aircraft mechanics, and 89,000 as aeronautical engineers and an overall total of 732,000 persons employed in air transport service (down from a high of 789,000 in 1990).[80] The FAA employed 53,108 persons in 1993,[81] so the total employed workforce in air service and with the FAA approximated 785,000.[82]

Air Carrier Services

About 200 U.S.-certificated and commuter air carriers are in operation today. Of these, the 10 major carriers account for about 80 percent of all passenger enplanements. Another 13 percent of enplanements take place on smaller, national carriers (15 firms), while commuter carriers account for 5 percent of enplanements, and regional carriers (35 firms) provide for 2 percent.[83]

Code Sharing. Unlike the lineal services once more commonly offered by air carriers, most services today are of the hub-and-spoke variety, with shorter-haul feeder routes terminating at major airports where passengers transfer to longer-haul flights. Many commuter carriers using smaller aircraft specialize in spoke services connecting with the majors at hubs. The 10 major carriers (down from 12 in 1990 with the bankruptcies of Eastern and Pan American) have developed their route systems to provide broad geographic coverage of major sections of the country, serving from one airport hub to another. A fairly recent development is for commuter and major carriers to combine their services in code-sharing systems to integrate carrier operations. (American Eagle and United Express flights are examples of such arrangements.) Although hub-and-spoke arrangements permit operational efficiencies and capital savings for the carriers (leading to the need for fewer aircraft and personnel), they can mean more time in transit for the air traveler; however, smooth commuter-major partnerships may be a means of off-setting consumer dissatisfaction with hub-and-spoke operations.

The Condition of Air Transportation

No complete *condition and performance* measurement system for air transport exists, however, data for elements of such a system are provided by the FAA for airports.[84] The FAA also compiles information about air traffic delay, recording flights delayed 15 minutes or more, and reports that the average delay per operation (a takeoff or a landing) was 7.1 minutes in 1992.[85] Even if capacity increases proposed by the FAA occur, the average delay is expected to increase, reaching 8.7 minutes by 1998. If improvements are not made, future delays are expected to be far greater.[86]

Condition of Commercial Passenger Service. Another measure of condition is the database on air passenger service complaints produced by the Office of Consumer Affairs of the U.S. Department of Transportation (DOT). DOT produces a monthly *Air Travel Consumer Report*—which is often used by the news media—containing information on flight delays, mishandled baggage, and overbooking. DOT periodically generates an internal report of complaints, and reviews the findings to identify trends and patterns.

Runway Condition. Most public-use runway pavement is inspected annually, and the pavement is classified as good, fair, or poor. Overall, in 1990 some 68 percent of the nation's public-use airports had runways with pavement condition rated good, 25 percent fair, and 7 percent poor. These figures are slightly improved over 1986 figures.[87]

Aircraft Condition. The FAA is preparing rules to govern *operational limits* for some aircraft that would require special maintenance as well as the retirement of older planes. According to the FAA, the average age of jets has increased to 17.8 years and 94,300 flights. New FAA rules could increase carrier costs (particularly for freight carriers which are more likely to use the older planes), but they should also lead to a newer, presumably safer, fleet.[88] Similarly, noise reduction requirements, such as the phase out of noisier Stage-2 aircraft by the end of 1999 affect average fleet (or power plant) age by stimulating earlier retirements or retrofitting.[89]

Condition of Human Capital. Changes in the quality of the air transport workforce—such as pilots and mechanics—are difficult to discern, but questions have been raised about the potential for increased retirements of airline pilots. Some 23,000 are expected to retire in the next 10 years (unless the current mandatory age limit of 60 is raised). This approximates one-third of the workforce. Moreover, the military is no longer training the quantity of pilots provided in the past. Recently 85 percent of airline crews learned to fly in the military, but by the year 2000 only a third will have that background. Flight hours are likely to fall (according to one estimate, from the recent average of 1,900 hours of jet experience for new hires to 500 hours by the year 2000) but better training, including the use of simulators, may maintain necessary skill levels. Some concern is expressed, however, that the increasingly more common two-crew-member cockpit will not permit the extensive learning experience once enjoyed by junior crew members.[90]

Intercity Rail Transportation

The physical railroad system consists of track, operating equipment, and the other capital and human resources required to produce rail freight and passenger services. For-hire rail freight transport is provided by a number of freight rail lines, and passenger service is provided primarily by Amtrak (the National Railroad Passenger Corporation), which operates over its own right-of-way in the Northeast Corridor of the U.S., as well as over the tracks of 24 rail freight carriers.[91]

Rail Track Inventory

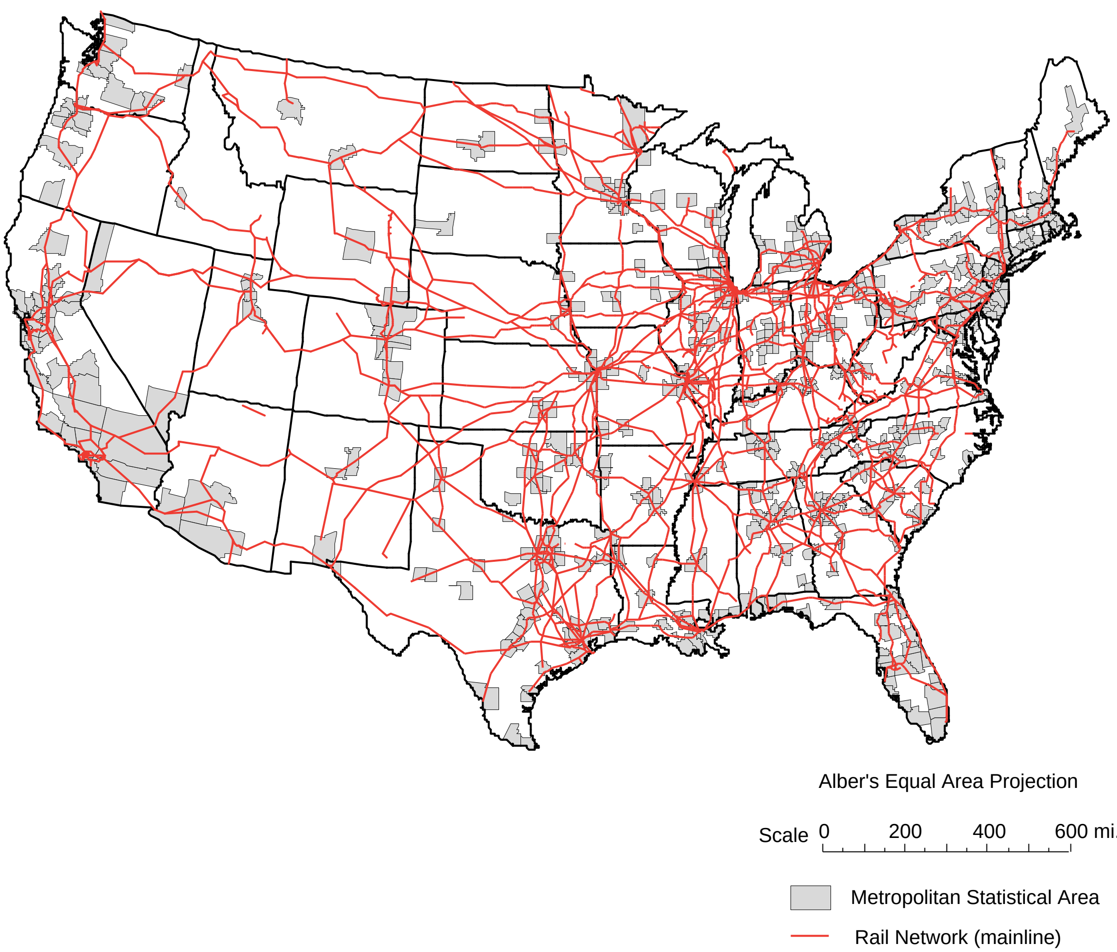
The density of the rail track network in the U.S. has been declining for decades,[92] reaching 113,056 miles in 1992.[93] In contrast with the National Highway System of road arterials (155,000 miles), the rail system provides less extensive geographic coverage for the country, particularly in the far western states, which historically built rail lines later than their eastern neighbors. The decline in miles of railroad and miles of railroad track should not be taken to imply that major markets no longer have rail freight service available. Rather, major origin and destination points are now likely to have one rail line instead of two; in some cases, direct rail service to minor markets and service to some agricultural production regions has been cut, requiring track interconnections to railroads. (See figure 2-4.)

Intercity Passenger Rail. Amtrak operates 25,000 route miles with 524 stations.[94] These numbers have increased slightly over the past decade, but the extent of available passenger rail services is less now than in the years prior to the formation of Amtrak in 1970. However, by the time Amtrak assumed responsibility for operating 23,000 route-miles of trains between 21 city-pairs as designated by the Secretary of Transportation, service (provided with outmoded and sparse equipment) was down to some 440 stations.[95]

Rail Classification. Rail lines are not functionally classified as highways are, in the categories of arterials, collectors, and local facilities;[96] but an approximate equivalent is to be found in the terms main line, secondary main, and branch line. However, these rail terms are not precisely defined, and no time-series figures report changes in the extent of facilities for each category. Moreover, although the ICC categorizes railroad firms like motor carriers, as to size into three categories of Class I, Class II and Class III, the biggest Class I railroad may operate light-traffic-

FIGURE 2–4

Railroad Network – Mainline



density branch lines as well as main lines, while a Class II carrier can have a high-volume main line.[97]

Weight of Rail. Rail lines can be characterized as to weight of rail (measured in pounds per yard), with heavier rail generally signifying the ability to carry heavier, more frequent traffic. The weight category with the largest number of miles is 130-139 pound rail (65,856 miles, or 51.1 percent of the total). Lines with relatively lightweight rail are often branch lines. By 1992 the miles of line with weight of rail under 100 pounds—a weight not suitable for mainline operations—had fallen to only about 15,000 miles (12 percent of the total).[98] Only 0.4 percent of the U.S. rail network uses the heaviest category of 150 pounds per yard of rail.

AAR Classification. The Association of American Railroads (AAR) has established another classification of railroads, adopting the ICC revenue category for Class I carriers (for 1992, Class I encompasses companies with $251.4 million or more in revenues), but calling Class II and Class III carriers as either Regional or Local.[99] Regional railroads are line-haul carriers operating at least 350 route miles of and/or earning revenue between $40 million and the Class I revenue threshold. Local railroads are line-hauls that fall below the Regional criterion, plus Switching and Terminal Railroads. (See table 2-5.) However, "miles operated" may include some or all of the functions of main line, secondary main, and branch trackage.[100]

Rail Equipment Inventory

The latest available figures for rail locomotives and freight cars indicate that the number of cars in operation in 1992 was about 1.17 million.This includes 18,004 diesel-electric locomotives; 168,078 boxcars; 295,728 covered hoppers; 190,896 tank cars; and 686,512 "other" cars. Summary information is not available for other railroad equipment (including non-operating items such as track maintenance and repair equipment) or for other rail capital goods.

Locomotives. The number of units of rail equipment in service for any particular year can be only a very general guide to rail productive capacity. The number of locomotives in service was far greater in the immediate post-World War II period than at present (for example, 41,701 in 1947), but the majority of those locomotives were steam powered, rather than the more efficient diesel electric units in common use today.[101] The number of locomotives in service has been falling gradually for the past decade, but it is likely that the newer locomotives brought on line are capable of substantially greater output than those being replaced.[102]

Cars. Railcars have increased productive capacity, averaging 82.4 tons of capacity for the average car in the fleet during 1983 and 89.3 tons in 1992.[103] The composition of the car fleet has changed dramatically, with virtually all new cars (and the largest portion of the entire fleet—almost 86 percent) now being specialized, as opposed to plain boxcars. (Table 2-7.) Specialized cars may lack flexibility, but they are tailored to shippers' needs and more efficient to operate, particularly in dedicated service, such as unit trains (trains which haul a single product). The total number of cars operated has been declining slightly year by

TABLE 2–5

Railroads By AAR Class: 1992

Railroad Category	Number	Miles Operated	Revenue ($000)
Class I	12	126,237	$27,507,607
Regional	33	20,697	1,514,195
Local	464	22,730	1,242,463
TOTAL	509	169,664	$30,264,265

Note: Total figure (169,664) includes 901 miles of road operated by Class I railroads in Canada and trackage rights for operations in the U.S.; therefore, it differs from the current net figure of 113,056.

year,[104] while the proportion of cars provided by car companies and shippers has steadily increased, to nearly 41 percent in 1992 (versus about 29 percent in 1983).[105]

Passenger Equipment. Amtrak has an inventory of 336 locomotives and 1,962 passenger train cars. The figure for cars (and the distribution of cars by car type) has changed very little over the past five years, but the operating fleet of locomotives has increased 13 percent since 1988, when it totaled 298.[106] By comparison, Amtrak started operations in 1971 with 1,275 old cars, 286 diesel locomotives, and 40 electric locomotives.[107]

Railroad Employment. The railroads reported an all-time low in number of employees in 1992, with 275,000. As recently as 1980 railroads employed more than a half-million persons, and right after World War II the railroads employed 1.598 million workers.[109] By contrast, in the most recent year reported, railroads in France, Italy, and the United Kingdom employed a total of 518,200 persons operating 67,022 kilometers of railroad.[109] Although the comparison may be inexact, the three countries operated approximately 35 percent of the rail line of the U.S. with more than 2.2 times as many employees.

It has been reported also that 29,000 persons work in railroad equipment manufacturing,[110] and that 722 persons are employed by the Federal Railroad Administration (FRA) in 1992.[111] Amtrak employed 24,090 workers in 1991.[112] When added to the 275,000 persons employed by freight railroads, the industry reaches a combined total of 329,000. (See table 2-6.)

TABLE 2–6

Rail Transportation Employment by Sector: 1992

Sector	Estimated Employment
Railroads	275,000
Rail equipment manufacturing	29,000
Amtrak	24,000
Federal Railroad Administration	1,000
TOTAL	329,000

Rail Carrier Services

Amtrak, which Congress established in 1970, is the primary provider of rail passenger services in this country. Amtrak initiated operations in 1971, taking over equipment and passenger facilities from the railroads. Recently Amtrak has operated about 220 intercity trains daily, serving stations in the Northeast Corridor and nationwide. Amtrak trains travel on 25,000 miles of rail line, about 700 miles of which are owned, operated, and maintained by Amtrak.[113] The remaining miles are lines of 24 freight railroads.[114]

Rail freight service is provided by 12 Class I systems, 33 regional, and 464 local carriers.[115] The recent trend has been toward a few large railroads—and many newly established small railroads—often operating on tracks abandoned by the Class I carriers. Those smaller railroads perform a gathering and distribution function, but some also carry overhead traffic originating from or destined for points that are beyond the territories in which the regional or short-line railroad is located.

The Condition of Rail Transportation

No broad-based and readily available information can be found to indicate the physical condition of the railroads. Track inspections are performed by FRA and state inspectors, and speed limits are placed indicating safe operations for the various lines; however, these data do not appear to be compiled and reported in a manner similar to the highway condition reports on present serviceability or levels of service rating.

On the freight side, some indication of freight operating condition can be inferred from improvements in rail car utilization, as measured by average turnaround time in days, the average figure was 18.9 days for all freight cars in 1991, versus 20.9 days in 1986.[116] Other indicators are average length of haul for a freight car (762.5 miles in 1992, up from 664.5 in l986)[117] and average freight car miles operated (26,128 miles in 1992, versus 24,414 in l986).[118]

Information about railroad investment over the years in track, structures, and equipment is available (figures on new rail and cross-ties laid, age of locomotives, annual number of new and rebuilt locomotives and freight cars installed in service, and weight of rail in place),[119] but it is not clear that such data are good indicators of performance. For example, technological changes may be prolonging the service lives of track components and improved maintenance methods may increase maintenance productivity and reduce costs.[120] Better signalization and train control can reduce the need for equipment investment. A firm can trade off maintenance and investment expenditures in track and structures (or in capital and labor expenditures) to achieve an ever-changing optimum mix. The amount of new rail installed may decrease due to the use of rail taken from unneeded double-track lines. Heavier weight rails may be employed, but heavy loading of unit trains may increase. For all these and many other reasons, an understanding of rail condition is extremely difficult to obtain.[121]

Transit

Urban transit service is provided in at least 293 of the 373 urbanized areas in the U.S.[122] The total number of transit system operators in all U.S. urbanized areas was 787 in 1990.[123] Yet transit in its various forms, as defined by the American Public Transit Association (APTA),[124] is far more pervasive. It involves some 3,495 private, nonprofit agencies that receive federal assistance to serve elderly and disabled persons,[125] encompasses 1,600 agencies providing rural public transportation services,[126] and employs numerous forms of transit and an extensive workforce of drivers, maintenance employees, supervisors, and others.[127]

Inventory of Transit Vehicles

The most common transit vehicle is the motor bus, but transit operators use other rubber-tire vehicles (vans and trolley buses, for instance), and a number of other forms of fixed-guideway transit vehicles: subways or heavy-rail transit, commuter rail, light-rail transit, and automated guideway transit, cable cars, and tramways. (See table 2-7.)

The number of U.S. transit operators has been growing in recent years,[128] including new rapid- or heavy-rail systems (e.g., Los Angeles Metro Red Line), light-rail systems (streetcars such as the St. Louis Metrolink), and commuter rail systems or services have opened throughout the country. The largest concentration of public transit is in New York City. The next largest concentrations are strikingly different in their mix: Los Angeles is nearly all bus service while Chicago is equally divided among commuter railroads, rapid rail transit, and buses. The next concentra-

TABLE 2-7

Transit Vehicles and Infrastructure: 1990

Vehicles, by type	Number
Buses	52,945
Subway cars	10,325
Streetcars and cablecars	940
Commuter Rail cars	4,174
Commuter rail locomotives	404
Vans	2,412
Other (including ferryboats)	372
Rural service vehicles (primarily vans)	10,101
Vans for service to senior citizens and persons with disabilities	20,970
TOTAL VEHICLES	102,643

Infrastructure	Number
Miles of rapid rail transit track	1,744
Rapid rail transit stations	911
Rapid rail transit maintenance facilities	43
Miles of light rail track	687
Light rail maintenance facilities	18
Miles of commuter rail track	4,830
Commuter rail stations	958
Commuter rail maintenance facilities	35
Ferry boat maintenance facilities	4
Bus maintenance facilities	523
Demand-responsive service maintenance facilities	86

FIGURE 2–5

Passenger Miles of Travel of Rail and Bus Transit Systems for Metropolitan Areas With More Than 100 Million PMT: 1991

The size of each circle represents total passenger miles of travel by rail and bus transit for the metropolitan area or consolidated metropolitan area. The grey slice is for commuter railroads, the red slice is for other rail transit, and the white slice is for bus transit.

tions are in the Northeast, Atlanta, and the San Francisco Bay area. (See figure 2-5.)

Transit Employment

Local transit employment in the U.S. was estimated at 157,000 persons in 1992, not including the 30,000 taxi employees.[129] A broader definition of transit employment (including, among others, workers in commuter rail, demand-responsive service, and rural systems) suggests some 282,000 employees in 1991.[130] It appears no estimates have been made for ancillary employment, such as transit equipment manufacture, although the Federal Transit Administration (which administers federal transit assistance) employed 485 persons in 1993.[131] By whichever employment measure adopted, the number of persons working in transit has been rising slightly in the past few years (except in the taxi category, which had about 20 percent fewer employees nationally in 1992 compared with 1985).[132]

Transit Services—Urban and Rural

Transit services were once supplied primarily by private enterprise in the U.S., but following passage of the Urban Mass Transportation Act of 1964, most transit services have come to be provided by either local governments or nonprofit organizations.[133] Conventional rail or bus services are usually the responsibility of a single transit system or a purchaser of services in each geographic area (such as a transit authority), but a system may do more than operate transit; often they also contract for services with various transit providers. One Chicago-area system is said to have more than 80 service providers under contract.[134]

Transit Classification. No ranking systems equivalent to the highway's functional classification, present serviceability or level of service ratings, are in place for transit. Providers operate different frequencies of service over the routes they serve (with headway varying according to anticipated ridership, hour of the day and day of the week). Providers also supply different

TABLE 2–8

Bus and Paratransit Fleet Condition Characteristics

Vehicle Type	Useful Life (In years)	Average Age (In Years)	# Over Age
Standard bus	12	8.2	9,011
Medium-duty Bus	10	6.7	553
Small Van	7	3.9	303
Urban Paratransit Van	4	2.8	827

equipment based on their estimates of demand.

Transit Condition and Performance

The latest national status report on transit for 1993 indicates that the average age of transit buses exceeds federally recommended average usable age by between 20 and 35 percent.[135] (See table 2-8.) In addition, between 20 and 30 percent of rail transit facilities and maintenance yards are rated in poor condition[136] and about half the commuter rail cars and locomotives are rated in good condition.[137] These ratings changed little throughout the 1980s. Transit infrastructure categories vary significantly as to the percent in bad and poor categories.[138]

The average fleet age for commuter rail vehicles was 17.4 years in 1991; for light-rail, 15.6 years;[139] for heavy rail, 16.9 years; and similarly measured, the fleet motorbus average was 7.9 years.[140] The number of new transit cars purchased or shipped has fallen a great deal in the last several years.[141]

Ocean, Great Lakes, and Inland Waterway Transportation

Water transportation includes domestic movements on the inland waterways, the Great Lakes, and along the coasts, as well as between the contiguous 48 states and Alaska, Hawaii, Guam, Puerto Rico, and the Virgin Islands. Water transport also encompasses international ocean shipping, which moves from coastal and Great Lakes ports of the U.S. in international trade. The inventory of water transportation facilities is extensive, encompassing harbors and ports, channels, navigation facilities, piers, wharves, cargo handling equipment, locks and dams, and storage facilities, as well as ships, barges, tugboats, and smaller vessels. (See figures 2-6 and 2-7.)

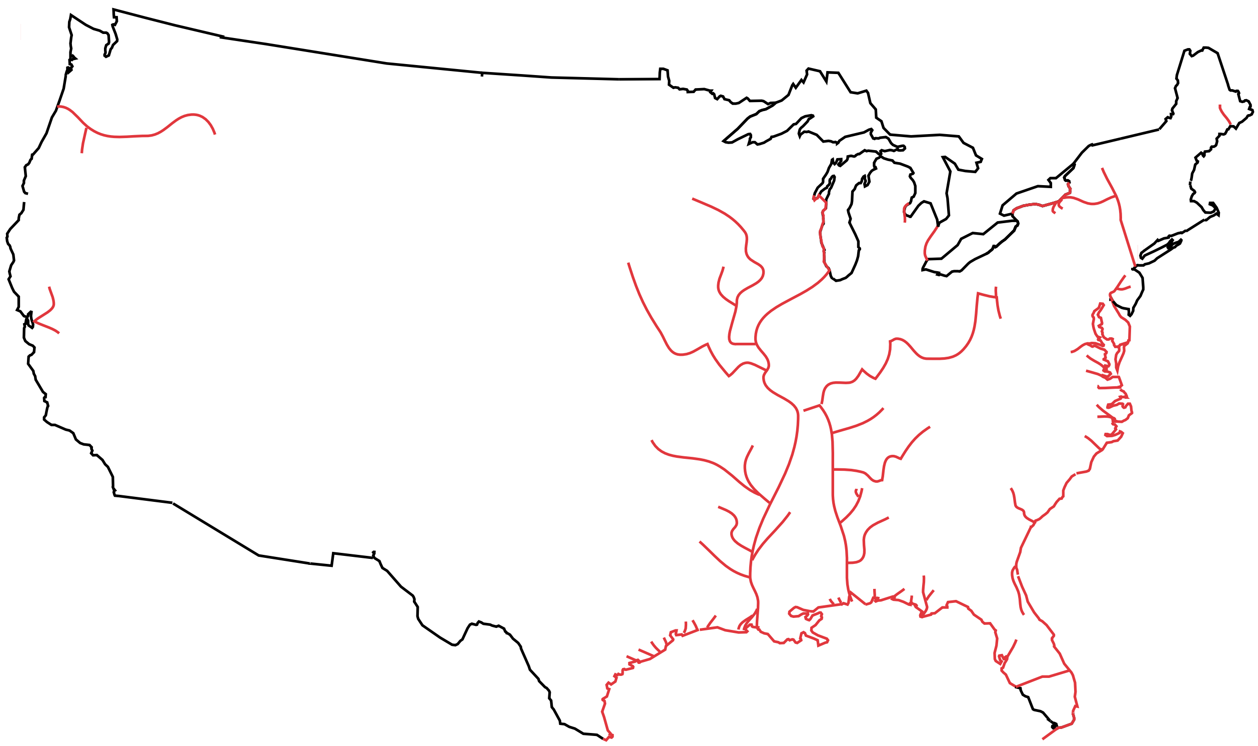
Vessel Inventory

Great Lakes Fleet. The U.S. Great Lakes Fleet of self-propelled vessels (1,000 gross tons and over) consisted of 78 vessels in 1989, almost all of which (69) were self-unloading or bulk carriers. These included three tankers and six ferries (which transport rail cars and highway vehicles as well as passengers).[142] Shipping services on the Great Lakes are not supplied solely by these 78 vessels, which are specifically configured and dedicated as Lakers to effectively meet the demands of the U.S. laker trade. In addition to the U.S. fleet, the Canadian Laker fleet as well as ocean vessels representing some forty foreign flags of registry operate among all the Great Lakes and through the St. Lawrence Seaway, serving U.S., Canadian, and overseas markets.

Inland Waterways. The inland waterway fleet consists of towboats/tugboats, dry cargo barges, and tank or liquid cargo barges. In 1990, there were 27,091 dry cargo barges, 3,913 tank barges and 5,218 towboats/tugs.[143] From 1950 to 1989, the number of dry cargo barges increased 139 percent, while their capacity grew 385 percent. Over the same period the number, as well as the capacity, of tank barges nearly

FIGURE 2-6

The Inland Waterway System



doubled, yielding a three-fold total capacity increase (307 percent). Finally, over this same period, the number of towboats/tugs rose 29 percent, average horsepower per tug went up 286 percent and total fleet horsepower increased four times (402 percent).[144]

These figures for U.S. inland watercraft, exclusive of the Great Lakes, totaled 36,222 in 1990. In contrast, the European countries with the greatest numbers of craft in service and major inland waterway activity, had considerably lower figures in 1990: Belgium, 1,942; France, 3,293; Germany, 3,077; and the Netherlands, 6,998.[145]

Deep Sea Shipping. Ocean carriage takes place along the U.S. coasts, between mainland ports and Alaska, Hawaii, Guam, Puerto Rico, and the Virgin Islands, and internationally throughout the world. Three main types of trade exist:

general cargo carriage undertaken by scheduled freighters—liner vessels and container ships—both usually operating as common carriers;

dry-bulk movements in specialized ships transporting coal, grains, minerals, and fertilizer under contract or in common carriage; and

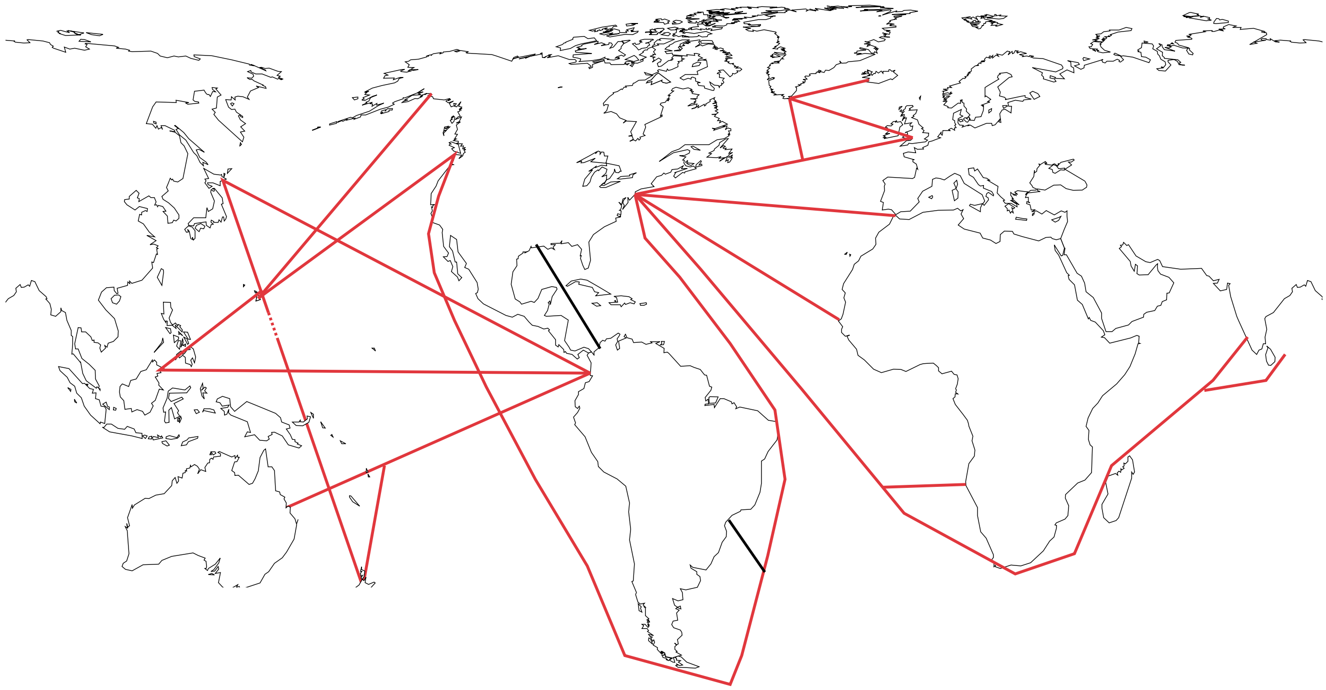
liquid-bulk shipping using common- or contract-carriage tankers and tank barges.

The U.S.-flag fleet of commercial size (1,000 gross tons and over) contained 394 privately owned ships in 1992, consisting of 201 tankers, 23 bulk carriers, 167 freighters and 3 combination passenger/cargo vessels. There are also 225 government-owned merchant ships (192 freighters)—most of which are inactive—laid up at national defense reserve fleet sites.[146] Other government ships are in use by government agencies or by state maritime academies.[147]

The private fleet was measured at 12.7 million gross tons (19.7 million deadweight tons), or some 3 percent of the world's total of 397.2 million gross tons.[148] Clearly the U.S. fleet, ranking 10th in the world, is not a major factor in international commerce. However, many of the ships registered in those countries with far larger fleets—such as Liberia (first in the world

FIGURE 2–7

U.S. Oceanborne Foreign Trade Routes



with 52.6 million gross tons), Panama (second in the world), Cyprus, the Bahamas, and British Dependent Territories—are believed to be owned by U.S. nationals or U.S.-owned firms.[149] Ships registered under such *flags-of-convenience* operate under a variety of more advantageous circumstances regarding vehicle operating and capital costs than do U.S.-flag carriers.[150]

Private U.S. ships are relatively more important among freighter fleets, particularly in the container trade (with 92 containerships, 52 partial containerships, 50 roll-on/roll-off vessels, and 19 barge carriers),[151] ranking sixth in the world (after Panama, China, Liberia, Cyprus, and Germany).[152] The U.S. rank is 29th in bulk carrier fleets, but sixth in tanker fleets (201 of the 5,542 ships—4 percent—and 7.7 million of the 153.3 million gross tons—5 percent).[153]

These several U.S.-fleet rankings are likely to fall in relation to other fleets, however, because U.S. vessels are not being augmented by new purchases. In 1991, another 601 ships were added to the world fleet, increasing it by 1.8 million dead-weight tons. No new ships were added to the U.S. fleet.[154] In the past ten years, the private U.S. fleet has decreased 31.4 percent in number of ships and 8.2 percent in dead-weight tons.

Other Vessels. The supply of vessels using ports and harbors, lakes and waterways is more extensive and more varied than has been described above. There are ocean going ocean-port-operated tugs and workboats (totaling 1,752 in 1989), and there are ocean-going dry cargo and tank barges (4,365 in 1989).[155] The U.S. had some 16 million recreational craft in 1990: 75,000 motorboats and 36,000 craft more than 5 tons operating as fishing vessels.[156] While these vessels may not place the same demands on infrastructure and maintenance as deep-sea ships or barge operations, clearly their operations affect the facilities provided, their condition and their performance.

Inventory of Ports, Waterways, and Navigation Facilities

Great Lakes Harbors. There are 96 commercial harbors on the Great Lakes in the territorial waters of the United States. Nineteen of these are private harbors, and have been constructed, and are operated and maintained, by private entities. The other 77 are federal harbors, with construction, operation and maintenance by the federal government. The Great Lakes harbors can be characterized according to operating depth; 36 of which are less than 20 feet in depth and therefore can only handle less than 1 percent of all freight transported on the Lakes. The top three commercial harbors in order of freight tonnage handled in 1989 were Duluth-Superior, Chicago, and Detroit. The top-ranked private harbor in 1989 was Calcite, Michigan, which ranked eleventh among all harbors on the Lakes.[157]

Connecting Great Lakes Channels. While important Great Lakes bulk-shipping operations take place solely within one or another of the Lakes, the longer-distance hauls from one lake to another and those with a trans-Atlantic terminus, require the use of connecting channels. Most of these are man-made or maintained through dredging and systems of locks. Moving from west to east, the St. Mary's River connects Lake Superior and Lake Huron, and contains the St. Mary's Falls Canal with four U.S. locks and one Canadian lock (the Soo Locks) handling the 20-foot drop from Superior to Huron. Lakes Michigan and Huron are connected by the Straits of Mackinac, which requires no locks and offers no constraint to ships except at two locations, Round Island Passage and the Poe Reef Shoal, where channel depth is 30 feet. Lakes Huron and Erie are connected by the St. Clair-Detroit River system, with a drop of eight feet; except for some dredging, this system is not a constraint to navigation between the two lakes. Lakes Erie and Ontario are connected by the Niagara River—with a 326-foot drop managed by the Welland Canal (the commercial link, situated entirely within Canada, and with eight locks) and the Black Rock Lock (connecting with the New York State Barge Canal—the current version of the Erie Canal—handling primarily recreational boating). Finally, the St. Lawrence Seaway spans 182 miles from Lake Ontario to Montreal, where the St. Lawrence River then runs an additional 340 miles to its mouth at Father Point, and the Gulf of St. Lawrence extends a final more than-700 miles to connect with the Atlantic. The Canadian government maintains a minimum navigable depth of 35 feet in the thousand-mile stretch of water from the open Atlantic. The Seaway has five subsections, three solely within Canadian waters and the other two in international boundary waters. The Seaway's seven locks permit ships to rise some 225 feet to Ontario.[158]

Inland and Intracoastal Waterways. In addition to the Great Lakes portion, the U.S. waterways system consists of three geographic groupings of waterways. The Mississippi River and its tributaries, and the Gulf Intracoastal Waterway and the rivers that intersect it, are an interconnected network that accounts for about 86 percent of the route length of the overall system. The Atlantic Intracoastal Waterway (linking ports from Miami to Norfolk, as an alternative to deep-draft coastal navigation) is the second largest system, with some 11 percent of all system mileage. The Columbia-Snake Rivers System is the shortest system, linking deep-water ports on the Columbia with inland Washington, Oregon and Idaho ports. The commercially active portion contains 10,673 miles with 168 lock sites and 211 lock chambers.[159] The overall system (including many other more minor waterways) totals more than 25,000 commercially navigable miles.[160]

Navigation Facilities. The Coast Guard operates the Aids to Navigation System (buoys and light houses) throughout the U.S., and eight vessel traffic service systems (VTS) at selected ports, akin to the air traffic control system. VTS monitors vessel traffic and navigation hazards through remote sensors and radio communication with vessels. The information and advisories provided help prevent collisions, grounding and other accidents. Of particular concern are hazardous material spills, but the estimated costs of emergency response to vehicle accidents, vessel damage and human deaths, and damage to bridges are also high.[161] Current VTS capabilities are not viewed as adequate. Some 23 port zones (encompassing 82 major U.S. ports and their adjacent bays, rivers, seaward approaches and other bodies of water) were analyzed by DOT's National Transportation Systems Center in a 1992 Port Needs Study. Seven of these zones were recommended for initial consideration in establishing or improving VTS systems. The investment required for these and other VTS improvements has been estimated by the U.S. Coast Guard to equal $145 million through fiscal year 2001.[162]

Shallow-Draft Ports on Inland and Intracoastal Waterways. There are 17 major shallow-draft inland waterway ports, each with more than a million tons of commerce annually. Seven of the 17 are located along the Mississippi River, five are on the Ohio, and the remaining five are on the Missouri, Cumberland, and Tennessee rivers and on the Gulf Intracoastal Waterway.[163]

Various surveys and reports suggest some 2,100 bulk cargo docks or terminals exist along the major waterways. These include 1,350 dry bulk docks for general cargo, forest products, building materials and unitized cargo total around 500. Average dock length is 500 to 700 feet (2.5 to 3.5 barge lengths), except for major coal terminals which average some 1,900 feet. Storage is present at about 70 percent of the docks.[164]

Coastal Ports and Harbors. The U.S. has 75 key ocean ports and port authorities, which may operate more than one port. The top five, as measured by capital expenditures in the 1979-1989 period were: Los Angeles; Long Beach; the Port Authority of New York and New Jersey; the Maryland Port Administration; and Oakland.[165] These port entities can be multistate and/or multicity regional or local authorities, departments of city or county government, and departments of state government (or of commonwealth or territorial government). In any event, they have a wide variety of responsibilities (in waterborne commerce, warehousing and distribution; in other modes of transportation; and in other government and commercial activities). No aggregate description of their facilities and resources appears to exist, but extensive information about port commodity flows from major to minor ports is reported in a later chapter.

Water Carriage

Barge Operators. The ICC's most recent annual report indicates there were 360 water carrier companies in 1992.[166] The number of carriers has increased greatly in recent years, from 82 in 1970 and 1980, to 327 in 1990.[167]

Ocean Shipping. There were six maritime carriers in 1991, however, in contrast with the rising trend in number of barge operators, the number of U.S.-flag maritime operators has fallen. International ocean commerce is dominated by conferences of operators from many countries, but the various ocean trades or markets (North Atlantic, Transpacific, etc.) have quite limited competition among the conferences that serve them.[168] Coastal trade (and trade to Alaska, Hawaii, and U.S. commerce within the Great Lakes, as well as certain agricultural and foreign-aid shipments) is limited to vessels approved to carry shipments under the Jones Act (the U.S. cabotage law). Foreign-flag competition is not allowed. About half the U.S. -flag fleet has unrestricted domestic trading privileges to supply these domestic markets.[169]

The Condition of Water Transportation

Great Lakes. The Great Lakes fleet is relatively old, with 15 of the 69 bulk carriers exceeding 50 years of age and 47 of the 78 vessels in use more than 30 years old. However, it should be noted that freshwater ships do not weather as rapidly as those in ocean trades. Moreover, one source states:

> *The U.S. Great Lakes fleet is modern and efficient. The strength of the fleet lies in the 13 Class 10 vessels, which can carry bulk cargoes long distance on the upper four Great Lakes very economically, as well as the large number of self-unloading vessels of all sizes ....[L]arge numbers of old lake vessels have been scrapped since 1980, while the average size of cargo shipments has increased greatly.*[170]

As to locks, ports, and harbors serving Great Lakes and Seaway traffic, while annual expenditure information for operations, maintenance and facility investment may be available, data on the physical condition of facilities, on the depreciated value of these investments, and on the replacement value do not appear readily at hand. However, studies of investment needs have been performed (as with other modes). For example, a replacement lock at Sault Ste. Marie, Michigan, was estimated in 1991 to cost $280 million, but, overall conditions and investment figures for the entire system could not be located.[171] Even if facility conditions were to be considered satisfactory, and although vessels may be viewed as modern and efficient, the relative role of Great Lakes shipping has been declining for a number of decades.

Inland Waterways. As of 1992, 85 of the 211 lock chambers on the commercially active waterways were considered aged—over 50 years old. Even with projected replacements, 85 lock chambers are still expected to be over 50-years-old by the year 2000. The median age of all chambers is about 35 years.[172]

Waterway system performance is affected by lock age and capacity, but also by processing and delay time, traffic characteristics and congestion, and by water levels—as a result of drought and flood periods. While the waterways, more than most transport systems, define and measure these elements of performance, no overall, system-wide measure of performance is produced. Rather, a Performance Monitoring System provides rankings of locks based on average delay, total delay time, average processing time, total down time, total stall events, and lock traffic.[173] No dollar measure is calculated of the cost to users of performance deficiencies.

Barge capacity, towboat/tug power, and the number of barges in a tow have been rising. The average age of medium-horsepower towboats operating in the Mississippi-Gulf Intracoastal region in 1988 was 17 to 22 years. These comprised 24 percent of the fleet (770 boats) and 42 percent of the horsepower operating on that system. High horsepower boats (7 percent of the fleet—54 boats—with 30 percent of the horsepower) averaged 13 years.[174]

Ocean Ports and Deep-Sea Shipping. No port conditions information appears to be available on a national level. Data about delays or congestion are absent, and no overall performance measures have been established. Ship age and condition information are available and suggest that the U.S.-flag fleet is aging without replacement.

TABLE 2–9

Water Transportation Employment

Sector	No. of Employed (est.)
Ships, Boat Building and Repairing	177,700
Total Water Transportation	173,400
Corps of Engineers	
Operations and maintenance	2,750
Oversight of construction and system administration	2,500
Maritime Administration	1,146
Saint Lawrence Seaway Development Corporation	174
U.S. Coast Guard (civilian employment)	6,412
TOTAL	370,500

Pipeline Transportation

There are two primary categories of pipelines—oil and gas. Oil pipelines transport crude petroleum and various petroleum products—gas pipelines move natural gases and liquefied petroleum gases. Oil pipelines comprise: gathering lines, eight inches or less in diameter which carry crude oil from wellheads to storage tanks; trunk lines, averaging 12 inches in diameter, which move oil from production areas and import terminals to refineries; and petroleum product lines, moving gasoline and other products from refineries to marketing terminals.[175] Gas pipelines similarly include: field and gathering lines of 2 to 4 inches in diameter moving natural gas from the wellhead to field processing; transmission lines, 24 to 36 inches in diameter, to move gas from the production field to local distribution or storage facilities; and distribution lines, two to six inches in diameter, to take gas to the final user.

Inventory of Pipelines and Terminals

Oil Pipelines. Almost 204,000 statute miles of oil pipelines were in operation in 1991, a decline from the nearly 219,000 miles operated in 1970. About 66,000 miles are trunk lines, 50,000 miles are categorized as gathering lines, and the remaining 88,000 miles are product pipelines. The relative proportion of product lines to crude oil lines (both trunk and gathering) has grown over the years, from 33 percent in 1970, to 41 percent in 1980, and to 43 percent in 1991.[176]

Natural Gas Pipelines. The extent of the oil pipeline system has been steady or contracting for the past two decades, while in contrast, natural gas pipelines had 16,000 more miles of transmission line in 1991 than in 1980, and 157,000 more mile of distribution line. Gas pipeline mileage is more extensive than that of oil pipelines, and the systems are growing in extent rather than contracting. (See table 2-10.) There were about 282,000 miles of gas transmission pipelines in 1991 in addition to more than 857,000 miles of distribution pipeline. The three-to-one ratio of distribution lines to transmission lines has also been growing (from 2.62 in 1980, to 2.99 in 1990, to 3.04 in 1991), most likely as a reflection of the further suburbanization of America and population shifts to the West and the Southeast, areas of relatively heavy consumption of natural gas energy requiring extended distribution systems.[177]

Pipeline Employment

Oil pipeline employment was estimated at 19,000 in 1992, a figure that has been roughly static for the past 30 years.[178] The number of persons employed by gas pipelines, in the production of pipeline equipment, and the number of government safety and economic regulators, is not reported separately, but the oil pipeline employment figure includes persons involved in petroleum production and distribution.

Pipeline Carriers

Natural Gas. In 1991 there were 44 major gas pipeline companies regulated by the Federal Energy Regulatory Commission (FERC) filing full annual reports.[179] In total, there are 125 gas pipeline operators.[180]

The Condition of Pipeline Transportation

The pipeline system is aging and while data are unavailable, concern has been expressed over the effects of corrosion and erosion of the pipe over time, which reduce its ability to support stress and higher pressures. However, pipelines are long-lived capital assets, and only the oldest facilities are likely to be at major risk. Some 19 percent of natural gas pipelines were built before 1950, while most of the liquid product lines were built after 1950 (and product lines account for more than half the pipelines). Moreover, preventive efforts such as frequent monitoring, corrosion control programs, and selective rehabilitation or replacement can be taken to offset the effects of aging.[181]

Intermodal Transportation

Clearly, terminal facilities such as airports and seaports, among others, are intermodal—for passengers and freight. A good portion of the stock of transport equipment has intermodal use, e.g., truck-tractors, while other parts of transportation fleets are specifically dedicated to intermodal operation, e.g., double-stack rail cars. Transportation employees work with intermodal shipments, sometimes interchangeably with shipments that utilize a single mode. However, one element of intermodal equipment that is dedicated in use, and for which statistics are gathered, is the ocean container.

The Maritime Administration has produced an *Inventory of American Intermodal Equipment* on an occasional basis since 1971. Container inventory data are published for January 1, 1990. The data cover the intermodal equipment of 10 U.S.-flag marine carriers and 12 leasing companies operating in the United States. The information also includes shipborne barges, Roll on/Roll off trailers, and container chassis. Although the data for this rapidly changing portion of the transportation system are neither current, nor complete, they are quite detailed by size of container (from 5-to-10 foot, up to 53-foot) and by container type (dry van, refrigerated, garment, open top, tank, platform, etc.). There were 1.7 million containers in 1990, totaling 2.4 million 20-foot container equivalents (TEUs).[182] Similar information about the stock of ocean containers does not appear readily available for other countries, although data about international movements of TEUs do seem to be.[183] Key summary information about the inventory follows.

U.S.-flag carriers own 13 percent of the containers and leasing companies own the remaining 87 percent. Carriers prefer 40-foot containers while leasing companies prefer 20-foot ones.[184]

The Transportation Network: What More We Need to Know

Transportation data that present the physical situation in the several modes—network, vehicles, etc.—are more complete as a general matter and extend over a longer period for the modes that can claim extensive and long-term federal government interest. Highway data, in particular, are full and comprehensive, but even in the case of highways, gaps exist. Bridge and highway data have been maintained separately until recently, and information about these facilities needs to be merged in order to provide condition data for managing complete systems. The extent of private roads and streets is unknown; yet financing through subdevelopment and the requirement on the private developer to provide facilities and for the homeowners association to maintain the facilities, means the growth of more private systems is likely. Private toll roads are being planned and built in Orange County, California and elsewhere, and data about these facilities, their traffic, and their costs need to be entered. In general, the inventories of modes that are primarily in private hands (including those subject to reduced economic regulation for the past decade and a half) are less fully tracked, and information is becoming more scanty with every passing year.

The least understood major modes of transportation in terms of extent, number of providers, and status of physical infrastructure are railroads, buses, and taxicabs. Railroads are private companies, and are reluctant to share information on the condition of their physical plant that might give competitors an advantage in the marketplace. The bus industry is difficult to measure—even for simple characteristics like the number of service providers—because the industry is scattered among a large number of local operators, charter companies, and school districts that are not covered by the programs of the Federal Transit Administration. The extent of taxicab operations is hard to identify because the industry contains a large and volatile number of operators who are regulated only at the local level.

For highways, as well as other freight and passenger modes, terminal location, throughput, and condition information is often missing. Highway terminals could be a focus for investment analysis for funding under the Intermodal Surface Transportation Efficiency Act, (ISTEA) of 1991,[185] but their very existence—let alone information needed to permit development of hierarchical project reviews—is not recorded on a national grid.

Other modes, the subject of more recent nation attention, have less than full data bases. Bicycle inventory information, for example, is not kept by federal or state authorities. The condition of the bicycle inventory, or of the bikeway inventory for that matter, is not even defined.

Intermodal data are not readily found. For example, how many vehicles are used in airport ground transportation service, and what types of service are available? Although individual airports may keep some of these data, no national compilation is made.

Data on the condition of the infrastructure and the vehicles of many modes are missing or inadequate. Capital conditions are poorly described, and the condition of the human capital is rarely even discussed let alone measured. Port capital needs figures are to be found, but measures of the condition of current facilities are not. Some of the government capital, such as navigation equipment, has no easily defined index of condition, so the need for replacement or upgrading is difficult to ascertain.

Finally, U.S. transportation facilities are not entirely self-contained, and

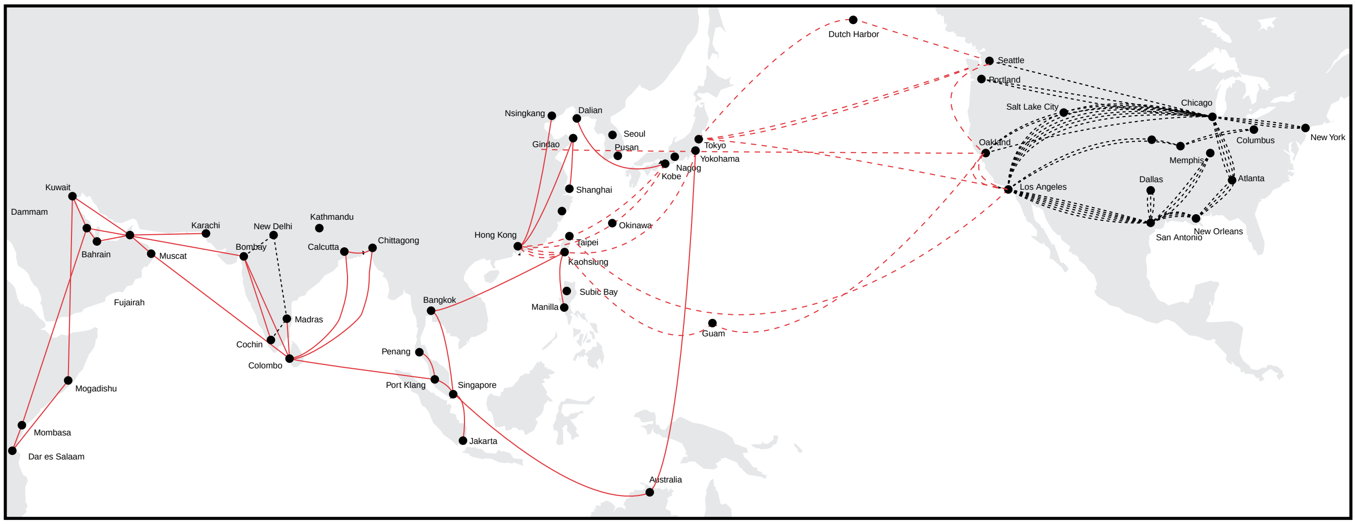
TABLE 2–10

Oil and Gas Pipeline Extent in the U.S.: 1980 to 1991

Year	Mileage of Pipelines			
	Oil lines		Gas lines	
	Crude	Product	Transmission	Distribution
1980	129,791	225,600	262,200	700,100
1990	118,799	249,300	276,900	836,700
1991	115,860	242,300	278,300	857,400

FIGURE 2–8

Intermodal Network – The American President Lines Example



international connections data are sparse. (See figure 2-8.) Land connection conditions for highway, pipeline and rail are missing; in addition, air and water service interconnection information needs to be provided, particularly with the recent large increases in trade occurring and anticipated among North American countries.

Better information on the extent and location of the transportation system is needed so that we know where its benefits and costs are accruing, and can understand this system in which we are so heavily invested. This knowledge will allow intelligent use of the system in normal times as well as in times of crisis.

Sources

Figures

Figure 2-1: U.S. Department of Transportation, *National Transportation Strategic Planning Study*. Washington, D.C.: Government Printing Office, March 1990, 10-1.

Figure 2-2: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 2-3: U.S. Department of Transportation, *National Transportation Strategic Planning Study*. Washington, D.C.: Government Printing Office, March 1990, 10-4.

Figure 2-4: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 2-5: Volpe National Transportation Center. Note: The size of each circle represents total passenger miles of travel by rail and bus transit for the metropolitan area or consolidated metropolitan area. The light slice is for commuter railroads, the dark slice is for other rail transit, and the white slice is for bus transit.

Figure 2-6: U.S. Department of Transportation, *National Transportation Strategic Planning Study*. Washington, D.C.: U.S. Government Printing Office, 1990, 14-4.

Figure 2-7: U.S. Department of Transportation, *National Transportation Strategic Planning Study*. Washington, D.C.: U.S. Government Printing Office, 1990, 14-8.

Figure 2-8: American President Companies.

Tables

Table 2-1: Bureau of Transportation Statistics.

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Table 2-5: Assocation of American Railroads. *Railroad Facts*. Washington, D.C.: Association of American Railroads, 1993, 45. Note that the total figure for miles operated, 169,664, includes 901 miles of road operated by Class I railroads in Canada and trackage rights for operations in the U.S.—therefore, it differs from the current net figure of 113,056 miles of road.

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Table 2-8: U.S. Department of Transportation, The Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, 1993. Washington, D.C.: U.S. Department of Transportation, 1993, 14. (Similar condition data are not currently available for the age or condition of bus and paratransit maintenanc garages and other fixed facilities, such as terminals, stations, waiting areas, and park-and-ride lots.)

Table 2-9: Institute for Water Resource. The 1992 Inland Waterway Review. Ft. Belvoir, VA: U.S. Army Corps of Engineers, 1992, ES-3,4. (This source also reports total private sector employment associated with the waterways system, 175,000; inland waterway vessel operations and supporting service, 50,000.) Strategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transporation, 1993.

Table 2-10: Oil and Gas Pipeline Extent in the U.S., 1980-1992. U.S. Department of Transportation, National *Transportation Statistics Annual Report 1993,* Washington, D.C.: U.S. Government Printing Office, 1993, p. 39. Stategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transportation.

Endnotes

1. *The Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, Report of the Secretary of Transportation to the United States Congress Pursuant to Section 307(h) of Title 23, United States Code, and Section 308(e) of Title 49, United States Code* (Washington, D.C.: GPO, 1993), 1, 19.
2. Private facilities include subdivision roads and roads or highways serving industrial facilities and shopping centers. Although there are believed to be more of these facilities today than in the past, no national data exist. Other roads exist that are owned by public bodies, but not open to public use, such as U.S. Forest Service roads (see *The Status of the Nation's Highways, Bridges and Transit, op. cit*., 28) and roads on military bases. These are not included in the 3.9-million-mile figure, and the mileage of these roads are not readily available. Also excluded from the 3.9-million-mile total are miles of roads in the Commonwealth of Puerto Rico [14,036 miles in l993; U.S. Department of Transportation, *Highway Statistics 1992* (Washington, D.C.: GPO, 1992), 206] and in American Samoa, Guam, the Virgin Islands and the Northern Marianas (1,853 miles; Highway Statistics 1992, op. cit., 227).
3. U.S. Department of Transportation, *National Transportation Strategic Planning Study* (Washington, D.C.: GPO, 1990), 10-2.
4. *National Transportation Strategic Planning Study, op. cit*., 6-3, 6-4, 6-6.
5. Total road and street mileage was 2.35 million miles according to the earliest special survey in 1904; there were 3.2 million miles by 1921 and 3.6 million by 1961. The current 3.9 million figure was first

reached in 1979. *See Highway Statistics, Summary to 1985* (Washington, D.C.: U.S. Department of Transportation, 1987, 187.

6. It was only in 1943 that the proportion of surfaced mileage—including gravel and stone—reached 50 percent, and it was not until 1972 that the proportion reached 80 percent. Calculated from *Highway Statistics, Summary to 1985, op. cit.*, 187. The proportion in 1991 was 92 percent, however 33 percent—1.3 million miles—was gravel or stone surfaced. Calculated from *Highway Statistics, 1991, op. cit.*, 123.
7. *The Status of the Nation's Highways, Bridges and Transit, op. cit.*, 30. Bridges are often inventoried (as well as managed) separate from the remainder of the highway due to their relatively high cost and longer-life characteristics.
8. There were 575,000 bridges in 1985 [see U.S. Department of Transportation, *Eighth Annual Report to Congress, Highway Bridge Replacement and Rehabilitation Program* (Washington, D.C.: U.S. Department of Transportation, 1987), 6], and 565,000 in 1982 [see U.S. General Accounting Office, *Limited Funds And Numerous Deficient Off-System Bridges Create Federal Bridge Program Dilemma* (Washington, D.C.: U.S. General Accounting Office, 1985), 7].
9. These major functional systems are further subdivided into rural and urban segments, and each of those has more detailed divisions, such as principal and minor arterials, or major and minor collectors. *See The Status of the Nation's Highways, Bridges and Transit, op. cit.*, 20 ff.
10. The National Highway System was mandated by the Intermodal Surface Transportation Efficiency Act of 1991.
11. *Highway Statistics, 1991, op. cit.*, 146.
12. The National Network for Trucks was established through the Surface Transportation Assistance Act of 1992, and allows the operation of truck-tractor and 48-foot trailer combinations and truck-tractor and 28-foot twin trailer combinations of l02-inch widths with no overall length limitations.
13. *National Transportation Strategic Planning Study, op. cit.*, 10-1 and Figure 10-2.
14. *Highway Statistics, 1992, op. cit.*, 17.
15. *Highway Statistics, 1991, op. cit.*, 16. This source contains no data on bicycles.
16. *Highway Statistic, 1992, op. cit.*, 31.
17. *National Transportation Strategic Planning Study, op. cit.*, 6-5.
18. *Highway Statistics, 1991, op. cit.*, 19, 21.
19. *Highway Statistics, 1992, op. cit.*, 20.
20. *Highway Statistics, Summary to 1985, op. cit.*, 25.
21. *Highway Statistics, 1992, op. cit.*, 20.
22. *Highway Statistics, 199l, op. cit.*, 17.
23. U.S. Department of Transportation, *National Transportation Statistics, Annual Report, 1993* (Washington, D.C.: GPO, 1993), 21. By comparison with *Highway Statistics, 1990* (Washington, D.C.: GPO, 1991, 17, auto registrations fell from 1990 to 1991 (from 143,550,000 to 142,956,000) but truck numbers grew slightly (from 44,479,000 to 44,785,000).
24. Calculated from *Highway Statistics, Summary to 1985, op. cit.*, 25 and *Highway Statistics, 1991, op. cit.*, 17.
25. It is an important economic factor in transportation, when comparing car use with the use of other urban and intercity modes, that automobiles are operated by their users rather than by hired drivers, and users may value the time they spend driving differently than the values obtained in the commercial driving market.
26. Renumber of miles in the U.S. totaled 173.1 million in 1992. *Highway Statistics, 1992, op. cit.*, 31.
27. Calculated from *Highway Statistics, Summary to 1985, op. cit.*, 50.
28. *Highway Statistics, 1992, op. cit.*, 30.
29. Frank A. Smith, *Transportation in America* (Lansdowne, VA.: Eno Transportation Foundation, Inc., 1993), 61.
30. U.S. Department of Transportation, *National Transportation Statistics, Annual Report, 1993, op. cit.*, 21, 26. Class I motor carriers are those with gross annual operating revenue of $5 million or more. There were 849 such carriers in 1991 required to file annual reports, according to the ICC. The revenue of Class II carriers falls between $1 million and $5 million, while Class III carriers have revenue of less than $1 million. ICC 92, Interstate Commerce Commission 1992 Annual Report, op. cit., 127.
31. Employment calculated from Department of Transportation, *National Transportation Statistics, Annual Report, 1993, op. cit.*, 24, where intercity bus employment is estimated at 24,500—see also p. 19 for intercity and rural bus transportation with the same 24,500—and school bus employment is estimated at 114,500. Employment and

Earnings for March 1992 estimates January 1992 employment is Standard Industrial Class 423, Intercity and rural bus transportation, at 23,800 and employment in SIC 415, School buses (commercial) at 129,200, for a higher total of 153,000. Bus registrations from *Highway Statistics, 1991, op. cit*., 20.

32. Bus figure from *Highway Statistics, 1992,op. cit*., 20. Bus employment estimate by Arthur L. Webster, EXP Associates, October 1993, based on regression estimate of 1.24 employees per bus from American Bus Association survey of members, and data from Bus Ride, which suggest 1.1 full-time employees per school bus. Were the lower estimate of 1.1 persons per vehicle to apply to private bus employers, the number of employees would be estimated at 303,000 rather than at the 139,000 presented in the above table.
33. U.S. Department of Transportation, *National Transportation Statistics, Annual Report, 1993, op. cit*. 19.
34. Some 4,016 full-time equivalents in September 1993; tabulation by Strategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transportation, 1993.
35. The civilian labor force was 116,877,000 in l991. Frank A. Smith, *op. cit*., 61.
36. *National Transportation Strategic Planning Study, op. cit*., 10-6.
37. Frank A. Smith, *op. cit*., 47.
38. Patricia S. Hu and Jennifer Young, *Nationwide Personal Transportation Survey, Summary of Travel Trends*, (Washington, D.C.: U.S. Department of Transportation), 23, 40.
39. *ICC 92, Interstate Commerce Commission 1992 Annual Report, op. cit*., 127.
40. Truckload carriers do not need to maintain the extensive terminal facilities that LTL carriers require. TL carriers can also specialize in market segments and geographic coverage.
41. The ICC does believe, however, that the motor carrier industry is intensely competitive and that figures showing a great deal of entry by new carriers since deregulation under the Motor Carrier Act of 1980 even understate the substantial extent of competition, due to such comparatively recent changes as the development of contract, 48-state, and brokerage authorities. *ICC, Interstate Commerce Commission 1992 Annual Report, op. cit*., 53.
42. *National Transportation Statistics, Annual Report, 1993, op. cit*., 26.
43. *ICC 92, Interstate Commerce Commission 1992 Annual Report, op. cit*., 127. Although intercity bus operators may carry primarily passengers—in scheduled service or in charter operation—they also transport freight packages.
44. Greyhound purchased Trailways in l987, and the firm now dominates the industry with 75 percent of revenues and 43 percent of passengers. *U.S. General Accounting Office, Federal and State Efforts to Support Declining Intercity Bus Service* (Washington, D.C.: U.S. General Accounting Office, 1993), 3.
45. ICC 92, Interstate Commerce Commission 1992 Annual Report, op. cit., 53.
46. Many businesses maintain their own private trucking fleets—or operate trucks under lease arrangements (which may include leasing of vehicles, drivers, and—indeed—management of the trucking operation). Besides moving the products or inputs of the business (and affiliated businesses), these private carriers may also transport goods for hire.
47. Frank A. Smith, *op. cit*., 46. The statistics are not entirely clear as to whether nonregulated carriage is equivalent to private carriage, but it appears reasonable to assume an equivalency in the majority of cases. Private truck carriage does appear to have somewhat different aggregate operating characteristics than does the for-hire segment of trucking, although both operate identical equipment in many instances. For example, private carriage operates shorter distances or smaller loads than for-hire trucking, as suggested by the intercity ton-mile figures: 11.4 percent of all intercity ton-miles are produced by ICC-regulated trucks and 15.8 percent by non-ICC trucks. (The ton-mile is an output measure, of a ton of cargo transported a mile.)
48. Frank A. Smith, *op. cit*., 61.
49. However, it should not be assumed that current highway condition measures find universal acceptance [for example, *see U.S. General Accounting Office, Bridge Condition Assessment, Inaccurate Data May Cause Inequities in the Apportionment of Federal-Aid Funds* (Washington, D.C.: U.S. General Accounting Office, 1988)], nor that the application of condition measures to signal investment needs is non-

controversial.

50. *Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 89.
51. *Op. cit.*, 119. Functional adequacy involves land and shoulder width and vertical clearance which need to be sufficient to accommodate the traffic demand.
52. A structurally deficient bridge is defined as a bridge that is not capable of accommodating the loads expected of a structure on the highway system of which the bridge is a part.
53. *Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 5.
54. There has been a substantial increase of more than one-third in heavy truck sales in the first three quarters of 1993 compared with 1992. John D. Schulz. "Sustained Boom in Truck Equipment Good News for Shippers and Manufacturers," *Traffic World*, vol. 236, No. 7 (November 15, 1993), 46, 49.
55. *Highway Statistics, 1991,op. cit.*, 202, 212.
56. *U.S. Federal Highway Administration, Our Nation's Highways*, Selected Facts and Figures, Washington, D.C.: U.S. Department of Transportation, 1992, 18. The age of pickup trucks and vans averages slightly older—7.8 years in l983 versus 6.7 years for cars, and 8.0 years in 1990 compared with 7.6 for autos. See Patricia S. Hu and Jennifer Young, *op. cit.*, 26. However, new car sales and truck sales appear to be up in 1993. *See* Robert L. Rose, "Truck Makers Leave Sales Slump in Rear-View Mirror," *Wall Street Journal* (November 16, 1993), B4.
57. A figure given for driver training costs is $30,000. Seating Every Truck, Traffic World, Vol. 236, No. 5 (November 1, 1993), 31.
58. *See Transportation Professionals, Future Needs and Opportunities. Transportation Research Board Special Report 207* (Washington, D.C.: National Research Council, 1985).
59. *Transportation in an Aging Society, Improving Mobility and Safety for Older Persons. Transportation Research Board Special Report 218*, Vols. 1 and 2 (Washington, D.C.: National Research Council, 1988).
60. Federal Aviation Administration (FAA), U.S. Department of Transportation, *FAA Statistical Handbook of Aviation, Calendar Year 1990* (Washington, D.C.: GPO, 1992), 3-3 for 1990, and U.S. Department of Transportation, *FAA Statistical Handbook of Aviation, Calendar Year 1989* (Washington, D.C.: U.S. Department of Transportation, n.d.), 3-3 for l980.
61. NPIAS is a federal plan produced by the Federal Aviation Administration containing improvement recommendations for the nation's airport.
62. U.S. Department of Transportation, *National Plan of Integrated Airport Systems (NPIAS), 1990-1999* (Washington, D.C.: GPO, 1991), 1.
63. Calculated from *FAA Statistical Handbook of Aviation, Calendar Year 1990, op. cit.*, 3-3.
64. *National Plan of Integrated Airport Systems, op. cit.*, 1.
65. *National Transportation Strategic Planning Study, op. cit.*, 6-10.
66. *National Transportation Strategic Planning Study, op. cit.*, 11-1; *National Plan of Integrated Airport Systems, op. cit.*, 1.
67. *National Plan of Integrated Airport Systems, op. cit.*, 3, 4.
68. *U.S. Department of Transportation, National Transportation Strategic Planning Study, op. cit.*, 11-2.
69. *FAA Statistical Handbook of Aviation, Calendar for 1991*. (1993)
70. Low altitude means below l8,000 feet, while high-altitude routes extend from 18,000 to 25,000 feet.
71. Twenty-six of these towers are operated by nongovernment controllers under contract to the FAA. There are also 188 terminal radar approach control (TRACON) facilities, with controllers to monitor airspace surrounding the busier airports. *FAA, Air traffic Fact Book, May 1993*, and FAA staff, December 20, 1993.
72. *National Transportation Strategic Planning Study, op. cit.*, 11-4—11-5.
73. *U.S. Department of Transportation, Census U.S. Civil Aircraft, Calendar Year 1991* (Washington, D.C.: GPO, 1992), 1-4. There are perhaps 20,700 military planes, as reported for 1987. U.S. Department of Transportation, *National Transportation Strategic Planning Study, op. cit.*, 11-7.
74. National Transportation Statistics, FAA Staff, December 20, 1993..
75. Frank A. Smith, *op. cit.*, 63.
76. *Census U.S. Civil Aircraft, Calendar Year 1991, op. cit.*, 2-10.
77. *Census U.S. Civil Aircraft, Calendar Year 1991, op. cit.*, 2-12.
78. Of these, 129,000 were student certificates; 108,000 were airline transport cer-

tificates instrument rated). *FAA Statistical Handbook of Aviation, Calendar Year 1990, op. cit.*, 7-3, 7-12. The total included 28,000 pilots located outside the U.S. *FAA Statistical Handbook of Aviation, Calendar Year 1990, op. cit.*, 7-6.

79. Ibid.
80. Frank A. Smith, *op. cit.*, 61, 62.
81. Full-time equivalent employment in September 1993. Tabulation by Strategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transportation, 1993.
82. Not including aircraft and parts manufacturing—617,000 in 1992 and such other employees as those who work for and at airports, Frank Smith, *op. cit.*, 61.
83. *National Transportation Statistics, op. cit.*, 12 and *National Transportation Strategic Planning Study. op. cit.*, 11-6.
84. The latest available issue of the *National Plan for Integrated Airport Systems* (NPIAS) (1991) states that the factors to be considered in a condition and performance system would be ". . . safety, capacity, conformity to FAA design standards, condition of facilities, ability to accommodate forecasted growth, and compatibility of land uses in the surrounding area." [p. 13] Data presently available and published, though, are primarily about delay and runway pavement condition, although some qualitative information on aircraft noise and safety is presented in the NPIAS. Capacity and delay are not particularly easy to define, measure, and manage in air transportation. *See Airport System Capacity, Strategic Choices. Special Report 226* (Washington, D.C.: Transportation Research Board, National Research Council, 1990), 12-16. The FAA has been criticized for being slow to develop performance measures. *See U.S. General Accounting Office, Airport Improvement Program, Opportunity to Consider FAA's Role in Meeting Airport System Needs* (Washington, D.C.: U.S. General Accounting Office, 1993), 6, 10.
85. There are three FAA traffic delay systems. One uses the Air Traffic Operations Management System, recording daily the number of flights delayed 15 minutes or more and the cause of delay. A second system is maintained elsewhere within the U.S. Department of Transportation to advise consumers monthly of the number of times each flight is 15 minutes or more behind schedule. A third is called the Standardized Delay Reporting System and uses reports from three major airlines about the delay encountered in four phases of flight, where the definition of delay is the difference between actual flight time and what might have been achieved in the absence of other aircraft in the system or problems with equipment outages or severe weather. See U.S. Department of Transportation, *National Plan for Integrated Airport Systems, op. cit.*, 13. The FAA reports that it ". . . is developing an improved aircraft delay data system to provide a single, integrated source of data to answer most analytical questions about delay at a detailed level." Ibid. Delay information is used to analyze airport congestion, and leads to the finding that in 1988, twenty-seven of the nation's busiest airports experienced average delay exceeding 7 minutes per operation. U.S. Department of Transportation, *op. cit.*, 14.
86. Building new airports to reduce delay (as opposed to improving current facilities) does not appear to be a very acceptable option, certainly not for the near future. *Airport System Capacity, Strategic Choices, op. cit.*, 12.
87. *National Plan for Integrated Airport Systems, op. cit.*, 19.
88. The FAA rules include "Structural Maintenance Program General Guidelines." See Paul Page, "Cargo carriers concerned that rules on aging planes will spur lifespan limits," *Traffic World*, Vol. 236, No. 4 (October 25, 1993), 21.
89. "FAA official warns of tougher noise demands beyond stage 3," *Traffic World*, Vol. 236, No. 4 (October 25, 1993), 25.
90. Fred Bayles, "As pilots retire, airlines will be winging it," *Chicago Tribune* (October 31, 1993), Section 17, Transportation, 1, 5.
91. In addition, some private rail services exist (such as the in-plant trackage of steel mills) as do some U.S. Department of Defense lines. The Defense Department has designated 33,000 miles of civil lines and an additional 5,000 miles of connector lines as being within a Strategic Rail Corridor Network (STRACNET). *See* U.S. Department of Transportation, *National Transportation Strategic Planning Study* (Washington, D.C.: GPO, 1990), 16-3.
92. The high point was in 1929, with 229,530 miles of railroad in operation, and as recently as 1970 the system comprised

206,265 miles of road, with 366,332 miles of track. Note that miles of track owned differs from miles of road by including multiple main tracks, yard tracks, and sidings. Association of American Railroads, *Railroad Facts* Washington, D.C.: Association of American Railroads, 1993), 44.

93. Ibid. Miles of track in 1992 totaled 190,691. From 1970 to 1992 the road miles declined 45 percent while the miles of track fell 48 percent, making the decline in double trackage, yards and sidings slightly greater than the decline in rail main-lines, secondary mains, and branch-lines.
94. *National Railroad Passenger Annual Report 1992* (Washington, D.C.: Amtrak Public Affairs Office [1993]), 17.
95. *Background on Amtrak* (Washington, D.C.: National Railroad Passenger Corporation, 1977), 27.
96. Or in the petroleum pipeline equivalent of gathering lines, trunk lines and product lines—or the gas pipeline categories of field and gathering, transmission, and distribution main-lines.
97. Size is measured by operating revenue of the firms in the industry.
98. *Railroad Facts, op. cit.*, 47.
99. The ICC revenue threshold for Class II carriers is $20.1 million; Class III carriers are smaller.
100. *Railroad Facts, op. cit*., 3. The AAR is a private trade association of railroads in the United States.
101. *Railroad Facts, op. cit*., 48. In 1947 some 5,772 diesel electric units were operated, 35,108 steam engines were used, and the railroads had 821 electric units. In 1992 all the units operated were diesel electric. Ibid.
102. About l.9 percent of the locomotive fleet has been purchased new annually over the past decade. Calculated from data in graph, Percent of Fleet Purchased New Each Year, *Railroad Facts, op. cit*., 54.
103. *Railroad Facts, op. cit*., 52.
104. Equipment orders in 1993, however, appear to be higher than average. See, e.g., C & NW to acquire 1,300 hoppers, up to 65 new GE locomotives, *Traffic World*, No. 4, Vol. 236 (October 25, 1993), 18. These equipment additions, all acquired under operating leases, are said to exceed the value of the North Western’s fleet additions over the last four years.
105. Calculated from data in table Freight Cars in Service, *Railroad Facts*, op. cit., 50.
106. These inventory data are for 1992. *See National Railroad Passenger Corporation Annual Report 1992, op. cit.*, 17.
107. *Background on Amtrak, op. cit*., 14.
108. *Railroad Facts, op. cit*., 55. According to the ICC, “Between passage of the Staggers Rail Act of 1980 and fiscal year 1992, rail industry employment levels have decreased about 56 percent.” *ICC 92, Interstate Commerce Commission 1992 Annual Report* (Washington, D.C.: GPO, 1993), 25.
109. Calculated from *Economic Commission for Europe, Annual Bulletin of Transport Statistics for Europe* (New York: United Nations Publications, 1992), 42, 44-45, 81.
110. Frank A. Smith, *op. cit*., 61.
111. Full-time equivalent employment in September 1993. Tabulated by Strategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transportation, 1993.
112. *National Transportation Statistics,op. cit.*, 37.
113. In 1991, 24,596 miles. Ibid.
114. *National Transportation Strategic Planning Study, op. cit*., 13-19.
115. *National Transportation Strategic Planning Study, op. cit*., 13-19. Until 1992, when the ICC raised the threshold for Class I status from $450 million (1978 dollars) to $250 million (1991 dollars), there were 13 Class I railroads, including the Florida East Coast Railroad. ICC 92, Interstate Commerce Commission 1992 Annual Report,op. cit., 33.
116. *ICC 92, Interstate Commerce Commission Annual Report, op. cit*., 50.
117. *Railroad Facts, op. cit*., 36.
118. *Railroad Facts, op. cit*., 34. The relative percentage of loaded to unloaded miles of car operation appears to be roughly static for the past half-dozen years. Ibid.
119. *Railroad Facts, op. cit*., 46-7, 49 and 54. The U.S. Department of Transportation did survey deferred maintenance on non-Class I railroads, finding few problems. *See National Transportation Strategic Planning Study, op. cit*., 13-6. Rail passenger cars averaged 21.5 years in 1992; however, 50 new Viewliner sleeping cars are to be ordered in fiscal year 1993 to replace some 40-year-old Heritage cars. Likewise, Amtrak’s locomotives averaged 13 years of age in 1992, but 26 new train sets are to be ordered soon for the Northeast Corridor. *See National Railroad Passenger Corporation*

Annual Report, 1992,op. cit., 13, 14 and 17.

120. *National Transportation Strategic Planning Study , op. cit.*, 13-5.
121. Also, as in other modes of transport, regulatory changes may lead to changes in equipment condition. For example, changes in AAR rules make cars that lack modern journal bearings ineligible for interchange with other railroads, leading to earlier replacement than would other wise occur. C & NW to acquire 1,300 hoppers, up to 65 new GE locomotives, op. cit.
122. *The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 43. Urbanized areas as defined in the 1980 Census.
123. *Transit Fact Book* (Washington, D.C.: American Public Transit Association, 1992), 31. APTA expects to release its l993 Transit Fact Book early in 1994; telephone conversation, October 19, 1993. Detailed 1991 data for the 515 larger transit systems participating in the Federal Transit Administration's (FTA) Section 15 program are available through FTA's *National Transit Summaries and Trends For the 1991 Section 15 Report Year* (Washington, D.C.: GPO, 1993), and an annual series of related Section 15 publications.
124. "Transit includes all multiple-occupancy-vehicle passenger services of a local and regional nature provided for public use. . . ." *Transit Fact* Book, op. cit., 10. Although the definition is broad, it does not encompass all urban transportation services—such as private vans, buses, and limousines. The American Public Transit Association (APTA) is a private, international association of more than 1,000 member transit systems and related organizations in the U.S., Canada, and other countries. *Transit Fact Book, op. cit.*, 7.
125. *See* section 16(b)(2) of the Federal Transit Act
126. Funded by Section 18 of the Federal Transit Act.
127. *The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 34. The 1,600 and 3,495 agencies are part of the Community Transportation Association of America's (CTAA) data base. The CTAA is a nonprofit organization representing rural and specialized transit operators. It should be noted that the above listing of agency providers does not encompass the entire supply of urban and rural transportation providers. Although the private auto transports the majority of persons in U.S. cities and rural areas, other transportation takes place via taxicab, private van pool, subscription bus services, school buses, bicycles, motorcycles, scooters and mopeds, walking, jitneys, and a variety of other mechanisms.
128. *National Transportation Strategic Planning Study, op. cit.*, 12-4.
129. Frank A. Smith, *op. cit.*, 61. The same reference cites a figure of 478,000 for bus driver employment; this figure most likely includes school bus drivers and intercity drivers. Frank A. Smith, *op. cit.*, 62.
130. *Transit Fact Book, op. cit.*, 96.
131. Full-time equivalent civilian employment, September 30, 1993. Strategic Planning and Systems Division, Office of the Secretary, U.S. Department of Transportation, 1993.
132. Frank A. Smith, *op. cit.*, 61.
133. *National Transportation Strategic Planning Study*, 12-1. Most services are publicly provided, but by no means all—such as taxis and limousines.
134. *Transit Fact Book, op. cit.*, 10.
135. Age is used as a surrogate for physical condition, which is not measured generally for transit buses. *See The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 138.
136. No similar data exist for bus and paratransit facilities. *The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 139.
137. Based on the latest, 1983-84 Rail Modernization Study assessment. Ibid.
138. *The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 5-6. This finding is based on 1984-85 data, but deemed ". . . in general, still valid. This is because total capital spending on rail modernization since that time has been at approximately the level which FTA believes is adequate to maintain conditions." *The Status of the Nation's Highways, Bridges, and Transit, op. cit.*, 139. Although it may still be valid to state in 1993 that rail transit infrastructure in general has not changed in condition since it was last physically surveyed nearly a decade ago, the categories in which expenditure for rail investment and maintenance have been made since that time (such as new rail starts and ADA—Americans with Disabilities Act—retrofitting) would seem to make the condition findings for particular infrastructure categories obsolete, and point to the need for more current data.

FTA has such a study under way, as well as a study to provide data on bus maintenance facilities. Richard P. Steinmann, "Data Needs for Transit Policy, Finance, and Evaluation," Transportation Data Needs: Programs for a New Era, Transportation Research Circular No. 407 (April 1993), 44-48, at 45.

139. Federal Transit Administration, *U.S. Department of Transportation, National Transit Summaries and Trends for the 1991 Section 15 Report Year, op. cit*., 23.
140. *National Transit Summaries and Trends for the 1991 Section 15 Report Year, op. cit*., 22.
141. To 23 in 1991 and 65 in 1990, from as many as 1,003 in 1986. Frank A. Smith, *Transportation in America, op. cit*., 69.
142. Data for 1989. *Maritime Administration, U.S. Department of Transportation, Domestic Waterborne Trade of the United States, 1987-1989* (Washington, D.C.: GPO, 1991), 54. Also operating on the Great Lakes are "several hundred other vessels consisting of small passenger vessels, tugs, barges, ferries, dredges, railroad car floats, and miscellaneous small cargo vessels." op. cit., 2.
143. *National Transportation Statistics, op. cit*., 31.
144. *The 1992 Inland Waterway Review, op. cit*., 39, 41.
145. *Annual Bureau of Transport Statistics for Europe, op. cit*., 154-5, 158.
146. Maritime Administration, U.S. Department of Transportation, *Merchant Fleets of the World, Oceangoing Steam and Motor Ships of 1,000 Gross Tons and Over seas of January 1, 1992* (Washington, D.C.: GPO, 1992, 12.
147. Maritime Administration, U.S. Department of Transportation, *Vessel Inventory Report* (Washington, D.C.: GPO, 1992), iv.
148. *Merchant Fleets of the World, Oceangoing Steam and Motor Ships of 1,000 Gross Tons and Over seas of January 1, 1992*, 12.
149. *Vessel Inventory Report, op. cit*., 11.
150. *See National Transportation strategic Planning Study, op. cit*., 14-17.
151. In terms of container ships and similar intermodal vessels the U.S. held 203 of the 2,458 ships in these three categories (8 percent of the world total) and 4,914,000 of the 40,794,000 gross tons (12 percent). Calculated from *Vessel Inventory Report, op. cit*., 21.
152. *Vessel Inventory Report, op. cit*., 20, 33.
153. Calculated from *Vessel Inventory Report, op. cit*., 38.
154. *Vessel Inventory Report, op. cit*., 39, 50 and 56.
155. *Maritime Administration, U.S. Department of Transportation, Domestic Waterborne Trade of the United States, 1987-1989* (Washington, D.C.: GPO, 1991), 14.
156. *Statistical Abstract of the United States, op. cit*., 240, 678.
157. *An Overview of the Commercial Navigation Industry of the United States on the Great Lakes, op. cit*., xx-xxii., 112. It should be noted that harbor depth is a somewhat complicated matter. The Corps of Engineers recognizes three definitions: (1) authorized depth, the depth or depths specified in a congressional authorization; (2) construction depth, the depth or depths to which a harbor (or its channel) was initially constructed; and (3) maintenance depth, the depth the Corps attempts to provide through dredging. Harbors may have multiple channels and channels have multiple depths (becoming more shallow as one proceeds into or upstream in the harbor). The depth figure usually assigned a federal harbor is based upon the depth in the outer harbor. *An Overview of the Commercial Navigation Industry of the United States on the Great Lakes, op. cit*., 121.
158. The Canadian lock failed in the 1980s and is now officially closed, as is the U.S.'s Sabin lock. *An Overview of the Commercial Navigation Industry of the United States on the Great Lakes, op. cit.*, 28-36.
159. *The 1992 Inland Waterway Review, op. cit*., ES-5, 12.
160. *National Transportation Statistics, op. cit*., 31.
161. Oil Pollution Act of 1990, P.L. 101-380
162. *Coast Guard, Selection of Ports for Establishing or Improving Vessel Traffic Service Systems* (Washington, D.C.: GPO, 1993), 2-6.
163. *The 1992 Inland Waterway Review, op. cit*., 49.
164. *The 1992 Inland Waterway Review, op. cit*., 43.
165. Maritime Administration, U.S. Department of Transportation, *United States Port Development Expenditure Report* (Washington, D.C.: GPO, 1991), 19, B1-2.
166. *ICC 92 Interstate Commerce Commission 1992 Annual Report, op. cit*., 127.
167. *National Transportation Statistics, op.*

cit., 31.

168. For a description *see* Maritime Administration, Review of United States Liner Trades (Washington, D.C.: U.S. Department of Transportation, 1992), 10 ff.

169. *Vessel Inventory Report, op. cit.*, viii.

170. *An Overview of the Commercial Navigation Industry of the United States on The Great Lakes, op. cit.*, xxv.

171. *An Overview of the Commercial Navigation Industry of the United States on The Great Lakes, op. cit.*, 149.

172. *The 1992 Inland Waterway Review, op. cit.*, 15.

173. *See*, for example, *The 1992 Inland Waterway Review, op. cit.*, 18-34.

174. *The 1992 Inland Waterway Review, op. cit.*, 42.

175. *National Transportation Strategic Planning Study, op. cit.*, 15-1.

176. *National Transportation Statistics, Annual Report, 1993, op. cit.*, 38.

177. *National Transportation Statistics, Annual Report, 1993*, 39.

178. Frank A. Smith, *op. cit.*, 61.

179. FERC defines major gas pipelines, in contrast with nonmajor companies, according to gas volume sold. *See Energy Information Administration, U.S. Department of Energy, Statistics of Interstate Natural Gas Pipeline Companies* (Washington, D.C.: GPO, 1992), iii.

180. *National Transportation Statistics*

181. *Transportation Research Board, Pipelines and Public Safety, Damage Prevention, Land Use and Emergency Preparedness, Special Report 219* (Washington, D.C.: National Research Council, 1988), 16-17.

182. *Maritime Administration, U.S. Department of Transportation, Inventory of American Intermodal Equipment, 1990* (Washington, D.C.: GPO, 1991), 4. See also iii.

183. *See Annual Bulletin of Transport Statistics for Europe, op. cit.*, 185-87 for TEUs of

USE *of the* SYSTEM

The nation's transportation system must serve nearly 260 million Americans in more than 90 million households, six million business establishments, and 83,000 governmental units. The system must also serve substantial numbers of foreign visitors, shippers, and carriers and the use of the transportation system to move people and goods. The chapter concludes with the use of transportation infrastructure to move vehicles, which is both a reflection of passenger and commodity flows and a means toward serving those goals.

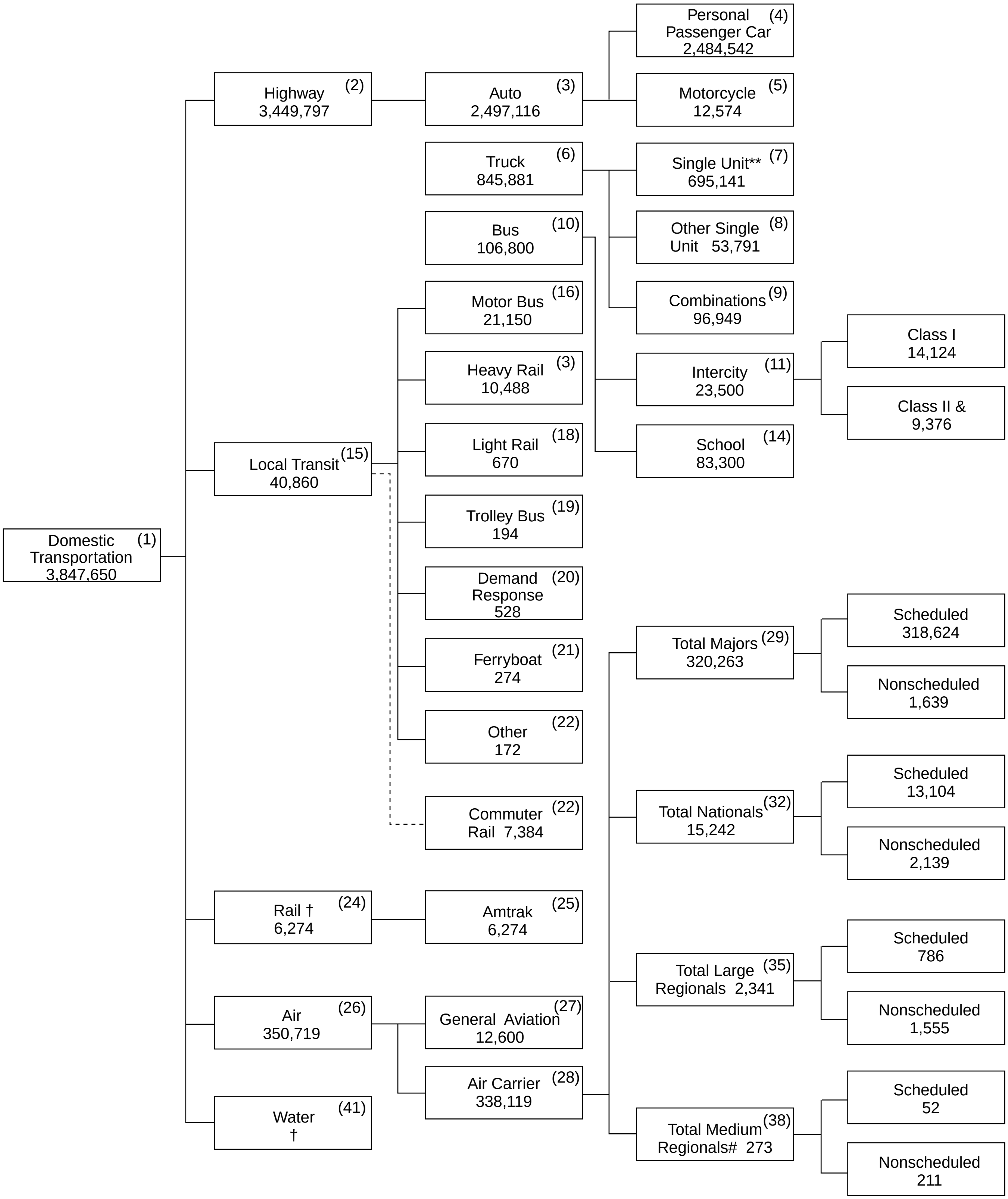
To Move People

America is a nation of prodigious travelers. According to U.S. Department of Transportation (DOT) statistics, total national passenger-miles of travel in 1991 amounted to about 3.85 trillion miles of travel, or about 15,500 miles per year per person. This travel—about 90 percent by automobile—is distributed among the different modes of transport. (See figure 3-1.)

It is most useful to discuss national travel by differentiating it into its main component parts—local travel and intercity travel. Local travel consists of the comings and goings of a household's members in their daily activities—work, shopping, school, personal business, visits to friends, and recreation opportunities, whether in a city, suburban, or rural setting. Intercity travel is more difficult to characterize. It is generally understood to mean long distance travel away from one's "usual environment" on a nonrepetitive basis, often involving an overnight stay away from home and exceeding a distance criterion of 100 miles or more to the destination. The long-term trend in total travel distributed between local and intercity travel has varied around 50/50 over the years, with much of the estimating based on a statistical question of average vehicle occupancies for local and intercity travel.

FIGURE 3 – 1

Passenger-Miles (Millions): 1991



† See Local Transit for Commuter Rail and Ferryboat figures.
* Includes Taxi
** 2-axle, 4-tire trucks.
\# Medium Regionals Include International.

Local Travel

Local travel is best characterized and understood from the perspective of the geographic area of the residences of the travelers. Thus metropolitan travel and nonmetropolitan travel, referred to here as rural travel, are the most useful subdivisions of local travel. Metropolitan travel makes up an increasingly large proportion each year. In 1950 the national population consisted of a rural or nonmetropolitan population that was 44 percent of the national total of 151 million. By 1990 the metro population had reached 77.5 percent of the population and was receiving 86 percent of national growth. The nonmetropolitan population had declined from approximately 66 million to 56 million people, representing about 22.5 percent of the population. (See figure 3-2.)

Our daily local travel activities are defined by our purposes and by the clock. Daily rhythms of work, school, shopping, and recreation have strong patterns that can complement or conflict with other activities. The fundamental elements of that daily cycle cause the morning and evening peaking characteristics that the nation has come to dread. (See figure 3-3.)

Discussions of metropolitan travel tend to focus on the work trip because its impact on morning and evening peaking. But daily transportation activities in a metropolitan context actually consist of much more, including the following:

- Resident Work Travel
- Resident Travel for Other Purposes
- Local Travel by Visitors
- Public Vehicle Activities
- Urban Goods Delivery
- Urban Services Delivery
- Through Travel by Passengers
- Through Travel by Freight

Our knowledge of many of these elements is limited. Some information is available regarding resident work travel and resident travel for other purposes, but even cursory information is unavailable for most of the other travel categories.

Over time the temporal and purpose patterns of metropolitan travel have changed and probably for the better. Time series data indicate that the tendency for work travel to peak abruptly in the morning and evening has declined about 10 percent between the late 1960s and the 1990s. The decline can be attributed to several factors. The trend away from manufacturing to services employment brings with it a decline in the fac-

FIGURE 3–3

Person-Trips by Purpose by Time of Day: 1990

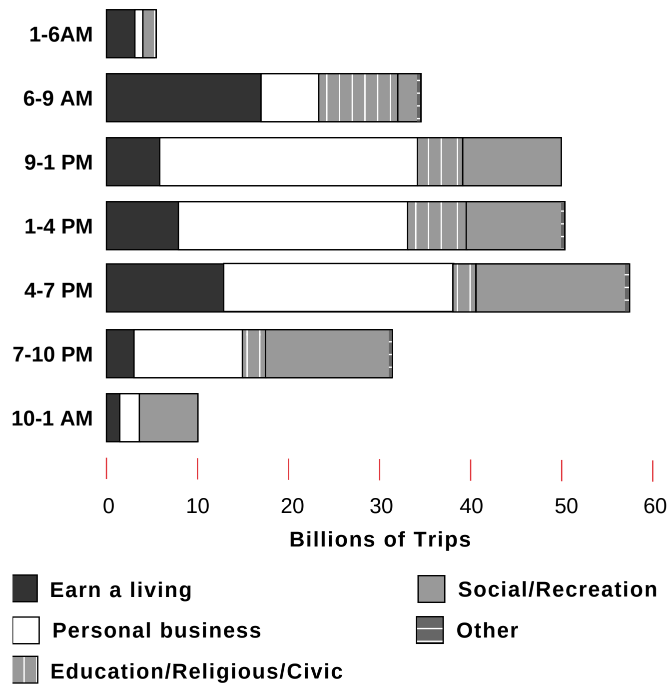
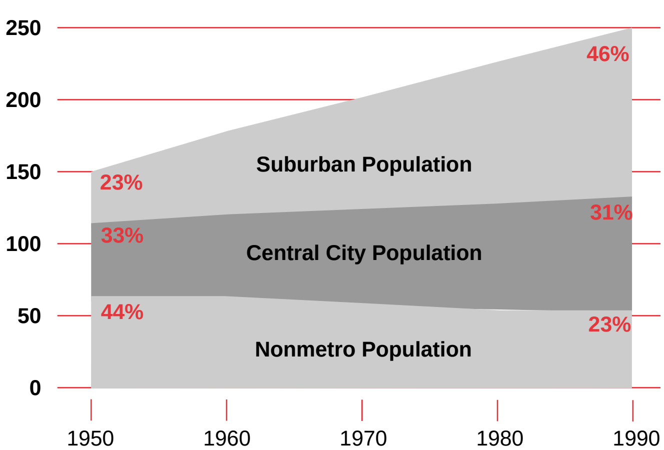


FIGURE 3–2

Long Term Population Trend by Major Geographic Area 1950–1990



*confirm cc and print

tory system—large numbers of employees at a central site starting and ending work at the same time. Services employment tends to bring smaller employment units together, and they are oriented around consumers with more weekend and evening employment. Also, the press of traffic congestion has often forced commuters to travel before or after the peaks to miss the congested periods. In addition, some employers have organized flextime schedules to reduce travel pressures, shifting to 10 hour four day schedules, or to other alternatives.[1]

Another factor tending to flatten the daily travel distribution is the proportionate increase in nonwork travel relative to work travel. From 1969 to 1990, the Nationwide Personal Transportation Surveys (NPTS) shows a decline in work and work-related travel from more than 41 percent of all local travel to about 26 percent. Although work travel was growing very substantially in this period, personal and social travel was growing even more dramatically. This suggests that many of our congestion problems are not solely related to work travel.[2]

Work Travel

The story of work travel in recent years is a story of dramatic and sometimes frustrating change. The dominant element was the prodigious creation of jobs in this nation in the 1970s and 1980s in response to the arrival into the labor force of the baby-boomers, and especially the entry into the labor force of women in dramatic numbers. From 1980 to 1990, the population grew by less than 10 percent for the first time since the Great Depression, but the number of workers increased by more than 19 percent—almost 19 million new workers.

Other equally dramatic forces have been at work to change the patterns of commuting. The most significant of these is the shift to the suburb-to-suburb predominant pattern in commuting. Following the rise of suburban populations came a parallel growth in suburban, commercial, retail, and overall employment. Roughly two-thirds of new employment has been in suburban areas.

The structure of contemporary commuting is complex. (See figure 3-4.) Suburb-to-suburb trips now are twice the scale of suburb-to-central city trips. *Reverse commuting* trips, i.e., from inner city to suburban job sites, are also significant. And one of the newer factors that has to be recognized is the interactions now occurring between adjacent metro areas. Many suburban and exurban communities now lie in the commuting fields of two metro areas.

Trends in Modal Shares to Work. The shift to a more circumferential pattern of commuting has challenged our road and transit systems, which are more oriented to the historical radial patterns of travel. The spread-out patterns of origins and destinations of work travel have especially challenged traditional transit services. At the same time increases in auto ownership and the extensive increases in women's acquisition of driver's licenses have further challenged transit's competitive abilities.

According to the 1990 census data, auto travel gained only slightly in modal share from 1980 to 1990, primarily as a result of a very significant shift from ride sharing to driving alone. (See figure 3-5.) That is, the proportion of people traveling by auto did not change dramatically, but the number of vehicles involved did. Walking and mass transit continued their declining shares of work travel. Transit served roughly the same numbers in 1990 as in 1980, with only a slight decline in overall persons

FIGURE 3–4

National Commuting Flow Patterns
(Millions of Daily Trips)

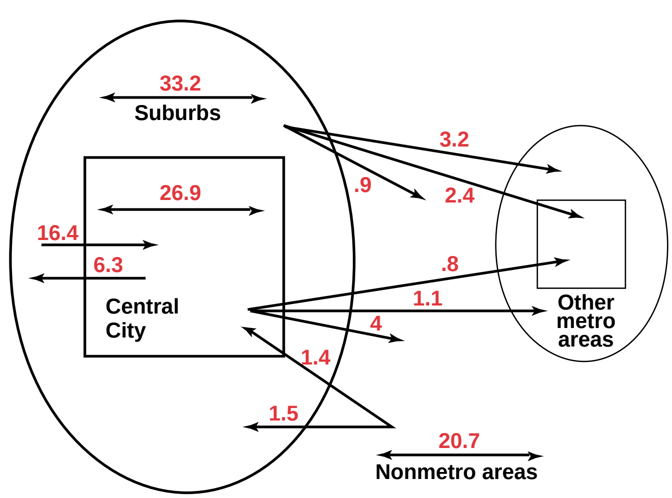
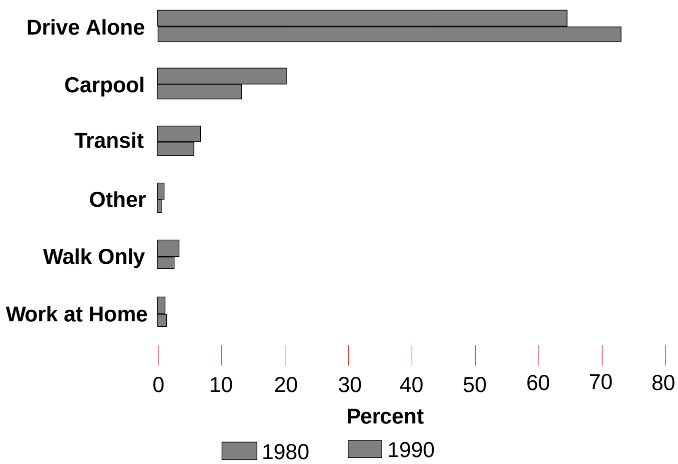


FIGURE 3–5

Broad Travel Mode
Percent Change: 1980-1990



served. Within the transit sector, large shifts occurred from bus travel to rail services wherever it was available.

In net terms the shifts are stark. Between 1980 and 1990 America added more than 22 million new single occupant drivers to work. (See figure 3-6.) Where did they come from? There were only about 19 million new workers added in the period. Apparently, most of these new workers drive to work alone. In addition, nearly four million former carpoolers now drive to work alone, transit dropped 200,000 riders, and more than 650,000 stopped walking to work. Despite a 19 percent increase in commuters, all alternatives to the drive-alone vehicle lost absolute amounts of users. One significant reversal in trend was an increase in the number of people working at home since 1980; however, this increase is predominantly in urban areas, suggesting the long-predicted growth in telecommuting may finally be happening. The number of people who work at home in rural areas—which declined for many years as people left farming—is now stable.

Causes for these shifts in mode share are not difficult to identify: continuing increases in auto availability, especially for women; continuing shifts to noncentral city oriented commuting; declining real gas costs; continuing shifts away from areas of the country traditionally disposed to transit toward areas where the auto is more dominant; and ultimately a society that is under great time pressures and feels the need for flexibility and speed.

The increasing number of people working at home appears to be an urban phenomenon; rural work-at-home trends remained stable, suggesting that the long-predicted rise in computer-oriented working at home may have in fact arrived.

Work, Travel Times, and Distances. Among the chief concerns of American urban travel is the amount of time it takes to get anywhere. The census of 1980 showed a national average work travel

FIGURE 3–6

Broad Mode of Travel
Net Change: 1980 – 1990

time of 21.7 minutes. The 1990 census indicated only a 40-second increase to 22.4 minutes on average. This is a remarkably small increase given the immense shifts to auto use. Why then the nationwide concern for commuting delays? First of all, average statistics can be deceptive, masking important changes in specific areas. Increases in travel times in the West were substantial. Second, the substantial shifts in mode already noted and shifts to different trip patterns may improve the average time. For example, shifts from walking or transit to the auto will typically improve the average travel times of those making the shift, but will also contribute to congestion and declining travel times on the roads they now use. (See figure 3-7.)

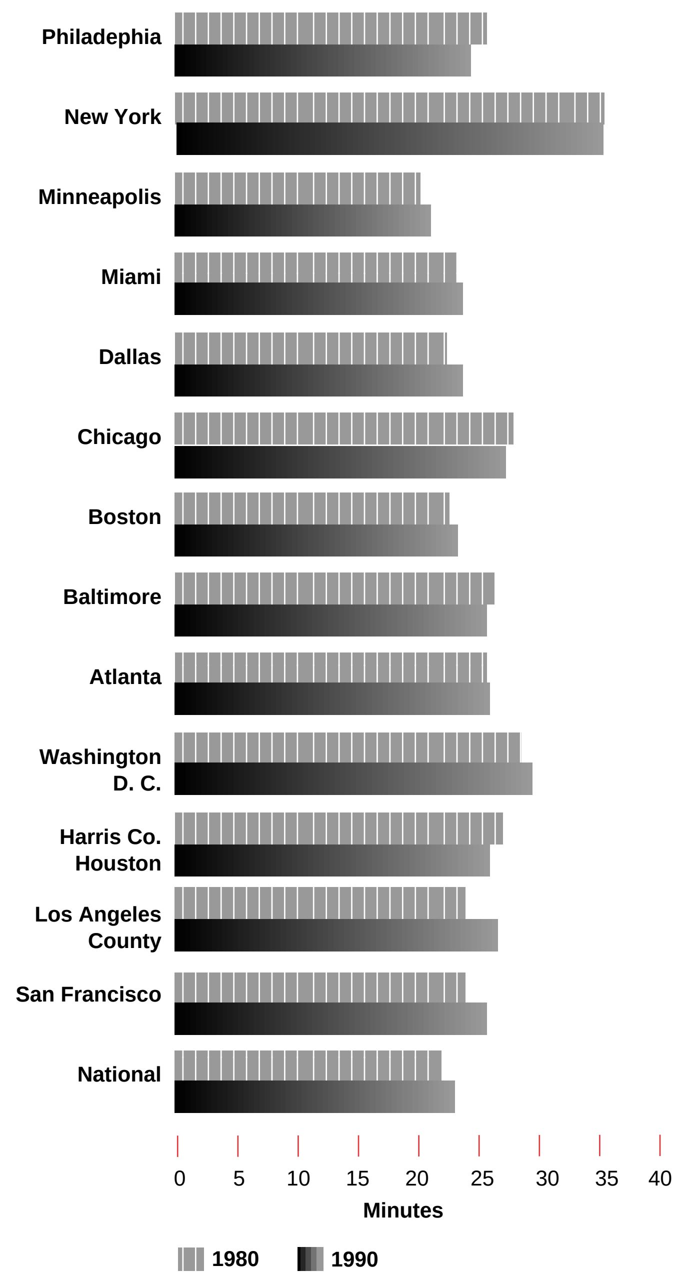
Nonwork Travel

As rapidly as work travel has increased, it has been exceeded in growth rate by nonwork travel. At the same time, the distinctions between work and nonwork travel have been blurred by important work and social changes. In part because of experiences associated with the energy crises and in part because more women are now in the workforce, there is a greater tendency for work and other trips to be combined. Dropping off and picking up children; shopping or picking up fast foods on the way home have increased the time and energy efficiency of daily travel. The importance of changes in women's travel behavior cannot be overstated. Women with driver's licenses (who tend to be those who work) make three times the work trips that women without licenses do, twice the number of personal business trips, and twice the social and recreational trips. Overall, for every one percent shift from nondrivers to drivers among women, total travel jumps 10 billion miles per year.[3]

Analyses of 1990 nonwork trip data show significant variations by income, age, location in the metropolitan area, and stage in the life cycle. (See table 3-1.) The generation of nonwork trips is more closely tied to household than to population changes. It is the care and upkeep of households, almost independent of the number of persons in the household, that frequently governs trip making. Declining household sizes and the more rapid growth in households relative to population have spurred nonwork trip travel, along with growing affluence. In 1990, average household size was 2.63 persons compared to 2.76 as recently as 1980 and 3.14 in 1970. Between 1980 and 1990, the number of households increased by 11.5 million, or 14 percent, compared to a population increase of less than 22 million (an increase of less than 10 percent). The dramatic changes occurring in household size are primarily a product of changes at either end of the household spectrum. At one end, one-person households have increased substantially, while households with more than five members have declined. Two-, three-, and four-person households have changed little. This suggests a continuing trend to smaller households in the future with all the transportation effects it implies. Except for walking and the use of school buses and public transit for school related trips, the auto is almost the exclusive form of travel for nonwork tripmaking.

FIGURE 3-7

Change in Travel Times: 1980 - 1990 (Selected Large Areas)



Local Travel–Rural

According to the 1990 census, rural populations have declined to about 22 percent of national population. In part, this trend is the result of the decline in farm populations. It is estimated that about a third of all rural counties rely on farming and farm-related business for the dominant share of their economic activities. Increasingly rural counties are business and manufacturing oriented, and today, about a third of the nation's rural counties are focused on manufacturing rather than farming. Thus questions of rural transportation access and service needs are questions that affect the manufacturing sector of the economy as well as the agricultural, mining, forestry, and fisheries sectors.

The only areas in rural America that came close to matching the national population growth rate are those counties adjacent to metropolitan areas. More than 15 percent of the commuting travel takes the populace of these counties into the metropolitan complex. These areas are statistically rural, but clearly metropolitan in their orientation and usually achieved for metropolitan status after the results of the decennial census are tabulated. This continuous shift in status from rural to metropolitan is a major explanation of the definitional decline in rural populations.[4]

The orientation of rural populations to the automobile is about the same as suburban populations, with a greater orientation to walking and much less orientation to transit, which is generally not available. Trip purpose distributions similarly are almost identical to suburban distributions with respect to trip making and total miles of travel. Significant differences occur in trip lengths, however, wherein work trips tend to be shorter than metropolitan trips, but all other trips tend to be longer. The rate of ownership of driver's licenses exceeds the national average, as does miles driven per driver. Auto ownership rates per household are almost identical to suburban rates.[5]

Comparison of consumer spending on transportation between urban and rural populations is revealing. Total rural spending per household in 1991 was slightly less than the average for urban spending—$5,055 per year versus $5,166. However, given the appreciably lower incomes in rural America, their expenditures represent a greater share of their incomes than does urban spending—20.4 percent of spending contrasted to 17 percent. Main points of difference in rural areas are the greater orientation to trucks than cars, and to used vehicles rather than new, and greater spending for gasoline and associated fuel taxes. Rural residents spend about 27 percent more on gas and oil than urban residents. Rural areas also lag in spending for purchased transportation, a product of less spending on transit and air travel.[6]

TABLE 3–1

Average Daily Trips, Travel per Person and Person Trip Length (by Sex and Trip Purpose)

	Male	Female	Total
Average Daily Person Trips			
Earning a Living	0.77	0.57	0.66
Family and Personal Business	1.12	1.42	1.28
Civic, Educational, and Religious	0.34	0.36	0.35
Social and Recreational	0.78	0.74	0.76
Other	0.02	0.02	0.02
Total	3.03	3.12	3.08
Average Daily Person Miles of Travel			
Earning a Living	10.5	5.12	7.69
Family and Personal Business	8.62	9.23	8.93
Civic, Educational, and Religious	1.79	1.89	1.84
Social and Recreational	10.4	9.38	9.86
Other	0.25	0.20	0.22
Total	31.56	25.83	28.56
Average Person Trip Length (Miles)			
Earning a Living	13.91	9.18	11.8
Family and Personal Business	7.75	6.63	7.11
Civic, Educational, and Religious	5.39	5.38	5.39
Social and Recreational	13.45	12.93	13.19
Other	11.59	9.13	10.3
TOTAL	10.54	8.47	9.45

Intercity Travel

Americans travel from city to city for an array of reasons, and often try to achieve several purposes with a single trip.

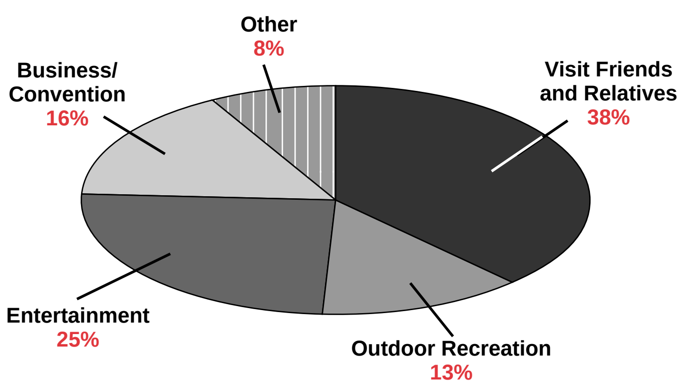
The simplest distinction is between business and personal travel. Applying this simplest of distinctions, the U.S. Travel Data Center (TDC) estimates that business travel accounts for 16 percent of all intercity travel; personal travel of varying types account for 76 percent. (See figure 3-8)

Travel industry growth has shown remarkable stability over the years, with annual growth rates exceeding Gross National Product (GNP) growth since 1978. The industry has exhibited important counter-cyclical character as well, often being a major source of service industry job growth, particularly in recession periods. Significant trends in the industry affecting transportation are:[7]

- The trend toward more frequent, shorter duration travel, as indicated by a decline of about 10 percent in total nights spent away from home from 1989 to 1991 while at the same time total trips made increased by almost 4 percent.
- A paralleling trend for more trips built around weekends.

FIGURE 3–8

Intercity Travel by Purpose: 1991

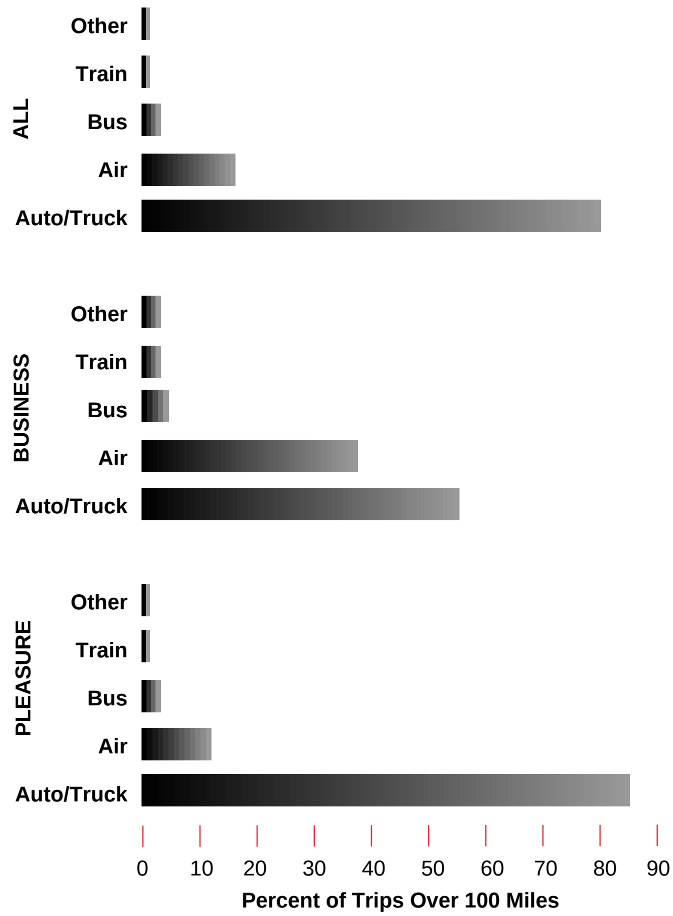


There is a tendency to equate intercity travel with air travel and, to a lesser extent, with rail and bus travel. In fact, the automobile is the predominant mode of intercity travel undertaken for both business and personal purposes. (See figure 3-9.)

A key factor in better understanding intercity travel is trip distance, which varies by trip purpose and choice of mode. Business travel averages more than 862 miles roundtrip, compared to 799 miles for personal travel. If all trips are examined by trip-length category, the modal choice patterns reveal a skewing in favor of autos in the lower trip-length categories and a shift favoring aviation in the longer-distance categories, although the auto still predominates for all trips less than 2,000 miles in roundtrip length.

FIGURE 3–9

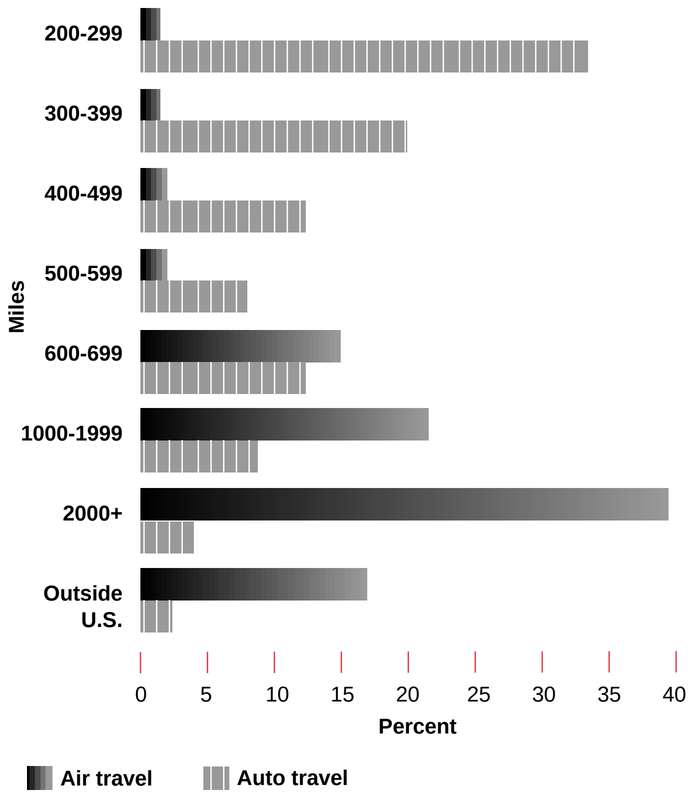
Modal Choice by Trip Purpose: 1991



If the auto and air patterns are examined in terms of percentages of trips by length the pattern is increasingly clear. (See figure 3-10.) More than 60 percent of trips made by auto are less than 500 miles roundtrip, with an average trip length of 577 miles. Only 10 percent of intercity air-travel trips are less than 500 miles in length, and average trip-length is roughly 2,200 miles. Only 3 percent of auto travel occurs in the more than 2,000-mile category in contrast to 40 percent of air travel. In comparison, Amtrak's average one-way trip length, as measured by Amtrak sources, is about 290 miles, and intercity bus is about 140 miles.

FIGURE 3 – 10

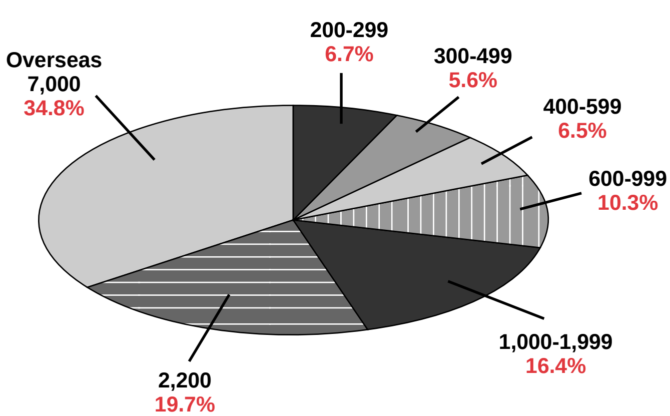
Air and Auto Trips by Trip Length: 1990



Ultimately it is the miles of travel generated by trip makers that affects the ability of the transport system to serve demand. The "more than 2000-mile range" (involving only 9 percent of all trips) accounts for a very high proportion of all travel miles. (See figure 3-11.)

FIGURE 3 – 11

Estimated Intercity Miles of Travel by Trip Length Category: 1991



International Travel

The United States, the world's most important international travel destination, has participated in a dramatic worldwide surge in international tourism and travel. After rapid growth in the 1980s, overall growth of foreign visitors to the United States has slowed in recent years. That slow growth is a composite of active growth from overseas visitors and limited growth from our land border partners Canada and Mexico. The number of overseas visitors increased by 10 percent from 1991 to 1992, and the U.S. Travel and Tourism Information (USTTA) predicts an increase of 6 percent in 1993. (In the same time frame, the visitor rate from Mexico grew by 7 percent.) The number of overseas visitors is expected to continue to rise, almost tripling between 1984 to 1994. In 1993 overseas visitors are expected to outnumber Canadian visitors for the first time—with foreign visitors reaching 18.5 million visitors compared to 17.5 million Canadians. About 48 million visitors are expected to arrive in the United States in 1994: 17.4 million from Canada; 10.2 million from Mexico; and 20.5 million from overseas.

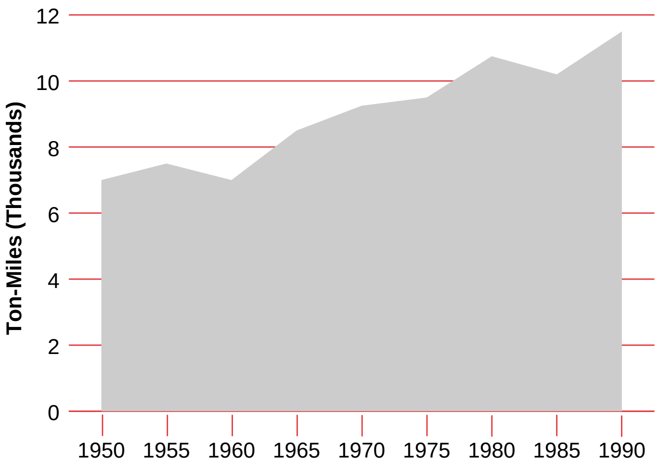
International visitors are a significant market for the U.S. transportation system, but not as overwhelming for our country as they are for some European destinations, where the total number of visitors each year exceeds the national population. The number of visitors expected in the U.S. in 1994 is equal to about 20 percent of the population.

To Move Freight

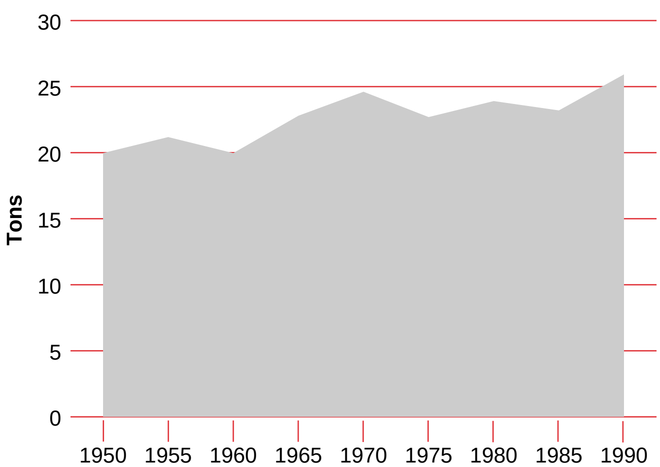
Americans produce and consume a vast quantity of freight movement services. The traditional measure of freight activity—the ton-mile (a ton moved a mile)—registers at something on the order of 3 trillion ton-miles per year—3.5 trillion if domestic coastal shipping is included. Relating the domestic intercity portion of freight movement to the national population works out to about 25 tons per person. (See figure 3-12.) Ton-miles per capita have shown steady growth over the years, from less than 7,500 ton-miles per year in 1950, to more than 11,000 in 1990. These numbers

FIGURE 3-12

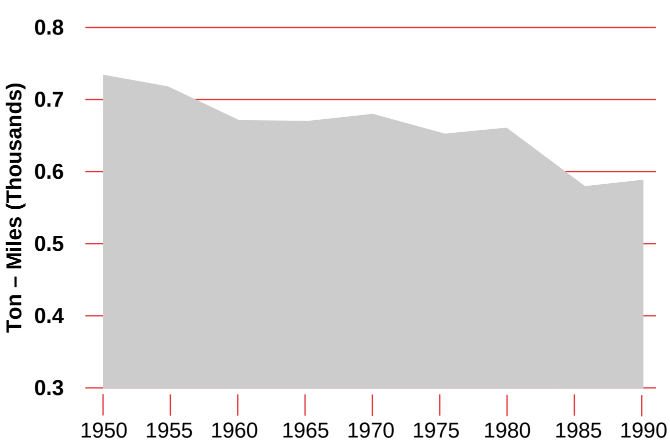
Freight Ton-Miles per Capita –
Long-Term Trend: 1950–1990



Freight Tons per Capita –
Long-Term Trend: 1950–1990



Freight Ton–Miles per Unit of GNP
Long – Term Trend: 1950–1990
(1987 Constant Dollars)



indicate that Americans are producing more goods, and consuming more per person each year.

It is important in understanding contemporary freight movement to recognize that these ton-miles increasingly consist of more miles of travel with less significant growth in tonnage. A look at the long-term trend in tons moved per capita reveals long-term growth over 40 years, but at a slower rate of growth. (See figure 3-13.)

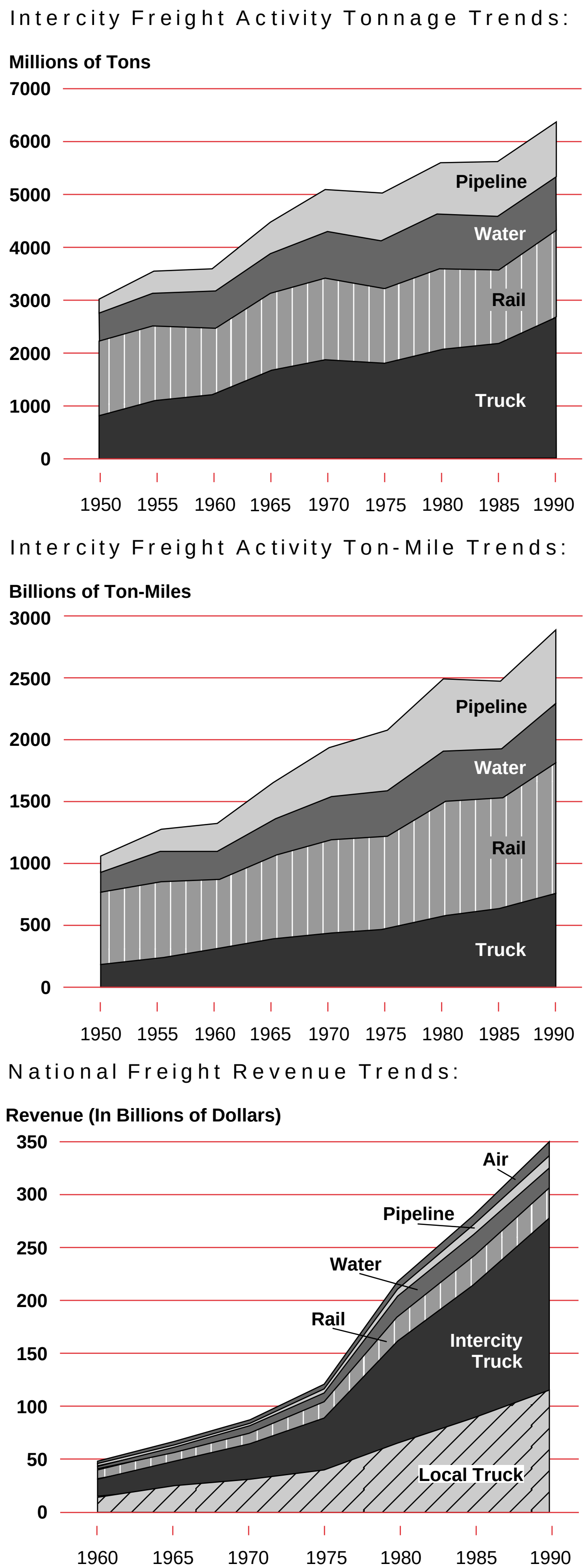
In contrast, ton-miles per dollar of GNP has significantly declined over the same time period to just below 0.6 ton-miles per dollar of GNP from a level about 0.7 in 1950, using GNP expressed in constant 1987 dollars. This dip is in part the result of a national shift in the economy toward services, and in part it is due to the increasing use of lighter materials in products we produce. Also, greater penetration into the economy of imported goods may reduce the overall need for domestic movements. Reference to tons-per-unit GNP trends indicate that, again, it is the miles of travel that is the significant growth factor, as tons have declined substantially.

Modal Shares

The long-term trend in modal tonnage, ton-mile, and revenue shares indicate the following:

- Rail freight has retained a share of approximately 37 percent for more than a decade, following a small decline from an approximate 40 percent share at the start of the 1970s.
- Trucking has shown slow but continuous gains in share since 1950. Overall shares were about 16 percent in 1950; they reached 20 percent by 1960 and 25 percent in the mid-1980s. Present shares are in the range of 26-27 percent.
- Waterborne shares on rivers and canals grew rapidly from about 5 percent in 1950 to a 10 percent share in 1970, growing slowly to a 13 percent share in 1990. Great Lakes shipping has been the great loser, dropping from 10 percent in 1950 to about 3 percent currently.
- Pipeline shares have shown an interesting pattern over time, rising from a 12 percent share in 1950 to a peak of just under 25 percent in 1975, declin-

FIGURE 3–13



ing thereafter to a current share less than 20 percent.

- Air shares have grown dramatically, the microscopic to the minuscule, increasing 10 fold from .03 percent to .37 percent.

The current pattern is best seen by viewing the modal shares of freight in 1991 in terms of tonnage, ton-miles, and revenues. (See figure 3-14.) It is interesting that trucking with about 25 percent of the ton-miles, receives 79 percent of the revenues, while airfreight, with only .3 percent of the ton-miles, receives 4 percent of the revenues.

Declining market shares are not as catastrophic as they might appear. For instance, the rail sectors share of freight market expenditures was more than cut in half, from about 20 to less than 10 percent from 1960 to the present. But in that same period the ton-miles hauled by rail doubled, and its revenues more than tripled. The other modes with declining shares of the market also enjoyed reasonable levels of growth in ton-miles and revenues. Only Great Lakes shipping has shown real market losses.

Part of the reason for the changing shares of each mode is the changing patterns of U.S. and world demand for the commodities each mode is best equipped to handle. A comparison of the use of the modes by commodity makes it clear that they respond to very different needs. (See table 3-2.) Waterborne carriers, for instance, relied on petroleum and related products for 42.3 percent of revenues in 1991. Other products typically hauled by waterborne carrier included coal and coke; chemicals; food and food products; iron ore, iron, and steel; sand, gravel, and stone; and logs and lumber—with each of these product areas accounting for anywhere from 2.5 to 16.2 percent of the revenues. Rail lines, on the other hand, relied on coal (38 percent) and farm products (11.9 percent) for nearly half their business. As for trucks, no single product area accounted for more than 15.5 percent of revenues (agriculture and food products); manufactured products of varied types appear to be most readily hauled by truck.

Air and pipeline modes have not been included in this summary. Air freight statistics that provide information about commodity detail are not available; however, as

FIGURE 3–14

Freight Activity by Mode

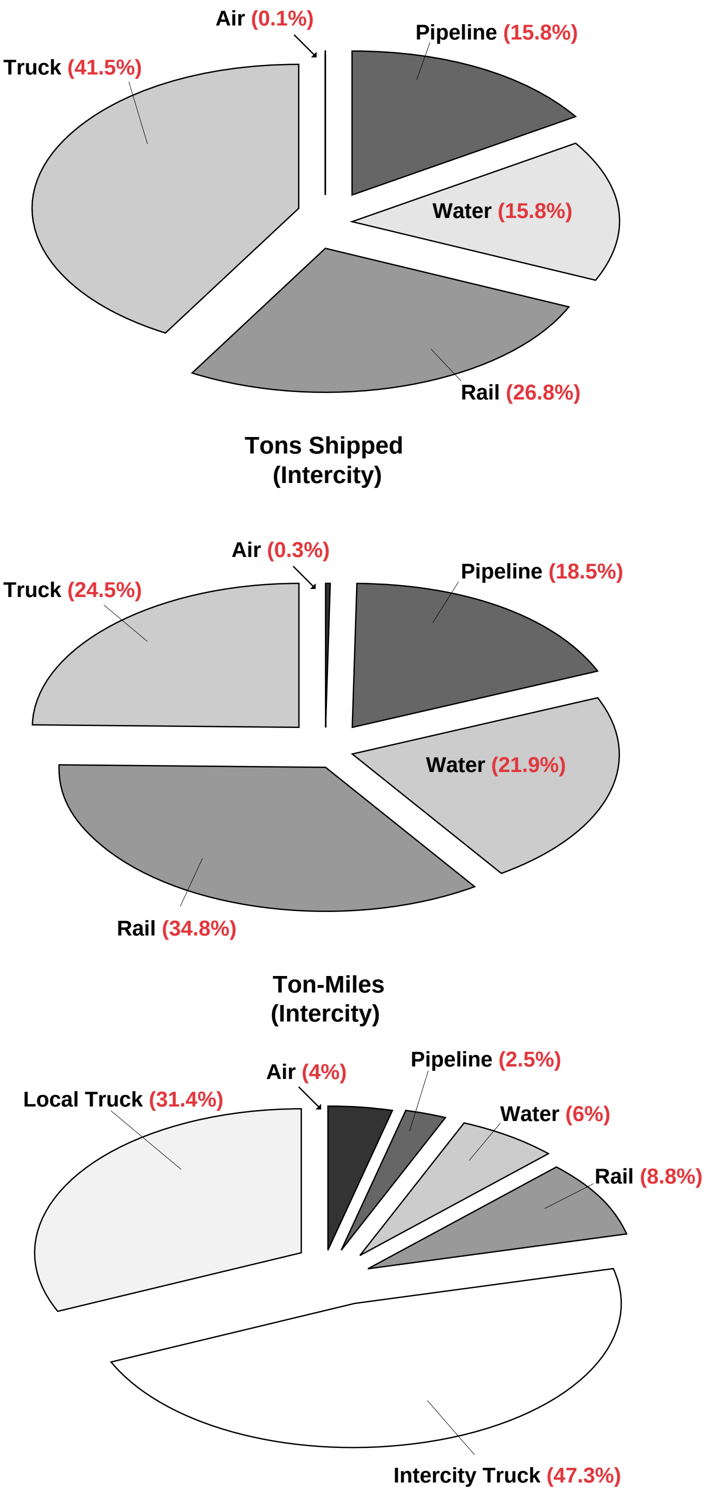


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TABLE 3–2

Commodity Shares by Mode

	Percent
Waterborne Commerce (Foreign and Domestic): 1991 Percent of Tons Moved by Commodity	
Petroleum & Products	42.3
Coal & Coke	16.2
Food & Food Products	12.6
Iron ore, Iron, Steel	7.5
Sand, Gravel, Stone	6.4
Chemicals	6.0
Logs & Lumber	2.5
Other	6.5
Rail Services—1992 Percent of Tons Originated by Commodity	
Coal	39.6
Farm Products	10.7
Chemicals	9.4
Non-Metallic Minerals	6.8
Food & Kindred	6.2
Lumber & Wood	3.6
Metallic Ores	3.2
Stone, Clay, Glass	2.8
Primary Metal Products	2.8
Petroleum & Coal Products	2.8
Pulp Paper & Products	2.4
Waste & Scrap	2.2
Transportation Equipment	1.7
Other	5.9
For-Hire Trucking Firms—1991 Percent of Revenues by Commodity	
Agriculture & Food Products	15.5
Other Manufactured Products	13.2
Metals & Metal Products	9.0
Household Goods	6.4
Forestry, Wood, Paper Products	6.3
Chemicals & Products	5.1
Building Materials	4.9
Petroleum & Products	3.3
Mining Products	1.4
Other	34.8

might be expected, air freight focuses on high-value goods with high time demands, either perishables or high-value technical goods. Pipelines are obviously directed to petroleum, petroleum products, and natural gases. Some other materials, such as coal and other minerals, move in limited quantities in pipelines or on conveyor systems.

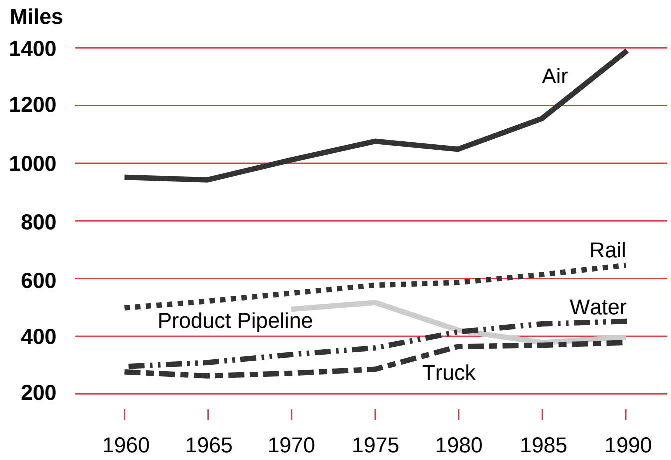
It is useful to assess the extent to which the modes actually compete for traffic. Modal comparison by commodity is difficult given the lack of comparability in the data sets. No sources exist, since the demise of the Commodity Transportation Survey in 1977, that would permit detailed analyses. Rough comparison indicates that the modes tend often to fill market niches rather than to compete head to head for much of their traffic. The advent of the new Commodity Flow Survey will help immeasurably to expand our understanding of this and other relationships between the modes.

Trucking particularly tends to compete in some services and as well as to serve as a complementary supporting mode, taking goods to and from rail and water terminals. Data are particularly weak in assessing the significant changes in the trucking industry since deregulation. The recently developed annual Bureau of the Census survey of Motor Freight Transportation and Warehousing (WATS) is a very beneficial addition, but it reflects only trucking provided by firms engaged in trucking services. Excluded from this census are very important sectors of the trucking industry such as owner-operator trucking and trucking by corporate truck fleets primarily engaged in hauling their own goods. These elements of the industry probably represent the majority of trucking activity.

Revenue distribution of trucking activity by commodity in 1991 indicates that about 60 percent was truckload traffic and the remainder was less than truckload (LTL) traffic. The element of the industry examined owns or leases almost two million units consisting of trucks, tractors, and various trailer configurations generating a total dollar revenues of about $108 billion a year. According to the 1991 survey, a further distribution of these revenues can be identified between intercity and local traffic and between general freight and specialty traffic. Intercity traffic represents about 77 percent of the traffic, more than three-fourths of which is general traffic. Local traffic is almost equally divided between specialty and general services traffic.

FIGURE 3–15

Freight Length of Haul Trends: 1960 to 1990



A further inference about current trends in trucking is obtainable from the 1991 WATS. Review of the expense accounts of motor carriers in the survey indicates that about $20 billion, or roughly 20 percent of industry expenses, involve expenditures for purchased transportation. Only about 13 percent of these expenditures go to purchases of air, rail, water services, or the services of other motor carriers. The remainder therefore goes to the rental or leasing of trucks with or without drivers. Inferentially, this can be assumed to be owner-operators for the most part.

As the trucking industry has changed in the post-deregulation era, it has become more difficult to describe. Private fleets now provide for-hire services, freight forwarders own their own fleets of vehicles, and railroads and air carriers increasingly own and operate their own trucking fleets.

In addition to the variations by mode in speed, service, shipment size, and cost, a further attribute is important to understanding current freight trends—average length of haul. (See figure 3-15.) The tendency in all modes, both passenger and freight, has been for the average trip length to increase over time. This is one measure of our society's increasing mobility, as places and things can be brought close from greater and greater distances with decreased cost and increased speed. The trend to longer average hauls in freight movement is clear with increases 20-30 percent or more across all modes in the period 1960-1990.

The Changing Structure of Market Demand

The Office of Economic Affairs of the U.S. Department of Commerce prepared a study for the National Council on Public Works Improvement assessing changes affecting the infrastructure as a result of the expanding and contracting shares of different industries in the future economy as well as from other structural changes in industry. Industry structure changes show continuing shifts from goods-producing to services-producing industries. In the period from 1972 to 1984 services-producing industries increased their share of the GNP from 55.33 percent to 61.5 percent; the share of these industries is expected to reach 62.7 percent by 1995.[8]

The industries identified in the study as expanding between 1984 and 1995 are listed below in descending order of their growth potential:

- Business Services.
- Telephone and Telegraph.
- Electric and Electronic Equipment.
- Real Estate, Except Owner Occupied.
- Machinery, Except Electrical.
- Printing and Publishing.
- Credit Agencies and Financial Brokers.
- Health Services.
- Banking.
- Instruments and Related Products.
- Amusement and Recreation Services.

The industries identified as contracting during the same period are set out below, in descending order of their growth potential:

- Chemicals and Allied Products.
- Water Transportation.
- Other Transportation Equipment.
- Federal Government Enterprises.
- Stone, Clay and Glass Products.
- Textile Mill Products.
- Tobacco Manufacturers.
- Fabricated Metal Products.
- Petroleum and Coal Products.
- Educational Services.
- Railroad Transportation.
- Gas Services.
- Automobile Repair and Services.
- Insurance.
- Motor Vehicle and Equipment.
- Personal and Repair Services.
- Apparel and Other Textile Products.
- Primary Metal Industries.
- Farms.
- Food and Kindred Products.
- Oil and Gas Extraction.
- Construction.
- Wholesale Trade.
- Retail Trade.

In the industry structure used in compiling GNP statistics, the activity labeled as *transportation* includes only the common carrier portion of overall transportation activity. A very small overall drop of -0.2 is expected in the transportation sector's share of overall GNP between 1984 and 1995 as defined. Declines in share are expected for the rail, waterborne, pipeline, and transit sectors, while air travel and travel services increase slightly and trucking holds a constant share of GNP. Through this type of measurement, private trucking and personal auto travel are not explicitly represented, but both vehicle manufacturing and vehicle servicing, which can serve as indicators of private vehicle travel, are forecasted to decline in share.

A review of the transportation-related structural characteristics of the industries forecasted to grow and decline relative to GNP reveals a great deal about future transportation demand. The Office of Economic Affairs examined growing and declining industries in terms of several attributes of which four are of importance to transportation. (See table 3-3.)

- Materials Intensity.
- Scale of Production.
- Product Transportability.
- Production Dispersion.

Materials Intensity. Materials intensity accounts for the volume of physical inputs used to produce a unit of value of output. Industries rank from highly materials intensive, e.g., a rating of 7.9 for oil refining, to using almost no materials, e.g., a rating of 0.1 for radio/television broadcasting. The average materials intensity measure for expanding industries is 0.7 compared to 2.0 for declining industries. This suggests a declining need for the heavy movement of bulk goods in the future economy. It would strongly support the forecast that ton-miles per dollar of GNP will continue to decline. Measures of pollution intensity and energy intensity move in parallel with materials intensity and therefore exhibit a similar and desirable trend as well.

Scale of Production. Examination of the scale of total output produced for an average establishment show a trend in the future in manufacturing toward smaller establishments. Measured in millions of dollars of product per establishment, the scale of production ratio was 26.4 for declining industries and 5.2 for expanding industries. Using average employees per establishment shows similar patterns: 113 employees compared to 65. Outside manufacturing, services industries show even lower levels of total output per establishment. Trends in capital intensities of growing and declining industries confirm this pattern toward smaller firms. For transportation again this trend favors smaller shipments, less bulk movement and demand for more individualized service.

Product Transportability. The measure employed in the development of this index is the ratio of dollar value of products produced to their weight. Applied to manufacturing industries alone, expanding industries exhibited an average value per ton more than twice that of declining industries. As value-per-ton increases, the likelihood of the need for rapid transport also increases. This suggests an orientation to the use of air and truck transportation with the need for fast, on-time delivery of products in the rapidly growing segments of the economy.

Production Dispersion. Using a measure of the share of national production generated by the top ten producing states provides an indication that overall national production is dispersing, and expanding sectors are more dispersed than declining sectors. This favors the case for low levels of total freight volumes moving in dispersed patterns rather than in heavy corridors. Again, this favors truck and air services.

The overall effects of these trends will have important implications for the nature of the economy and its transportation needs. They make a case for a different kind of industrial economy, very different from the *industrial power* ideas of earlier years. Instead of regions of heavy industry, there will be dispersed manufacturing. Instead of large factories taking in raw materials and belching smoke there will be smaller facilities with fewer inputs, less energy consumption, less pollution, and more valuable products produced. The transport implications favor modes of transportation that can preserve goods in transit, move them expeditiously, and assure on time arrival.

TABLE 3–3

Expected Changes in U.S. Industries

Industry	Expanding Industry	Contracting Industry
Pollution Intensity	Low	High
Materials Intensity	Low	High
Scale of Production	Small	Large
Capital Intensity	Low	High
Energy Intensity	Low	High
Transportability	High	Low
Dispersion	Dispersed	Concentrated

Bulk Commodity Flows

Although the nature of the dominant trend is clear, we can still expect selective growth in the bulk freight sectors that will provide increased demand for rail, water, and pipeline bulk services. Long-term projections of bulk cargo movements domestically and in international trade, published by DRI/McGraw Hill quarterly and annually, do not indicate major increases in grain, coal, or petroleum flows, and these are the mainstays of the bulk freight handling modes.

Expectations are for an increased role of foreign trade in the U.S. economy. In particular, high growth in exports will help create greater balance between goods entering and leaving the country. Export growth is expected to increase at about 8 percent–twice the rate of import growth in the early nineties. There will still remain an imbalance of about 1.5 million equivalent container loads flowing into the country vs outflow.

Foreign trade accounts for about 48 percent of U.S. waterborne tonnage, and that share will increase over time. Foreign trade activity has been growing at a rate of 3.8 percent annually compared to domestic waterborne commerce growth of 1.2 percent. Domestic and foreign trade statistics are affected by very large shifts in bulk movement patterns. The shifts in petroleum flows from domestic to foreign sources, changes in petroleum flow patterns from Alaska, and declines in Great Lakes iron ore shipments are examples.

Foreign trade flows are concentrated in a limited number of ports, with more than 80 percent of total tonnage in 1987 moving through the top 50 ports. There are, however, 143 ports that handle more than a million tons per year.

Intermodal Flows

Intermodal movements should continue to receive great impetus from foreign trade flows. They also will receive further support in the 1990s from their advantages over direct truck travel in terms of fuel and labor costs, as fuel costs rise and truck driver labor availability is constrained. Rail container and trailer movements in revenue service increased by 2.6 million units, an increase of 80 percent, in the last ten years and now exceed 6.7 million units a year.

The intermodal movement of containers has been characterized by the development of highly integrated, information-intensive companies providing the advantage of *one-stop* service to shippers and complete control of cargo movements from beginning to end. The advent of double stack container train movements across the country in the booming Pacific-rim markets is the best example of this pattern of freight movement. Truck fleets owned by rail or ocean shipping companies feed trains capable of carrying upwards of 280 containers in a single doublestack train moving in daily service, generally from West Coast ports in Seattle, Oakland, and Los Angeles to Chicago and the Gulf and East Coasts. Ships like the American President Line's 900-foot long C-10 are capable of moving the equivalent of 4,300 twenty-foot containers in one crossing. Travel times in the range of 12 days from Japan to Chicago or Dallas are typical.[9] To accomplish this, extensive investments in dedicated terminals, equipment, rolling stock, and information systems are required. A recent development permits movements within the system of perishables moving in refrigerated containers.

To Move Vehicles, Vessels, and Aircraft

America has at its disposal one of the world's great vehicle fleets. These fleets of privately owned and publicly available vehicles provide an extraordinary level of service to our society for both person and freight movements. Not only do we own this vast collection of vehicles, representing an immense investment by individuals, businesses, and governments, but we use them extensively as well. Generally, the level of use of vehicles in America, expressed in miles traveled per year, hours of use per day, or other comparable measures, exceeds that of other countries.

TABLE 3–4

Motor Vehicle Registrations and Use: 1992

Vehicles	Number of Vehicles (in Millions)	Average Annual Vehicle Miles of Travel per Vehicle
Automobiles	144.2	11,063
Motorcycles	4.1	2,343
Buses	0.6	8,901
Trucks (2-axle/4-tire)	39.5	12,055
Trucks (6 or more tires)	6.0	25,547

One of the statistical problems analysts often face regarding personal motor vehicle travel is the increasingly unclear boundary between automobiles and trucks, particularly with the rapid increases in the use of pickup trucks, vans, and sports-utility-type vehicles for personal use. Much of the U.S. growth in vehicles in recent years has been in these categories. Our shift into these vehicles is illustrated by the fact that the U.S. now trails several European countries in the statistical measure of autos per 1000 population. Statistical measurement must increasingly use the concept of *vehicles available* rather than automobiles to capture properly the range of mobility options available to the American public.

Private Vehicles

The U.S. private use vehicle fleet has reached substantial proportions. The majority of U.S. households own two or more vehicles. The long-term trend indicates that the number of households with one vehicle has been roughly 30 million since 1960. The number of households with two vehicles has jumped in that time period from 10 million to almost 35 million, and the number with three vehicles has ballooned from about 2 million to more than 15 million. Importantly, the number of households without vehicles has remained at about 10 million households—slightly rising in fact, in the most recent census. There are clear racial disparities in these ownership patterns. Tracing the mobility characteristics of these zero-vehicle households will be an important future area for study. (See table 3-5.)

A comparison of households with vehicles available based on decennial census data collected from 1960 to 1990 provides a number of insights.[10] One trend pattern that seems clear is that the shares of households in different vehicle ownership categories appears to be stabilizing, reconfirming the sense that the rapid growth years of the personal vehicle fleet in America are past. (See figure 3-16.) On average, the majority of households have vehicles equal to or exceeding the number of license holders, suggesting that there is something like saturation among households independent of the number of drivers. In fact, 93 percent of households with one licensed driver have one or more vehicles; 83 percent of those with two licensed drivers have two or more vehicles; and of those with three licensed drivers, 73 percent have three or more vehicles.

Further indicators of stability in the fleet include the facts that the share of households with three vehicles actually declined slightly between 1980 to 1990, and that vehicles per worker also declined, from 1.34 vehicles per worker to 1.32 in the period.

It is more difficult to see indicators of stability in the use of the vehicle fleet. The 1990 National Personal Transportation Survey (NPTS) indicates that there has been substantial growth in miles of travel per vehicle.[11] A key factor in these trends is that there is no significant diminishing of travel with increased household vehicle ownership. All household vehicles average about 12,500 miles per year, with only about a 4 percent variation by number of vehicles in the household.

What this means is that, on average, households with three vehicles travel three times as much as households with one vehicle. Inspection of the locations of these households provides some clarification of the sense that adding cars causes added travel. The decennial census is very revealing with respect to their locations. For the most part the places with higher-than-average shares of households with three or

TABLE 3–5

Percent of Households With No Vehicles Available (by State)

	1980	1990
New York	32.5	30.0
Massachusetts	16.5	14.3
Pennsylvania	16.6	15.2
Illinois	15.9	14.0
New Jersey	14.8	12.9
Louisiana	13.9	13.9
West Virginia	13.7	13.7
Mississippi	13.1	12.1
Kentucky	12.7	11.5
National Average	11.3	10.2

FIGURE 3–16

Households By Vehicles Available Trends: 1960 to 1990

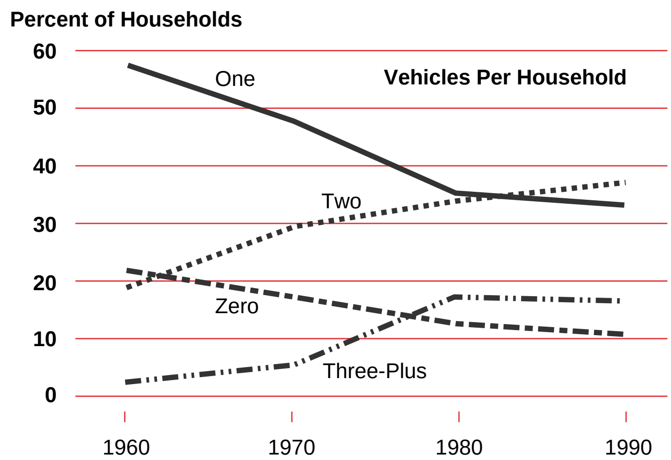
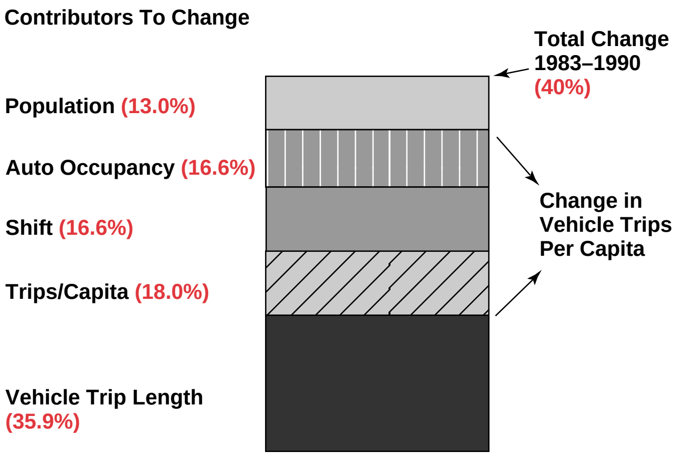


FIGURE 3–17

Vehicle Miles of Travel Factors of Change: 1983–1990

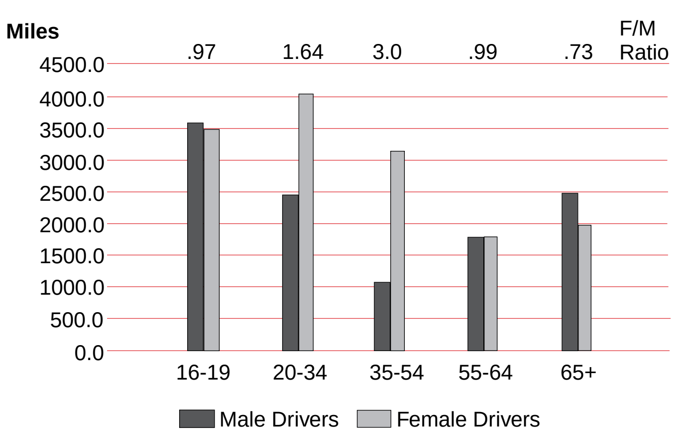


more vehicles are not the states with affluent suburbs, but rather those with working farms and ranches. The states with highest shares in contrast to the national average of 17 percent are Wyoming (27.4 percent), South Dakota (25.4 percent), Montana (25.2 percent), Utah (24.3 percent), and North Dakota (23.6 percent).

Analysis of travel behavior trends using NPTS indicates that the major sources of travel increase have been in trip-length, trip making, and shifts from carpooling and other modes to the single occupant auto. (See figure 3-17.) Population increase accounted for only about 13 percent of the increase in vehicle travel. Examination of the sources of these trends are revealing.

FIGURE 3–18

Absolute Growth in Annual Miles Driven by Male/Female and Age: 1983 - 1990



(See figure 3-18.) Growth in women's travel activity has been a significant factor in the overall trend. Women's daily trip rates now exceed men's, as they seek to juggle household duties and work trips. The substantial increases in driver's licenses among women has resulted in significant shifts to the use of the auto. As a result, the increase in travel among working-age women was about three times that of men in the same age group. The very low increase in travel for men in this age group is perhaps an indicator of stability. This is the group that historically has had the highest average travel miles and the group that showed the lowest travel increase.

Trucks and Buses

Trucks and buses account for over one–forth of all vehicle miles of travel in the U.S. Much of that mileage is in personal-use vehicles, such as pick-ups and vans, rather than in large trucks and buses associated with commercial transportation. Trucks with six or more tires, ranging from local delivery vehicles to combination trucks with three trailers, account for less than 10 percent of total vehicle miles of travel. While the share of total mileage is small, the annual average miles of travel for large vehicles is substantial. (See table 3-6.)

TABLE 3–6

Average Annual Miles by Truck Type

Vehicle Type	Average Annual Miles
2-Axle, 4-Tire Truck	12,103
Other Straight Trucks	12,656
Combination Trucks	60,456
All Trucks	13,877
Intercity Buses	50,000
Transit Buses	39,010
All Buses	9,097
Demand-Responsive Vehicles	20,857

Travel of Other Vehicles

The public transit fleet also contains heavy railcars, light railcars, trolley buses, and commuter rail vehicles. The nation's 10,700 heavy railcars average 50,000 per year per vehicle, while 4,550 commuter railcars log almost as many miles (48,000 per vehicle). Light railcars average about half that mileage, and trolleys log only about 16,000 miles per vehicle.

Amtrak

Overall, in the 1990s, Amtrak's vehicles operated in the range of 160,000-170,000 miles per year per vehicle. Diesel-fueled locomotives average about 160,000 miles per year and Amtrak's few electric locomotives operated at around 130,000 miles per year.[12]

Vehicle, Aircraft, and Vessel Travel

U.S. freight cars operate in trains averaging 71 cars, running about 20,000 miles per year. Intermodal activity continues to be a major growth area in railroading. Trailer and container loadings were 6.6 million units in 1992, more than double the 1980 figure. Given that total carloadings are down in that period, the share of total rail activity represented by intermodal traffic has grown substantially.

The annual miles covered by nonmilitary aircraft varies by category of airplane, but the nation's major aircraft average 906,000 miles per year. (See table 3-7.)

TABLE 3–7

Aircraft Inventory and Use: 1991

	Number of Aircraft	Annual Miles per Aircraft
Air Carrier Type		
Total	4580	842,000
Major	3782	906,000
National	584	590,000
Regional	214	401,000
General Aviation Type		
Total	198,474	22,777
Personal	115,000	—
Business, Etc.	83,000	—

Shipping

The nation's inland water and coastal waterway shipping fleet consisted of 8,200 self-propelled vessels and 31,600 nonself-propelled vessels. Of the self-propelled fleet, about 4,700 are towboats and tugs. Of the nonself-propelled fleet, the great majority consists of dry cargo barges. The total of coastwise, internal and lake-wise ton-miles of travel approaches 800 billion ton-miles of travel with an average length of haul of 1,600 miles.

The U.S. Merchant Marine fleet consists of approximately 620 vessels, including passenger/cargo ships, freighters, bulk carriers, tankers, and a growing fleet of intermodal carriers.

Use of the System: What More We Need to Know

A substantial number of occasions have arisen in the development of this chapter when it was necessary to accept the fact that the data needed were not available in the scale and quality required. Even in this broad summary context, there are severe weaknesses and gaps that challenge our ability to describe the national system. As a sampler, in lieu of a detailed inventory of data deficiencies in this area, the following observations are presented:

- Basic information on the geography of travel and goods movement is not yet available.
- Next to nothing is known about the activities of large vehicle fleets (i.e., rental cars, company vehicles, and vehicles owned by governments and utilities, etc.).
- Data on tourism flows, especially international flows are extremely limited in terms of counts of travelers, their characteristics, itineraries, expenditures, and the character of movements. This will be increasingly crucial in the future.
- The ability to establish the ways in which businesses use transportation is very limited. Knowledge of the physical inventory and the use made of transportation equipment and facilities owned by all industries—in terms of kinds of vehicle fleets owned, spe-

cial terminals and loading and unloading facilities is basically unavailable. This will be central to effective intermodal planning. Data regarding corporate expenditures for passenger and freight services is also seriously limited.

Sources

Figures

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Figure 3-2, 3-4: Alan Pisarski, *Commuting in America*, forthcoming.

Figure 3-3: Compiled from unpublished releases of the U.S. Bureau of the Census, 1993.

Figures 3-5 through 3-7: Compiled from unpublished releases of the U.S. Bureau of the Census, 1993.

Figures 3-8 through 3-11: Calculated based on U.S. Travel Data Center, *1991 Travel Market Report*, Washington, D.C.: U.S. Travel Data Center, 1992, p. 5.

Figures 3-12 through 3-15: Frank A. Smith. *Transportation in America*. Lansdowne, VA: Eno Foundation for Transportation, 1993.

Figure 3-16: Compiled from unpublished releases of the U.S. Bureau of the Census, 1993.

Figures 3-17 through 3-18: *National Personal Transportation Survey*.

Tables

Table 3-1: *National Personal Transportation Survey*.

Table 3-2: Water: Navigation Data Center, U.S. Army Corps of Engineers. Rail: *Railroad Facts*, 1993 edition, p. 29. Truck: *Motor Freight Transportation and Warehouse Survey*, *1991*, U.S. Bureau of the Census

Table 3-3: Office of Economic Affairs, U.S. Department of Commerce, *Effects of Structural Change in the U.S. Economy on the Use of Public Works Services*, Washington, D.C., U.S. Department of Commerce, 1987.

Table 3-4: *Highway Statistics*, 1991.

Table 3-5: U.S. Bureau of the Census.

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Table 3-7: Volpe National Transportation Systems Center, *National Transportation Statistics*, pages 5, 12, and 16.

Endnotes

1. *Nationwide Personal Transportation Survey*, 1990. Federal Highway Administration, Office of Highway Information Management.
2. Federal Highway Administration, *New Perspectives in Commuting*, July 1992, p. 3.
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8. *The Effects of Structural Change in the U.S. Economy on the Use of Public Works,* Report to the National Council on Public Works Improvement, September 30, 1987.
9. Presentation by Carl Seiberlich, American President Lines, to the Intermodal Task Force, Transportation Research Board, October 20, 1993.
10. Vehicles available includes vehicles owned, leased, owned by others such as an employer but housed at a household and available for use.
11. NPTS is conducted approximately every five years by the Department of Transportation, Federal Highway Administration, Office of Highway Information Management.
12. All statistics are unpublished and provided by Amtrak.

HOW WELL *does it* WORK?

Transportation is a part of the value of virtually every good or service produced in our economy It is also an important part of our culture and quality of life. The performance of our transportation system is critical to our national social well being and international competitiveness. Government policies directly or indirectly affect the performance of nearly every mode and component of the transportation system. Investment in infrastructure, roads, airports, and terminals, and traffic management are perhaps the most obvious ways in which government policies and actions affect system performance. But other policies affect performance in more subtle ways, for example through intermodal integration or competition. Comprehensive new policies, such as the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), have established new ground rules for investment, operation, and intermodal integration. It is important that we develop and monitor meaningful indicators of transportation system performance, not only to track trends and look for problems, but also to evaluate how well new policies are working.

The Purpose of the Transportation System

It has been said that the purpose of transportation is to overcome the *friction of distance*, to make places that are separated in space as close together as practical. This chapter explores how well our transportation system achieves its primary purpose. It deals with accessibility, circuity, speed, and reliability. Maintaining and improving the performance of the system requires planning, investment, maintenance of infrastructure, and effective day-to-day management and operation. The transportation system of the United States is extensive and places are, generally speak-ing, well connected. As our transportation system matures, maintaining and improving performance becomes an increasingly complex and difficult task, demanding the balancing of safety, environmental, land use, economic, and other objectives with the benefits of an effective transportation system. In a mature system such as ours, the emphasis increasingly shifts from expanding capacity by means of new physical infrastructure to capacity enhancement through operating efficiency improvements and management of demand.

To bring people and places closer together, transportation networks must be available and accessible to the customers they serve. Accessibility of the transportation systems to potential users is the most basic aspect of performance. The directness of the connections—or circuity—is also important because it determines the effective distances between places. But accessibility of transportation is not only a matter of physical presence; it is also a matter of availability to potential users. That is, accessibility is not only a matter of efficiency; it is a matter of equity as well. All citizens, and all places should have the opportunity for reasonable and fair access to the transportation system.

Time is perhaps the most critical factor in transportation performance. Timeliness comprises not only average speeds, but also variability in terms of delays and interruptions of service. Although data on average speeds for many modes are inadequate to determine trends accurately, it appears that overall average velocities are either increasing or holding steady. If this seems contrary to intuition, it is because delays (the variability of speed) appear to be increasing in highway and air travel, at least. Congestion of the highway system, especially in the largest urban centers, appears to be steadily growing. Even here our information is weak, hampered by the difficulty in agreeing on meaningful and consistent definitions of delay and congestion, and by inadequate national measurement and information systems. Data on air delays suffer from having been designed to monitor individual airline performance rather than overall system performance.

Time is also crucial to intermodal transport, as delays in transferring from one mode to another can be critical to the competitiveness of intermodal shipment. Unfortunately, we know little about the performance of the system in this area.

A final element of performance covered in this chapter is the vulnerability of our transportation system to catastrophic interruptions by floods, hurricanes, earthquakes, and other disasters—whether natural or caused by human hands. This past year, record-breaking floods in the Midwest caused wholesale closures of waterways, railroads, highways, and even airports in the flood-ravaged areas. Two years ago, major earthquakes in Northern California caused major damage to highways and other infrastructure.

Do all regions and all citizens have adequate access to the national transportation system? Have we built the infrastructure necessary to connect our nation? Are modes effectively connected so that the system can function as an efficient and integrated whole? Are we managing the system so as to increase its proficiency in moving people and goods quickly and reliably? Is our transportation system robust enough to stand up to disruptions—natural or otherwise? Have we responded effectively to past emergencies? At present, we can only begin to answer these questions.

Accessibility

The national transportation network is primarily composed of five major systems: highway, rail, waterway, air, and mass transit. This section discusses the accessibility of these systems, primarily in terms of the extent of the network infrastructure and the number of Metropolitan Statistical Areas (MSAs) traversed by each network. (See tables 4-1 and 4-2.) Although this does not indicate the accessibility to the entire population of the United States, it does provide some insight into the availability of services to most of the nation's population centers.

Aside from geographic proximity, the ability of individuals (especially those with handicaps) to utilize these networks is another important aspect of accessibility. Therefore, the status of systems providing passenger service in compliance with the Americans with Disabilities Act (ADA) requirements is also discussed in this section.

Highway Network

The highway network is the most extensive transportation facility in the United States, consisting of nearly four million miles of roadway that serve all Metropolitan Statistical Areas (MSAs). This system is the primary mode of personal transportation and an important mode of commercial transportation as well. The large-scale use of this system can be attributed to its accessibility; using this system, it is possible to travel to almost any location within the continental U.S.

The Federal-Aid Highway Acts of 1944 and 1956, along with the Highway Revenue Act of 1956, established the National System of Interstate and Defense Highways in the United States. The Interstate System connects, as directly as practicable, the nation's principal metropolitan areas, cities, and industrial centers. It also serves the national defense, connecting with routes of continental importance. In 1991, the Interstate System goes through 87 percent of all MSAs.

Now that the Interstate System is essentially complete, attention has turned to defining a National Highway System serving all major communities more comprehensively than the system of Interstate Highways. In comparison, railroads have access to 99 percent while 97 percent have some form of air transport service. A key issue in defining the new National Highway System will be its relationship to the other modes and its role in a intermodal national transportation system.

Railway Network

Almost every large community in the nation is connected to the rail freight system. In 1991, the railroad network served 99.4 percent of MSAs in the U.S. Used primarily for transporting bulk commodities for the agricultural and industrial sectors, the majority of railroad tonnage is comprised of commodities such as grains, livestock, coal, ores, and machinery parts. In 1991, the railroad system was responsible for transporting more than a trillion ton-miles of freight within the United States.

Although railroads primarily transport freight, passenger service is also provided by Amtrak on the rail network. Amtrak does not operate on its own mainline track—except for the Northeast Corridor between Washington and Boston—but rather on track owned by other railroad companies. In 1991, Amtrak operated 25,000 route miles out of 523 stations and completed nearly 6.3 billion passenger-miles. Amtrak provides both commuter and long-distance services and is accessible to 53.7 percent of MSAs in the U.S. (See figure 4-1.)

TABLE 4–1

Extent of Transportation Infrastructure

Network	Facilities	Extent (Miles)
Highway		
Interstate		45,280
Other Expressways		7,714
Arterials		355,923
Collectors		807,334
Local		2,673,048
Air	6,818 airports	386,889[1]
Primary	394 airports	
Commercial	172 airports	
General Aviation	6,252 airports	
Rail		173,808[2]
Class I		129,839[2]
Regional		19,662[2]
Local		24,307[2]
Amtrak	253 stations	25,000[2]
Waterway	188 ports	
Ocean	119 ports	
Inland	69 ports	125,777
	160 locks	
Petroleum Pipeline		203,828
Crude		115,860
Products		87,968

[1] U.S. Route Airway Mileage. Includes direct low altitude and jet routes. Converted from nautical miles for comparison purposes.
[2] Route miles operated.

Waterway Network

The waterway network is the oldest transportation system in the United States. It was by ship that Europeans first reached America, and much of the early trade among the colonies and with other countries was carried out via the Atlantic Coast. The current waterway network is much more complex, consisting of rivers such as the Mississippi and the St. Lawrence; the Great Lakes; various sea ports on the Atlantic, Pacific, and Gulf coasts; as well as a number of constructed canals and waterways. Like the railroad, the waterway system primarily transports bulk commodities. Unlike rail, it is geographically limited by the extent of navigable waterways. Barges operating on inland waterways transport such freight as grain and coal. Sea-going vessels primarily carry goods and commodities for import and export, and a large amount of domestic oil from Alaska is transported to the continental U.S. via large supertankers. The waterway system serves 49.55 percent of MSAs and is an important mode of both foreign and domestic transportation.

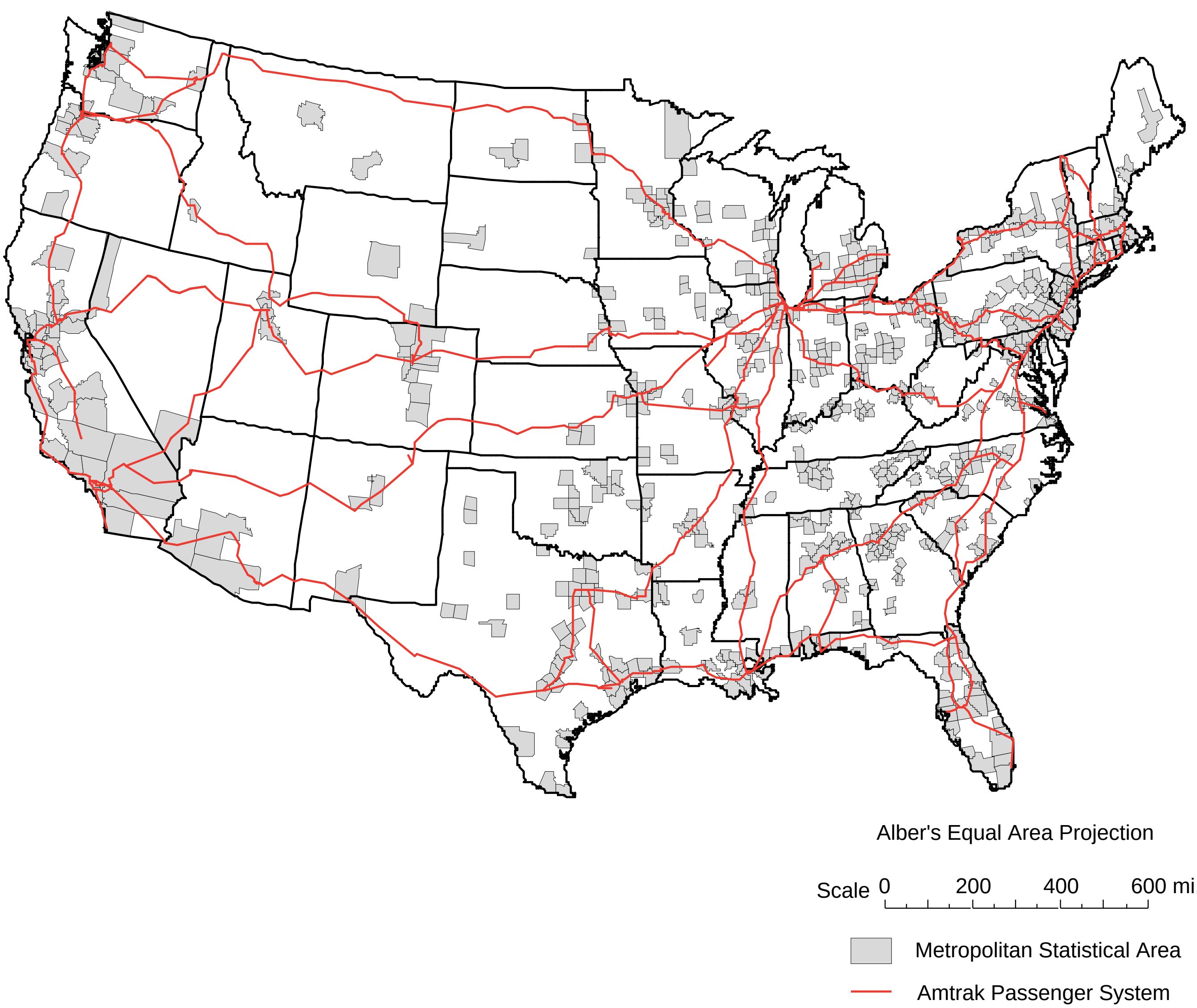
Air Network

The air network consists of airports ranging in size from tiny, privately-owned, general aviation airports to gigantic international airports served by major airline companies that transport freight and/or passengers around the world. Airports served by major airlines are quite common and can be found in 69.6 percent of all MSAs. (See figures 4-2 and 4-3, and table 4-2.) Those at which foreign enplanements take place, however, are restricted to large population centers and/or major carrier network hubs. Such airports can only be found in 9.85 percent of MSAs in the U.S. Commuter and air taxi services, on the other hand, are available in 77.3 percent and 97.3 percent of MSAs, respectively.

The air passenger transport system has evolved into a very pronounced hub and spoke structure. Flights from small and

FIGURE 4–1

Amtrak Railroad Network



medium-sized cities are routed to major hubs, where passengers are consolidated onto flights to their final destinations. Major hubs account for more than one-third of all enplanements. (See table 4-3.) The hub and spoke structure permits more efficient use of aircraft and is no doubt largely responsible for continuing increases in airline load factors, as well as more frequent service. (See table 4-4.) At the 50 busiest air carrier airports, an average of 530 take-offs and landings (combined) were performed per day in 1991. On the other hand, the hub and spoke system may increase circuity, increasing the distance traveled from origin to final destination, and possibly the travel time, as well, but existing data do not contain this information.

Mass Transit

Mass transit includes all multiple-occupancy-vehicle passenger services of a local and regional nature provided for general public use. In 1991, there were more than 5,000 transit systems in the U.S., 1,500 of which operated more than one mode. Furthermore, it is estimated that approximately 8.6 billion trips were taken on mass transit systems and that about 6.5 million people used these systems each weekday. (See table 4-5.)

The motor bus is the most widely used form of mass transit and can be found in medium to large population centers. Their wide-spread use comes mainly from the fact that they are relatively inexpensive and rely only on the highway system to operate. In 1991, approximately 2,700 transit systems operated motor buses, servicing 5.7 billion trips. An estimated 45.7 percent of all MSAs have this type of transit service. (Table 4-2.)

Demand response is another common form of mass transit which operates on the highway network. However, rather than keeping a daily route and schedule like most mass transit systems, demand response operates as an *on-call* service, meeting individual transportation needs (usually for persons with disabilities or the elderly). About 3,900 mass transit systems provided demand response service in 1991, and forty percent of MSAs had such systems.

Rail-based mass transit systems are less common than highway-based systems, and their use is usually restricted to large

TABLE 4–2

Transportation Network Accessibility by Mode: 1991

Mode	MSAs Served	Percentage of MSAs Served
Railroad	333	99.40
Amtrak	180	53.73
Waterway	166	49.55
Interstate	293	87.46
Air		
Major	233	69.55
Commuter	259	77.31
Air Taxi	326	97.31
Foreign	33	9.85
Mass Transit		
Motor Bus	153	45.67
Demand Response	134	40.00
Van Pool	17	5.07
Trolley Bus	5	1.49
Heavy Rail	10	2.99
Light Rail	17	5.07
Commuter Rail	9	2.69
Intermediate Rail	0	0.00
Automated Guidance	2	0.59
Inclined Plane	3	0.89
Ferry Boat	4	1.19

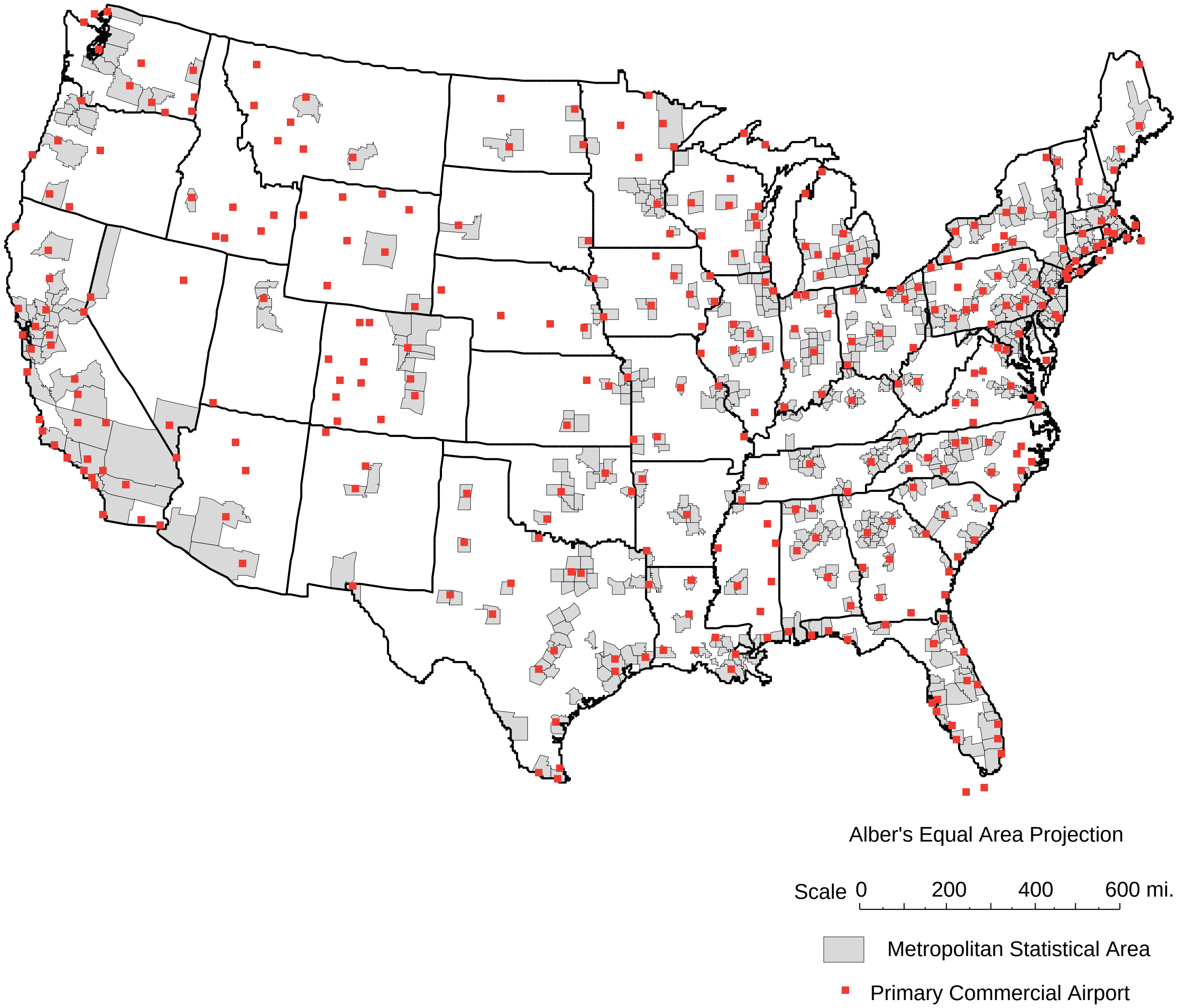
TABLE 4–3

Enplaned Passengers for the Top Ten U.S. Airports: 1991

Air Traffic Hub	Enplaned Passengers	Percent of Total Enplanements
Chicago, IL	28,816,463	6.73
Dallas/Ft. Worth, TX	25,448,951	5.94
Los Angeles/Burbank/ Long Beach, CA	23,348,631	5.45
Atlanta, GA	17,691,130	4.13
New York, NY	17,439,839	4.07
San Francisco/Oakland, CA	16,987,581	3.97
Miami/Ft. Lauderdale, FL	12,761,352	2.98
Denver, CO	12,313,733	2.87
Houston, TX	11,585,160	2.70
Washington, D.C.	11,340,673	2.65

FIGURE 4-2

Primary Commercial Airports



population centers. Rail-based mass transit serviced an estimated 2.7 billion trips in 1991. A small number of MSAs were serviced by such systems, but these are the largest metropolitan areas in the nation.

Ferryboat is the only water-based mass transit service. Only 1.2 percent of all MSAs had this type of service in 1991.

Accessibility of Public Transportation Systems: Americans with Disabilities Act Compliance

The Americans with Disabilities Act (ADA) of 1990 was implemented to remove barriers to equal opportunity, provide full societal access, and guarantee protection against discrimination in both public and private services to qualified individuals with disabilities. ADA changes the manner of providing transportation services in the U.S. Its accessibility requirements cover all modes of public and private transportation except air travel, which is covered by the Air Carriers Access Act of 1986 and related US Department of Transportation (DOT) regulations.

Implementation of ADA rules and regulations is well underway and is an ongoing process. Data collected by DOT's Federal Transit Administration (FTA), from 458 federally-assisted transit agencies in urbanized areas, indicate that 50 percent of the nationwide fleet of 52,500 buses are accessible with lifts or ramps. The American Public

FIGURE 4–3

Enplanements at Primary Commercial Airports

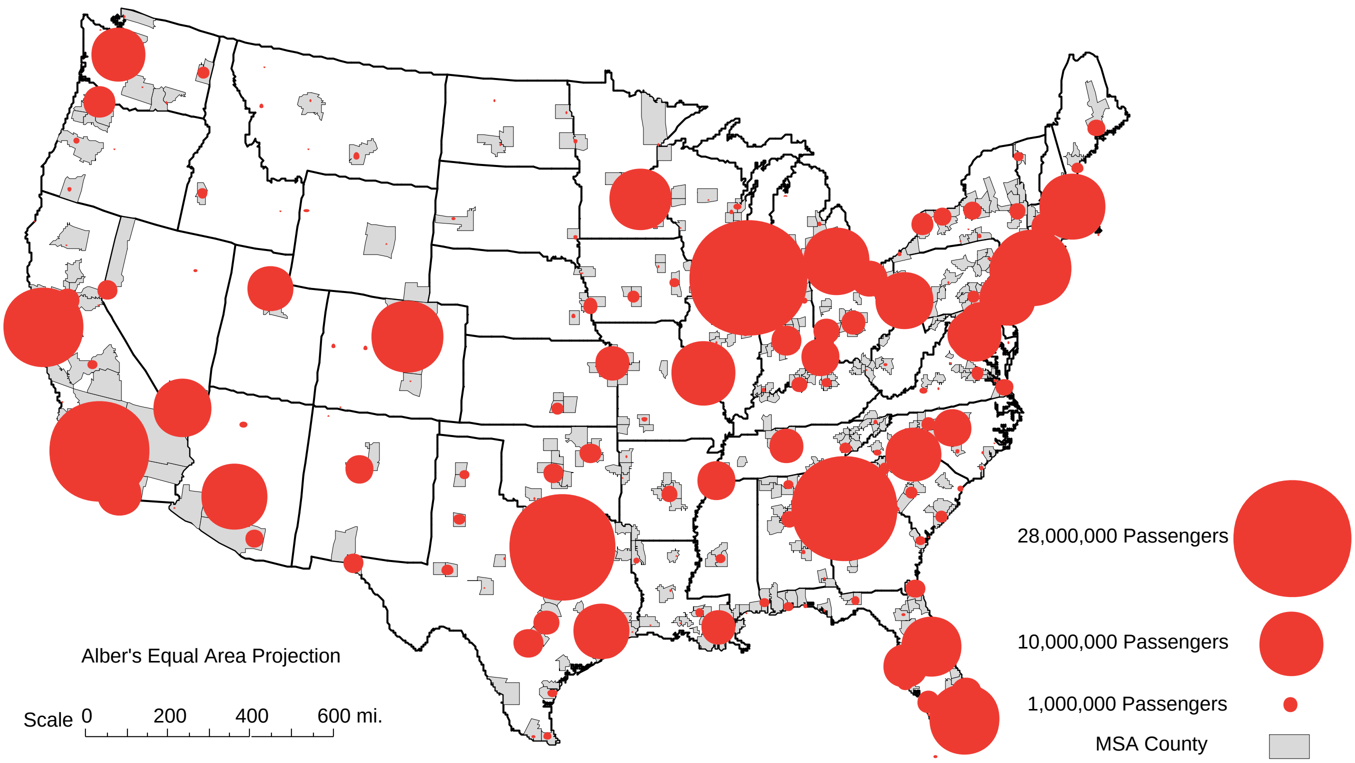


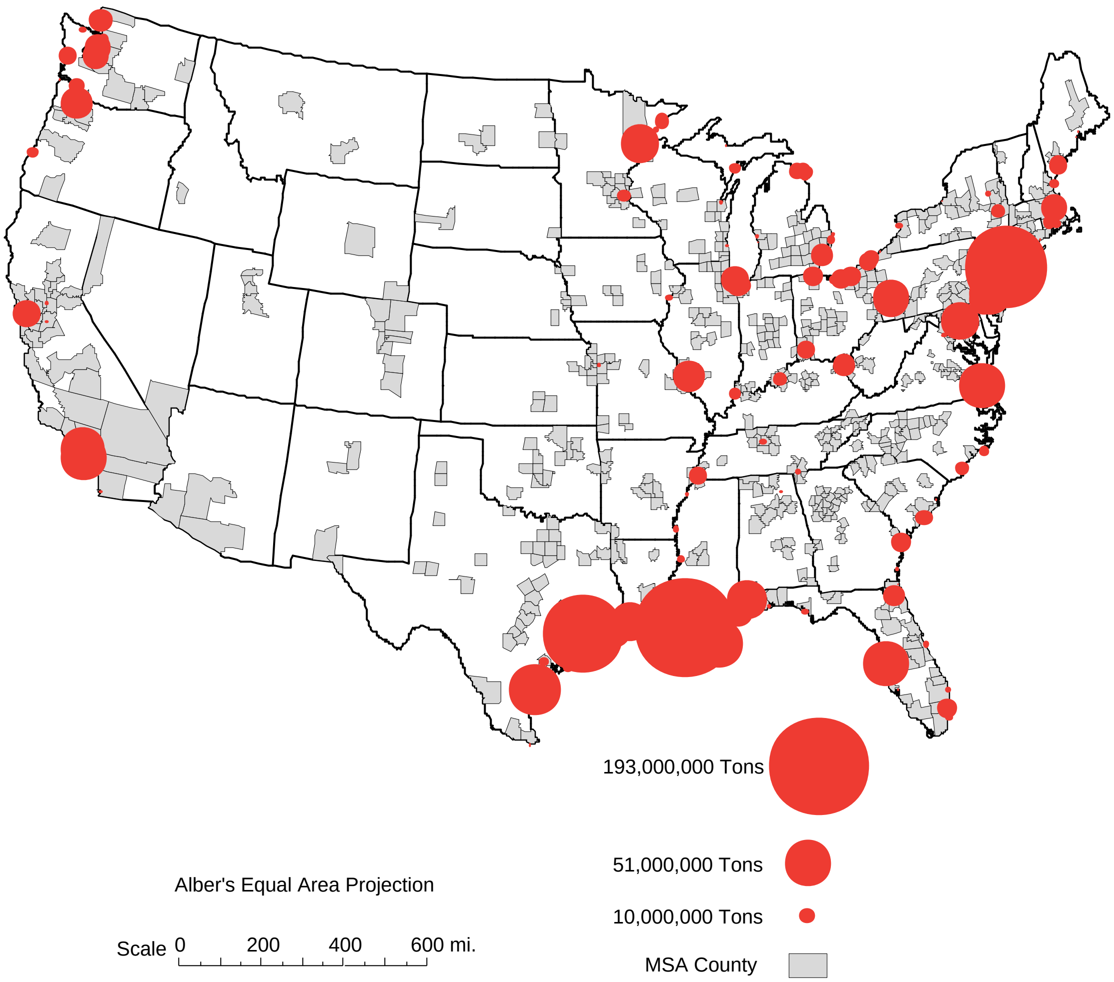
TABLE 4–4

Load Factors and Service Frequency of Domestic Passenger Service

Year	Total Air Carrier Operations	Operations/Day	Passenger Load Factor (Percent)
1980	9,956,045	27,277	59.7
1981	9,339,067	25,586	59.3
1982	9,156,496	25,086	59.8
1983	9,907,170	27,143	61.4
1984	11,110,294	30,439	59.8
1985	11,450,621	31,372	62.1
1986	12,523,570	34,311	60.8
1987	13,092,751	35,871	62.3
1988	12,741,239	34,908	62.9
1989	12,484,530	34,204	63.6
1990	12,948,295	35,475	62.7
1991	12,336,595	33,799	62.6

FIGURE 4–4

Tonnage for Selected U.S. Ports



Transit Association (APTA) estimates that 67 cities have lift- or ramp-equipped vehicles on 100 percent of their routes.

FTA completed review of 540 plans required from transit agencies to implement ADA complementary paratransit service requirements over a five year phase-in period ending in 1996. As of year-end 1993, 18 percent of paratransit systems were targeted to be in full compliance. Recurring capital and operating compliance costs of ADA complementary paratransit services are estimated at $700 million per year.

The ADA required "key" rail stations (e.g., those generating high demand, providing transfer points between lines, or interfacing with other transportation modes) on rapid, light and commuter rail systems to be accessible by July 1993. FTA estimates 500 of 708 key stations are wheelchair accessible.

TABLE 4–5

Population of MSAs Serviced by Mode of Mass Transit

Mode	Population of MSAs	Percent of Population
Motor Bus	141,117,000	57.4
Demand Response	128,315,000	52.2
Van Pool	27,516,000	11.2
Trolley Bus	13,056,000	5.3
Heavy Rail	37,501,000	15.3
Light Rail	48,880,000	19.9
Commuter Rail	39,959,000	16.3
Ferry Boat	15,115,000	6.2

DOT granted 284 key stations time extensions beyond the ADA compliance deadline due to extraordinary structural expenses. DOT denied time extensions requests for 115 key stations which are in probable noncompliance. The one-time capital cost of ADA key station implementation is estimated to be $907 million for 36 rail operators.

ADA's compliance deadline for rapid, light, commuter, and Amtrak rail operators to provide one accessible car per train is July 1995. Currently, only rapid railcars are accessible to wheelchairs. Rapid, light, and commuter railcar car modification costs are estimated at about $15 million per year.

Many Amtrak stations are providing accessible service with station-based lifts to accommodate passengers in wheelchairs onto railcars. Amtrak is purchasing new accessible railcars and expects to meet ADA's one accessible car per train compliance deadline. All Amtrak stations must meet ADA requirements for full accessibliity by July 2010.

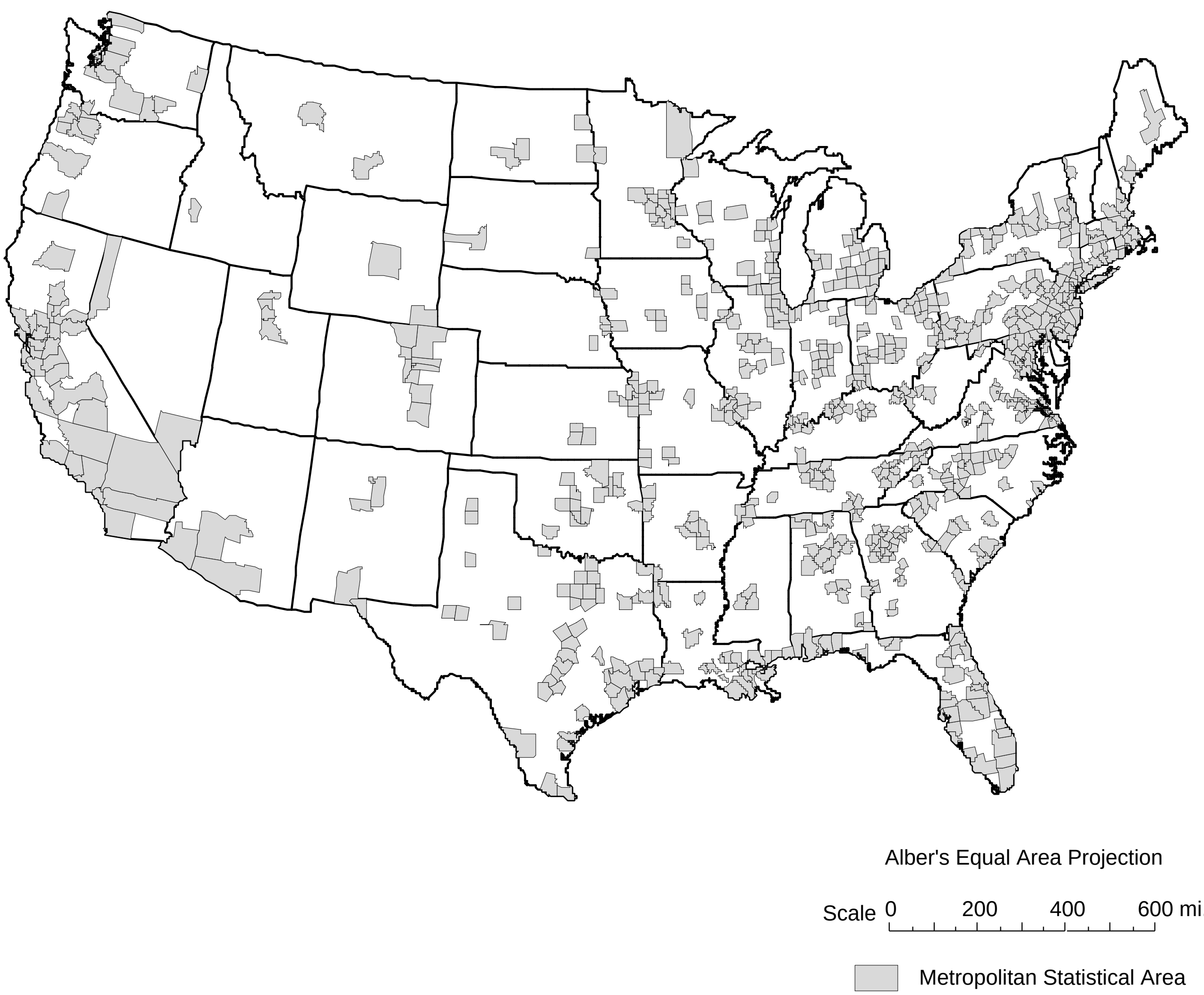
APTA will begin to compile information regarding ADA compliance as part of its 1992 fleet data collection efforts. These data should be available in the spring of 1994. The degree of compliance by the 550 U.S. public transit systems will be included in the publication, but data on the approximately 3,000 dial-a-ride services operating in the U.S. will not be included.

Intermodal Facilities

Intermodal facilities serve the movement of both freight and passengers and can be as simple as a bus terminal or as complex as an

FIGURE 4–5

Metropolitan Statistical Areas



international airport or waterway port. The primary purpose of these facilities is to perform intermodal transfers so that the most appropriate mode can be used for each segment of a trip or shipment. These components of the transportation system require a somewhat more intricate form of accessibility: Various modes must be effectively linked, physically, via intermodal transfer facilities. For freight movements, four basic intermodal connections predominate: rail-truck; ship-truck/rail; pipeline/ship-truck connections facilitated at ports and sea terminals; and truck-air connections facilitated at airports. (See figures 4-4 and 4-5.)

Over the last decade, trailer-on-flat-car (TOFC) and container-on-flat-car (COFC) shipments have almost doubled. To accommodate these movements, there are currently 53 TOFC facilities, 5 COFC facilities, and 207 facilities that both service TOFC and COFC intermodal connections. (Figure 4-5.)

Network Circuity

Circuity is the ratio of the actual distance traveled to the great circle distance. It can be used as an indication of both network accessibility and efficiency. Less circuitous, or more direct, routes make destinations more readily accessible or *convenient* in terms of distance; they also make goods and services arriving from other locations are more acces-

FIGURE 4 – 6

Highway Syeterm Inter-MSA Circuity

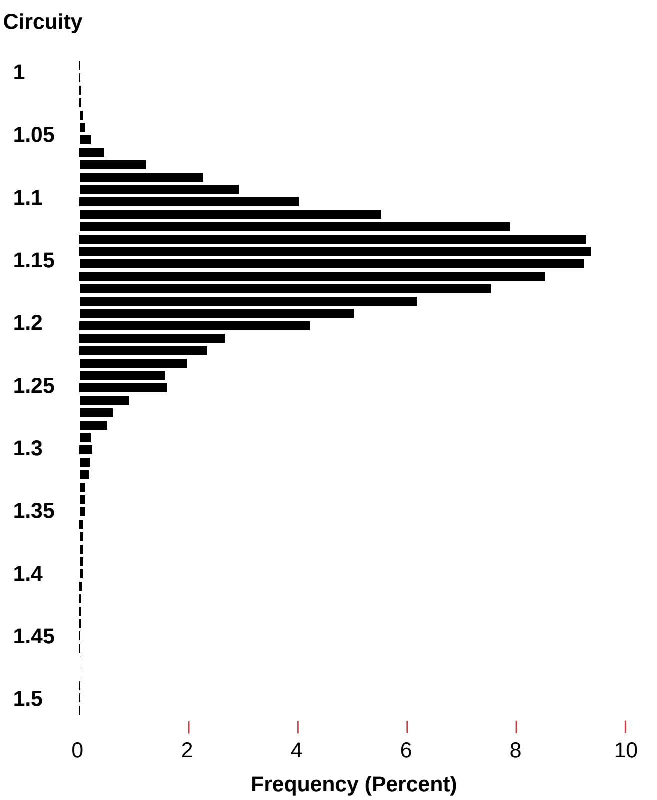
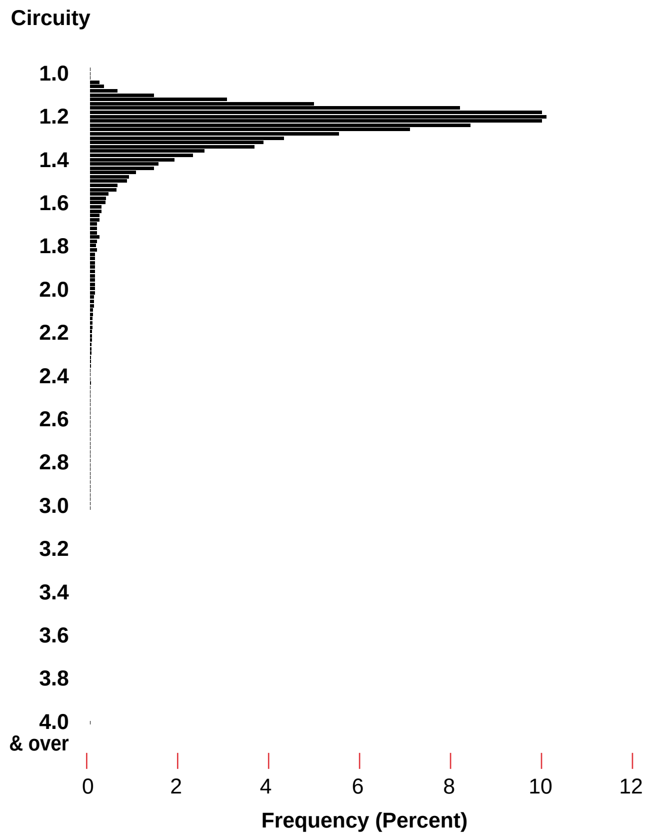


FIGURE 4 – 7

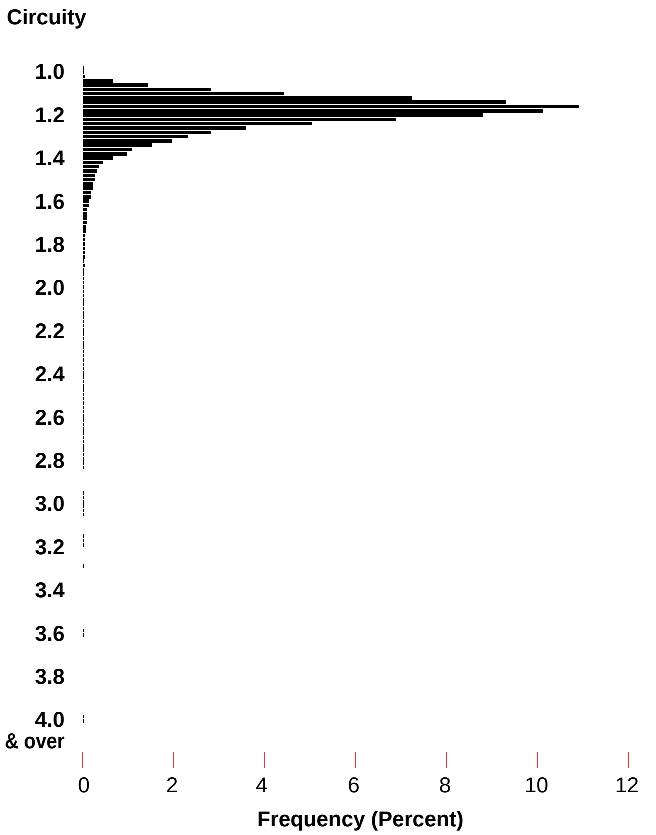
Interstate System Circuity



sible. The construction of a national highway network has been an attempt to provide more direct transportation routes, especially among major population and industrial centers. As a result, the national highway system is minimally circuitous. This is especially true for routes between population centers. Highway network circuity between Metropolitan Statistical Areas is an average of 1.16. (See figure 4-6.) The Interstate System is slightly more circuitous than the overall highway network. The inter-MSA Interstate circuity is 1.3 on average. (See figure 4-7.) Thus, for the most highway travel in the continental U.S., the actual distance is usually only 15-20 percent farther than the great circle distance ("as the crow flies"). However, it must be remembered that distance is only one of the factors affecting network accessibility and efficiency: Delays and congestion resulting from capaci-

FIGURE 4–8

Railroad Circuity



ty constraints are also factors.

The air network also faces a number of issues related to efficiency, accessibility, and circuity. Since deregulation, airlines have switched from a less circuitous direct-flight system to a more-circuitous *hub and spoke* system. In terms of accessibility, increased flight distances have made destinations less readily accessible. However, the reduced fares resulting from this system has made air transportation more affordable, which means it is more accessible financially. Thus, it is difficult to determine whether increased circuity has made air transportation more accessible or less accessible. It is likewise difficult to determine whether or not this trend has improved efficiency. The hub and spoke system has increased the number of revenue-miles required to transport freight and passengers, but it has also allowed airlines to increase aircraft load factors.

Rail network circuity is difficult to determine. Although the shortest distance by rail is easily estimated, actual train routes are determined primarily by rail line ownership. Freight trains operate primarily on their own lines, regardless of whether it is the least circuitous route. Also, freight is not normally transferred between rail companies to ensure that it is shipped via the least circuitous route. However, if rail line ownership is disregarded, the inter-MSA circuity of the freight rail system would be an average of 1.22. (See figure 4-8.) The actual system circuity is, of course, greater than this, however, it has not yet been determined how much greater.

Rail passenger circuity is much easier to estimate since the Amtrak schedule is fixed and it has no major national competitor. The inter-MSA circuity for Amtrak is an average of 1.7. (See figure 4-9.)

Waterway network circuity is related to the location of navigable bodies of water. Thus, waterway travel is much more circuitous than that of highway- and rail-based modes. The inter-MSA waterway circuity is and average of 2.44. (See figure 4-10.) Circuity can be reduced by the construction of canals to connect waterways.

Circuity is most interesting when discussed in connection with intermodal transportation. The concept of using the rail system as a bridge between the

FIGURE 4–9

Amtrak System Circuity

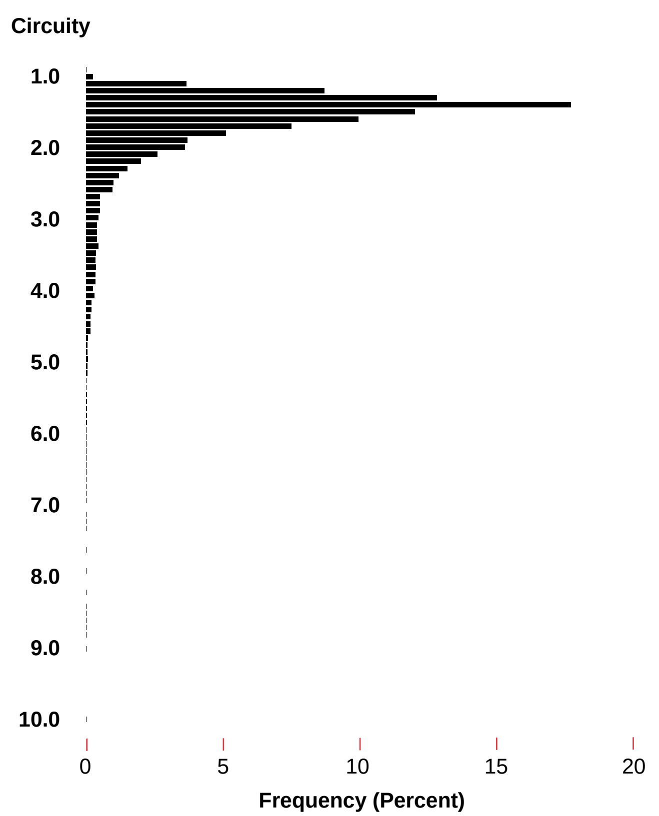


TABLE 4–6

Average Speed, Trip Length, and Travel Time Statistics for Work-Related Trips

Mode	Travel Time (Minutes)	Trip Length (Miles)	Calculated Speed (mph)
Privately Operated Vehicle	19.0	11.0	34.7
Transit	49.9	12.6	15.2
Walk	9.6	0.5	3.1
All	19.7	10.7	32.3

Atlantic and Pacific Oceans rather than shipping through the Panama Canal or other waterway routes was developed as a method of decreasing the circuity of shipments. There is currently little known about the circuity of intermodal transport.

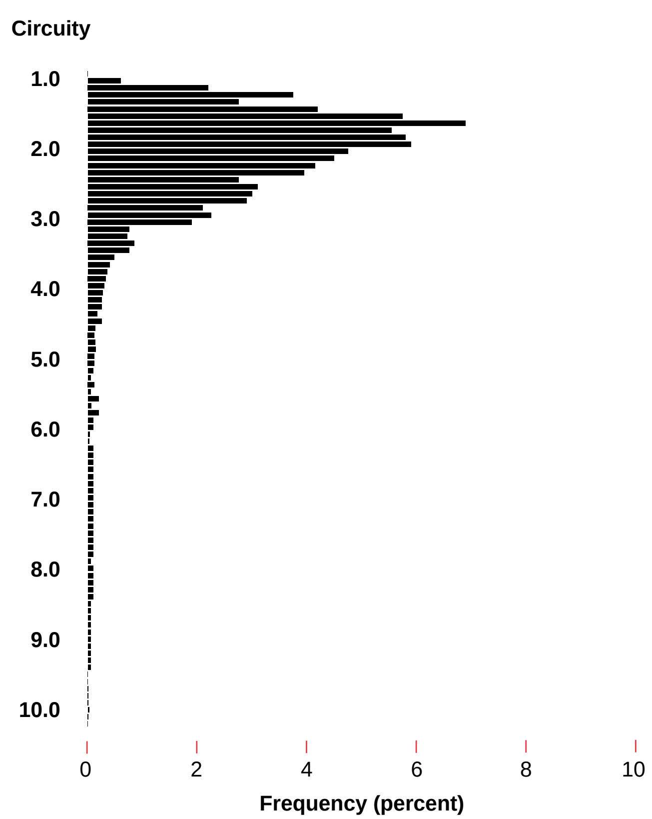
Timeliness and Reliability

Probably the most important quality of transportation performance is speed. To the user, faster and cheaper almost always mean better. For some modes, such as air passenger travel, our knowledge of average speeds is quite good. For other important modes, such as highway passenger and freight travel, our knowledge is piecemeal, and in many cases, questionable. In addition, there is more than one way to meaningfully measure speed. Passenger aircraft speeds are typically measured from gate to gate, or from take-off to landing (airspeed). Of greater interest to the traveler, however, may be the distance from origin to final destination divided by the total time required, including transfers and layovers. To the transit bus rider, time waiting for the bus is as important a part of travel time as the time spent riding. Similarly, to the motorist time spent sitting in traffic jams, waiting for a light to change, or searching for a parking space is all part of the speed of travel. Survey data provide the best approximation we currently have to total trip speeds. These data indicate that for the journey to work, privately operated highway vehicles get travelers to work twice as fast as transit. (See table 4-6.)

Despite the perception that transportation systems are becoming increasingly congested, what information we have on travel speeds suggests that average speeds are holding their own or even improving. Rail freight movements have clearly speeded up, and air and highway speeds seem to be holding constant. Most surprisingly, survey data suggest that commute trip lengths have become longer while commute travel times have remained constant, implying that commuters are traveling at faster speeds. If this is true, it may be more a reflection of the dispersion of jobs to less dense urban areas than an indication that highway travel conditions are improving. But the evidence is indirect, coming from survey responses rather than actual measurements. What data we do have on highway speeds comes from the higher order

FIGURE 4–10

Waterway Circuity



systems (freeways, expressways, and Interstates) and is not collected so as to be a valid representation of the entire traffic stream, but rather to monitor compliance with national speed limits. Moreover, for all systems we need to know more about actual speeds that are meaningful to system users: travel times and distances from origins to final destinations, including transfers, delays, and interruptions of service. About these aspects of speed we know relatively little.

This section discusses trends in travel time, velocity, and trip length for the rail, air, highway, and mass transit networks (no waterway data was currently available). Trends in work-related trip speeds, lengths, and travel times are also discussed.

System Speed and Travel Times

Railroad Speed, Length of Haul, and Travel Time.[1] From 1982 to 1991, the average length of haul increased significantly, from 628.8 miles to 751.9 miles, or almost 20 percent. During this same time, the estimated average velocity increased from 21.42 mph to 23.72 mph, almost an 11 percent increase. The average trip travel time (estimated using average velocity and length of haul) has fluctuated over these years but does indicate a noticeable upward trend. (See figure 4-11.)

Aircraft Speed, Flight Stage Length, and Travel Time.[2] The average velocity, flight stage length, and travel time for aircraft flights have remained almost constant between 1988 and 1992. During these years, the average velocity has fluctuated between 405.71 and 409.35 with no apparent trend. The average flight stage length has also fluctuated (between 563.2 miles and 588.4 miles) with a slight upward trend. The average flight stage travel time (estimated using average velocity and average flight stage length) has remained around 1.4 hours with no significant change. (See figure 4-12.)

Mass Transit Velocity, Passenger Trip Length, and Passenger Trip Travel Time.[3] The average velocity and passenger trip length estimates for the overall mass transit system show no particular trend in operations between 1986 and 1991. Only light-rail and demand response systems show an increase in trip length and velocity; statistics for other systems have remained constant or fluctuated with no apparent trend. The average passenger trip

FIGURE 4–11

Speed, Length of Haul, and Travel Time Statistics – Railroad

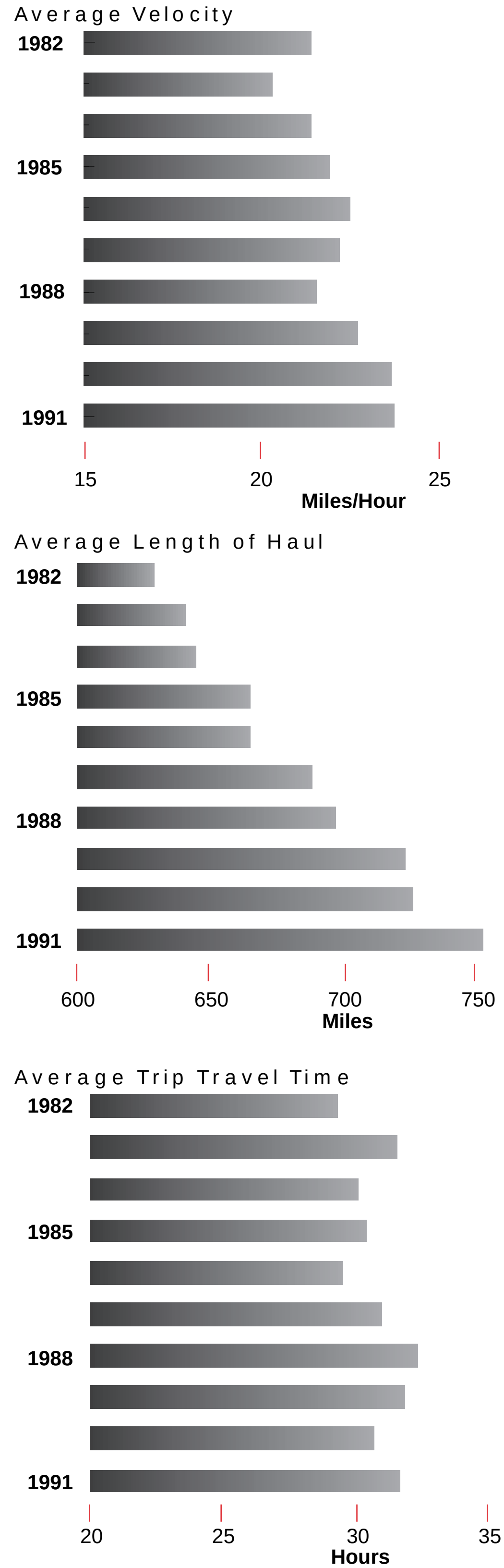
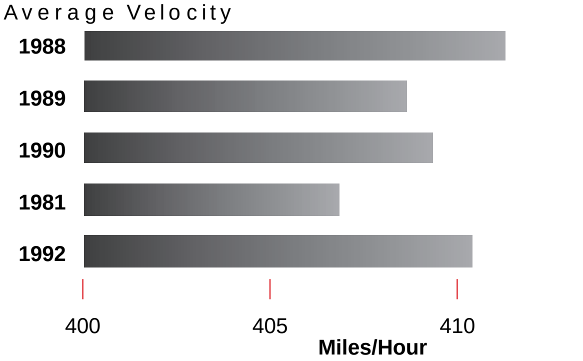


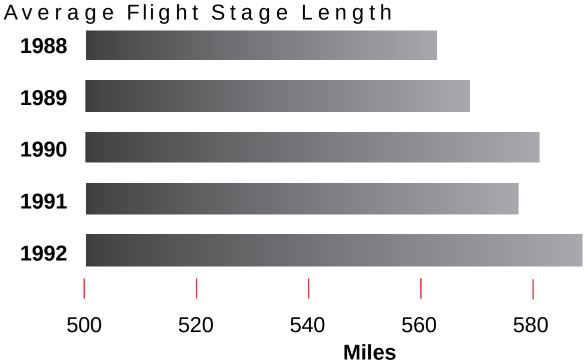
FIGURE 4–12

Speed, Trip Length, and Travel Time Statistics – Aircraft

Average Velocity



Average Flight Stage Length



Average Flight Stage Travel Time

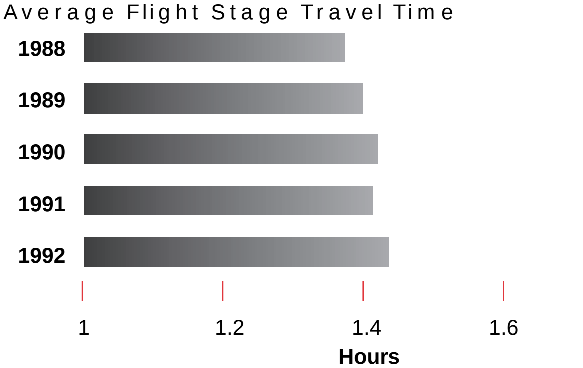
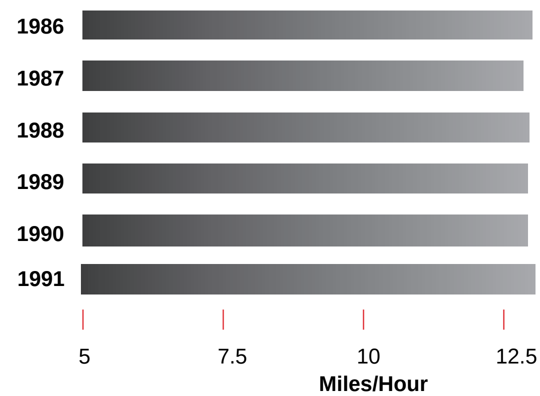


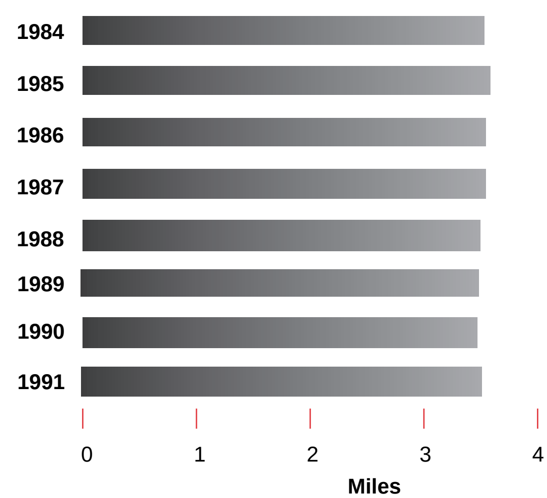
FIGURE 4–13

Speed, Trip Length, and Travel Time Statistics – Transit Motor Bus

Average Velocity



Average Trip Length



Average Trip Travel Time

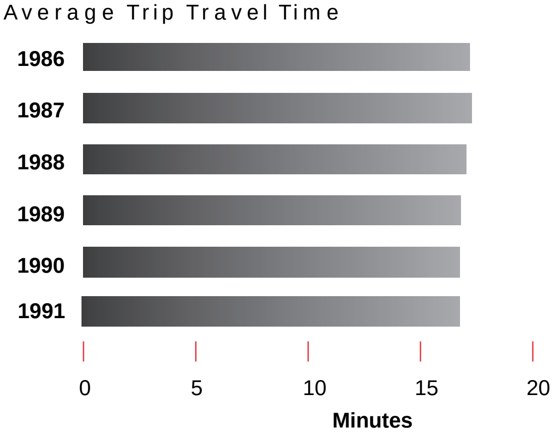


FIGURE 4–14

Speed, Trip Length, and Travel Time Statistics – Transit Heavy Rail

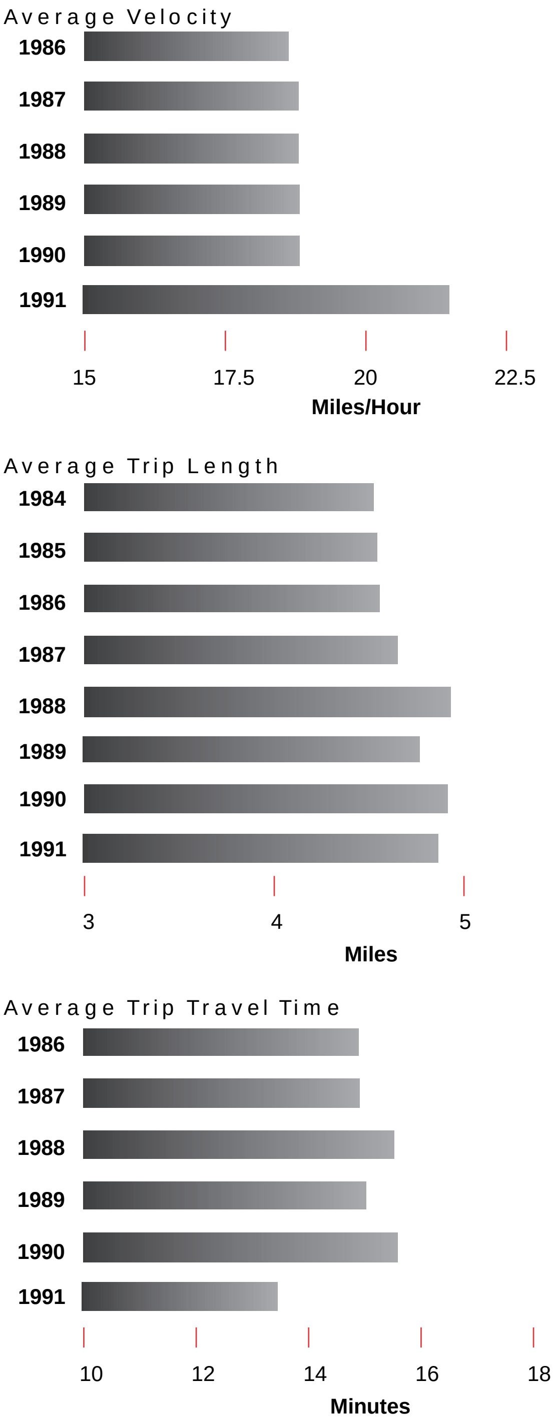


FIGURE 4–15

Speed, Trip Length, and Travel Time Statistics – Transit Commuter Rail

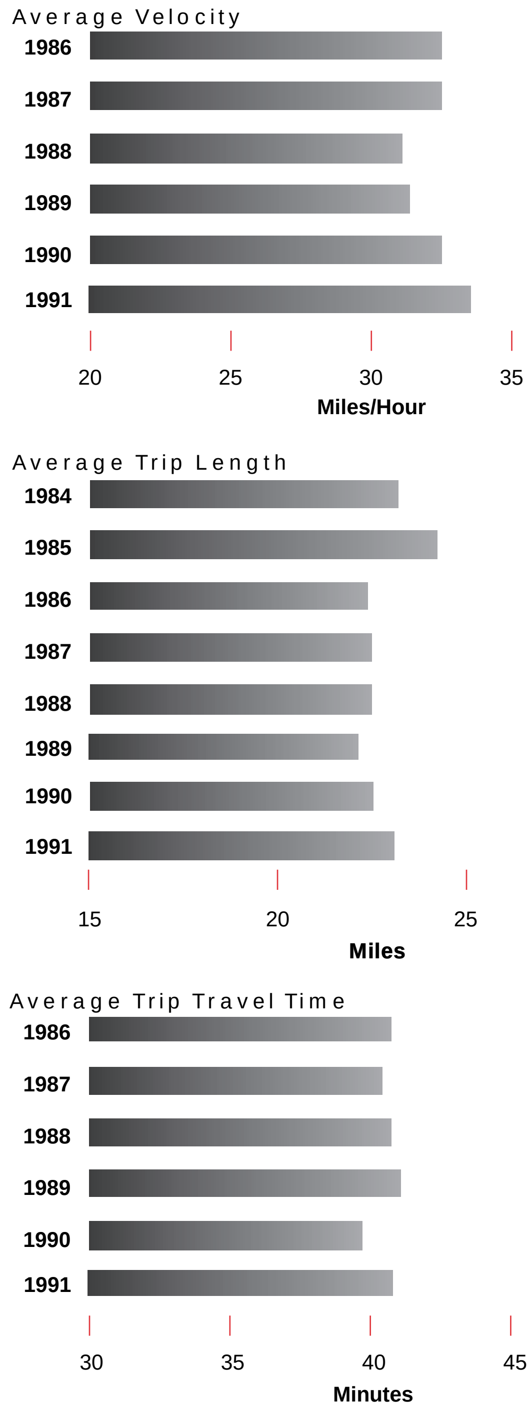
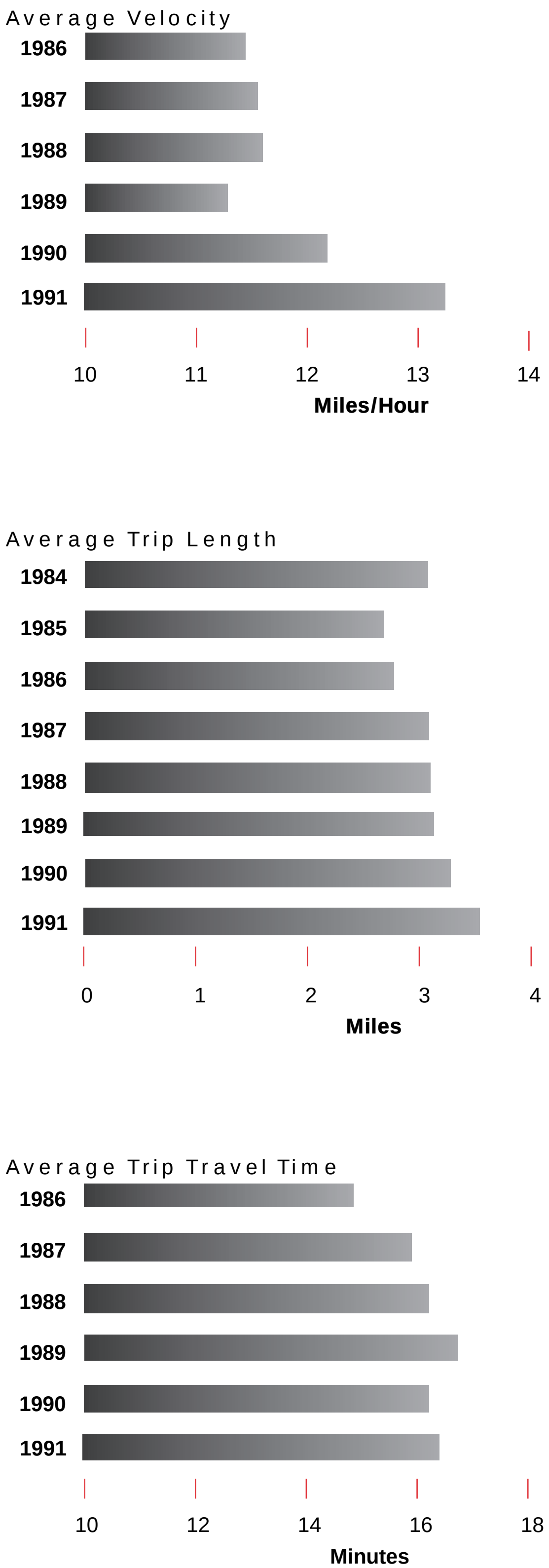


FIGURE 4–16

Speed, Trip Length, and Travel Time Statistics – Transit Light Rail



travel time statistics for these systems indicate similar results as trip length and velocity were used to estimate travel time. (See figures 4-13 through 4-16.)

Highway Speed. Urban interstate and expressway traffic shows a steady, but slight, increase in speed. (See figure 4-17.) However, highway speed data are collected for annual certification of speed limit enforcement rather than for statistical representation of system performance.

Intermodal Transfer Time. The most efficient use of the transportation system requires that users be able to select the most appropriate mode for each segment of a trip or shipment. Unless intermodal transfers are fast and efficient, the potential time and cost efficiencies of combining modes can be lost. At present, our knowledge of intermodal facilities is scant, and our ability to assess the adequacy and efficiency of intermodal connections is virtually nil.

Work Trip Speed, Length, and Travel Time.[4] Work trip speed and trip length increased steadily between 1974 and 1989. (See figure 18.) However, these two factors have canceled out one another, resulting in a fairly constant travel time. This trend holds true for both renters and homeowners. Home owners have consistently traveled around two to four miles farther than renters and at a speed of around five miles per hour faster. Still, the travel time for home owners exceeds that of renters by approximately two minutes on average.

Delays and Reliability

Speed describes the average velocity of transportation; delay and reliability describe its variability around the mean. In many cases the variability is just as important as the average. With increasing emphasis on *just-in-time* and *lean* production techniques, timeliness is becoming as important in goods movements as in passenger transport. Although there are many threats to the timeliness of transport systems (mechanical failure, human error, even weather) undoubtedly the greatest problems are caused by traffic congestion. Congestion is a serious problem for infrastructure with a fixed capacity that experiences peak demands. Morning and evening rush hours are the most familiar examples, but transportation facilities also become congested on holidays, for special events, and during emergencies.

By definition, congestion occurs whenever demand on a system exceeds its design capacity. On many systems (e.g., highways) throughput actually declines as congestion increases because speed decreases faster than the density of vehicles increases. Unwillingness or inability to expand capacity to keep pace with growing travel demand is a key factor in growing traffic congestion in the United States.

In the U.S., highway vehicle travel has grown much faster than highway capacity. Lane miles of every type of highway have grown more slowly than highway use. (See table 4-7.) Since 1985, however, lane miles of capacity, and capital expenditures have increased. (See figure 4-19.) This recent increase however, was only sufficient to bring levels of capital expenditure back to the levels of the 1960s (in constant dollars).

Highway travel is not the only mode with constant or declining investment in capacity expansion. Both capital and maintenance expenditures by railroads have decreased as miles of roadway have contracted. (See table 4-8.) Despite substantial growth in the number of passenger enplanements and airport operations

FIGURE 4 – 17

Speed Trends for Urban and Other Freeways & Expressways

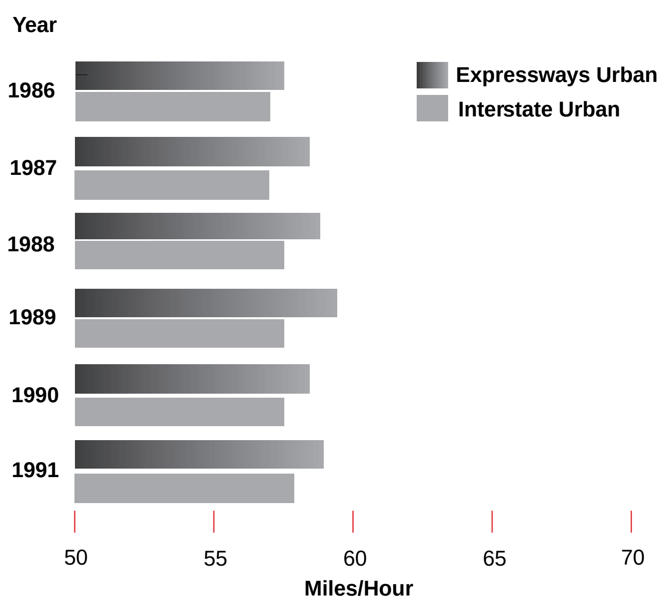
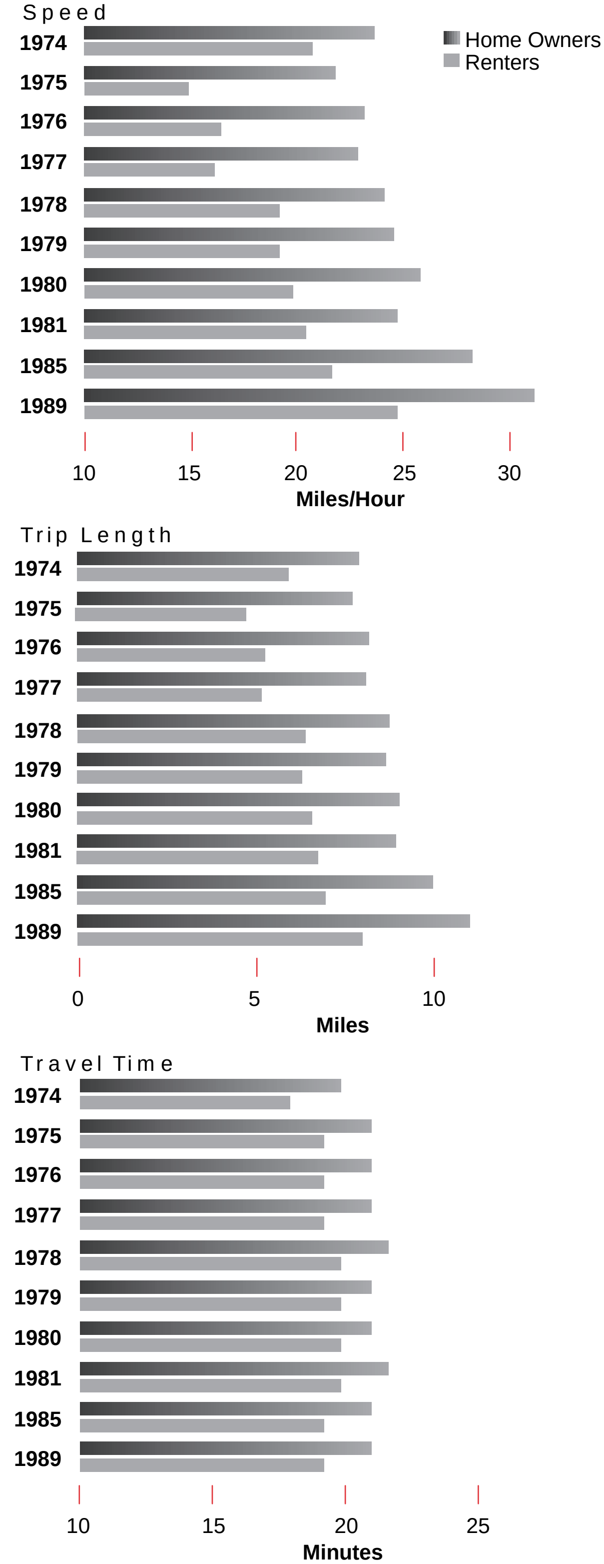


FIGURE 4 – 18

Speed, Trip Lenth, and Travel Time Statistics – Personal Work Trip



(takeoffs and landings) the number of major and minor airport hubs in the U.S. has remained essentially constant. We lack, however, an adequate measure of the capacity of these facilities.

Highway. Highway congestion and delays continue to increase. Statistics derived from data collected in the Highway Performance Monitoring System (HPMS) indicate a general worsening of traffic congestion as measured by the Roadway Congestion Index and increasing hours of traffic delay. (See figures 4-20 and 4-21.) Although about half of all traffic delays are caused by incidents (accidents, breakdowns) rather than recurring high volumes, congestion exacerbates incident delays to such an extent that there is a nearly perfect correlation between total hours of incident delay and recurring delay. (See figure 4-22.) Finally, although traffic congestion is perceived to be a ubiquitous national problem, it is in fact highly concentrated in the largest urban areas. The two largest cities, Los Angeles and New York, account for about one

TABLE 4–7a

Highway Vehicle Miles Traveled versus Lane Miles (Rural)

	Interstate Rural		Other Arterial		Other Rural		All Rural	
Year	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)
1981	139,304	n/a	267,220	n/a	193,508	n/a	600,032	n/a
1982	142,546	n/a	270,021	n/a	195,058	n/a	607,625	n/a
1983	145,250	n/a	273,408	n/a	200,649	n/a	619,307	n/a
1984	149,139	131,315	280,817	510,189	301,878	1,469,201	631,834	2,110,705
1985	154,275	131,808	282,595	509,832	206,526	1,465,311	643,396	2,106,951
1986	159,477	131,973	290,148	513,579	208,118	1,461,906	657,743	2,107,458
1987	171,866	133,521	301,974	512,557	218,664	1,465,889	692,504	2,111,967
1988	181,284	134,441	312,036	514,465	230,492	1,467,716	723,812	2,116,622
1989	191,120	134,969	322,619	514,084	235,267	1,464,508	773,563	2,116,701
1990	200,573	135,858	331,226	517,222	241,764	1,464,508	773,563	2,117,588
1991	205,011	136,477	334,849	517,965	245,609	1,465,903	785,469	2,120,345

TABLE 4–7b

Highway Vehicle Miles Traveled versus Lane Miles (Urban)

	Interstate Urban		Other Arterial		Other Urban		All Urban	
Year	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)	VMT (Millions)	Lane (Miles)
1981	166,479	n/a	483,196	n/a	80,587	n/a	730,262	n/a
1982	175,879	n/a	514,387	n/a	83,726	n/a	773,992	n/a
1983	192,470	n/a	533,004	n/a	86,827	n/a	812,301	n/a
1984	204,304	56,028	560,613	526,871	87,893	160,100	852,810	582,899
1985	216,160	57,327	576,170	534,005	89,552	162,203	883,882	591,332
1986	231,177	58,831	602,247	539,932	90,251	160,704	923,675	598,763
1987	245,339	59,831	638,680	554,176	95,964	164,395	979,983	614,007
1988	258,662	60,680	668,037	556,007	99,245	164,710	1,025,944	616,687
1989	270,652	61,854	683,815	560,633	10,1259	167,699	1,055,726	622,487
1990	278,404	62,306	698,154	564,410	10,3756	167,218	1,080,314	626,716
1991	285,325	62,936	707,631	565,828	10,7272	164,752	1,100,228	628,764

third of the hours of delay experienced in the 50 largest U.S. cities and one-fourth of the delay in the 300 largest MSAs. (See table 4-9 and figure 4-23.)

An alternative to expanding capacity is to attempt to manage use of transportation facilities or manage transportation demand to mitigate the peaking of demand. Because the next user of a congested system bears only a small fraction of the additional delays he or she causes, transport systems with essentially free access are unable to ration their use efficiently and are thus prone to congestion. Highways and airports are the most notable examples. Freeway ramp metering, congestion tolls, and road pricing are all directed at better rationing scarce transportation infrastructure. The major thrust of the Intelligent Vehicle-Highway Systems movement is to increase the capacity of highways without building more lane miles by means of better driver information, improved areawide traffic management, and eventually automated vehicle control. Gauging the success of these efforts will be critical to future transportation policy and planning.

Traffic congestion problems have steadily worsened, thereby increasing traffic delays, fuel consumption, and air pollution while decreasing productivity. The total delay for the five most congested metropolitan areas (Los Angeles, New York, San Francisco, District of Columbia, and Chicago) constitutes more than half of the total delays of the 50 most congested metropolitan areas. (See table 4-10.) These increases have prompted federal, state, and local highway agencies to rank urban traffic congestion as a top priority.

Without any measure to curb future travel demands, additional capacity is required to alleviate congestion. However, due to the scarcity and cost of right-of-ways, high construction costs, and environmental considerations, it is becoming increasingly difficult to increase the lane-miles of infrastructure in many urban areas. Thus, to address the needs of severely congested corridors, other improvements and initiatives must be implemented in conjunction with, or in place of, roadway expansion.

Highway Congestion and Reliability. The maintenance of the existing highway system is an important factor in its reliability. (See chapter 2.) According to the Federal Highway Administration, overall highway and bridge conditions have been improving slightly in recent years.

Air Transport Congestion and Reliability. Airports also experience congestion. Of the 566 primary and commercial airports in the United States, 30 (or 5.3 percent) operated above their National Plan of Integrated Airport Systems (NPIAS) annual capacity rating. (See table 4-11.)

Air carriers report on-time perfor-

FIGURE 4–19

ane Miles of Capacity and Highway
apital Expenditures: 1984-1991

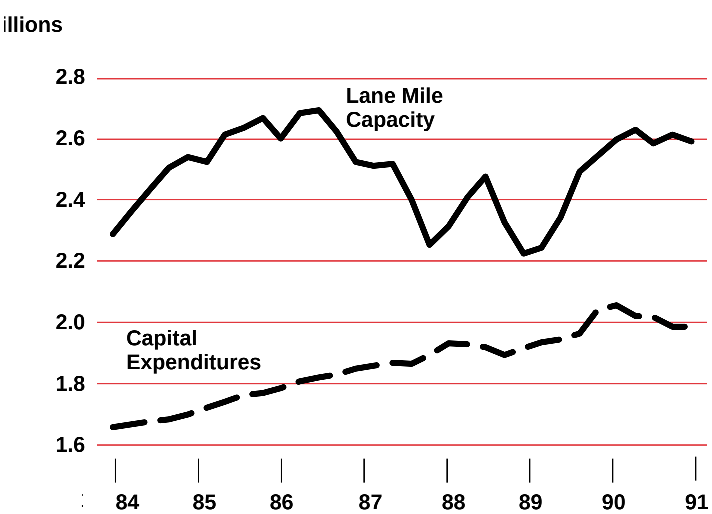
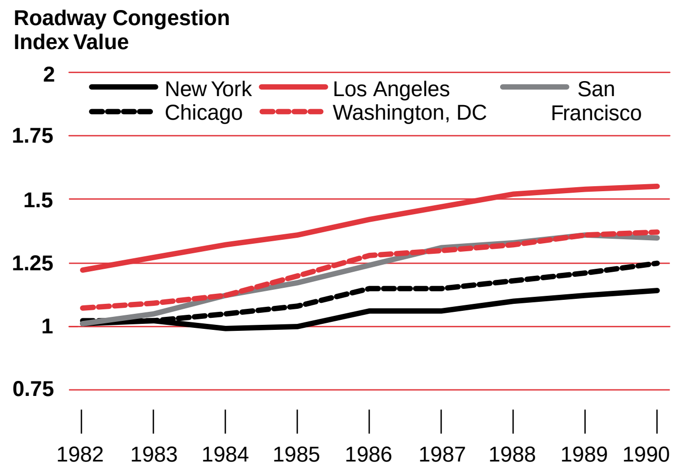


FIGURE 4–20

Roadway Congestion Index
(Selected Cities)



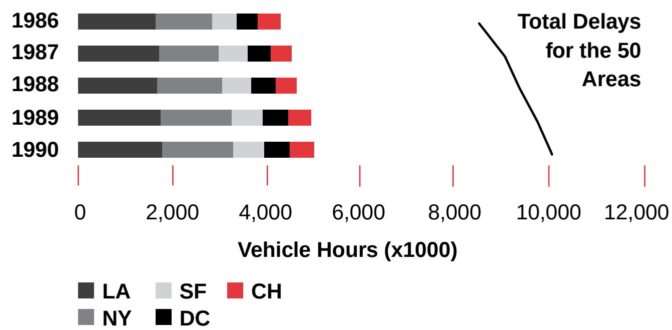
mance by certain rules that do not necessarily reflect the delays a passenger may encounter. If a flight is not more than 15 minutes late departing or arriving, it is considered *on time*. If a flight is delayed by weather conditions it is reported as not on time, whereas a delay due to a mechanical problem is not. The percentage of flight operations reported as arriving on time increased from 76.3 percent in 1989 to 82.3 percent in 1992. (See figure 4-24.) In 1991, passengers were more likely to experience delays in arrivals and departures in the evening hours (4:00 p.m. to 9:00 p.m.) instead of in the early morning. (See figure 4-25.)

Passengers traveling by air are also subjected to delays because of overbooking. Although the number of involuntary denied boardings has declined from 167,000 in 1986 to 46,000 in 1992, the number of voluntary denied boardings has increased, probably due to incentives offered by the airlines. (See figure 4-26.)

Intercity Rail Passenger Congestion and Reliability. Amtrak passenger trains have improved on-time performance from 1988 to 1991. (See figure 4-27.) Systemwide, 77 percent of trains were on time in 1991, up from 71 percent in 1988. Long-distance on-time performance for Amtrak has been more 20 percent less than short-distance performance over the last four years. The reliability of rail freight movement cannot be determined due to the lack of comprehensive, consistent, public data sources.

FIGURE 4–21

Trends in Vehicle Delays in 50 Selected Urban Areas



System Vulnerability: Impact of the 1993 Midwest Flood

An important indication of the transportation system's reliability is its performance during instances of natural disasters and other large-scale catastrophes. Natural disasters such as floods, hurricanes, and earthquakes have the potential to damage infrastructure severely and disrupt the movement of people and essential commodities. The ability of the system to overcome such disruptions is essential, both to the continuation of national productivity and to the recovery of the impacted area.

This section discusses the impact of the 1993 Midwest flood on the national

TABLE 4–8

Railroad Capital and Maintenance Expenditures: 1960–1992

Year	Capital Expenditures: Current Dollars (In Thousands)	Capital Expenditures: Constant 1990 Dollars (In Thousands)	Maintenance Expenditures: Current Dollars (In Thousands)	Maintenance Expenditures: Constant 1990 Dollars (In Thousands)
1960	285,664	1,240,441	1,191,690	5,174,685
1965	327,084	1,300,274	1,235,801	4,912,744
1970	358,344	1,152,622	1,612,585	5,186,919
1975	486,417	1,116,189	2,408,980	5,527,924
1980	953,467	1,501,345	4,940,091	7,778,749
1985	3,458,015	4,135,698	4,332,663	5,181,755
1990	2,643,966	2,643,966	4,278,075	4,278,075
1992	2,736,002	2,528,066	4,373,006	4,040,658

Note: A change in the accounting practices of railroads after 1980 caused some changes in the definition of capital and maintenance expenditures.

transportation system. The impacts on the air, highway, waterway, and rail networks are discussed in terms of the number and extent of closures resulting from the flood, the number of MSAs in which closures occurred, the impacts on related industries, and damages to the network infrastructure. (See figure 4-28.)

This information was compiled using Situation Reports generated during the flood by the U.S. Department of Transportation Research and Special Programs Administration along with network databases implemented on a geographical information system. Because the Situation Reports were developed to describe the state of the transportation system during the crisis, rather than for statistical purposes, the accuracy of the data is unknown. Furthermore, these reports only describe the impact on the transportation system during the period from May 24 to September 15, 1993.

Waterway

Effects on Routing and Service. During the flood, 1,612.2 miles of the waterway network were closed, as follows:

- 789.6 miles of the Mississippi River from Minneapolis-St. Paul, Minnesota, to a point south of St. Louis, Missouri, were closed and/or experienced lock closings.
- The entire Missouri River (669.8 miles) was closed from Sioux City, Iowa, to St. Louis, Missouri.
- The Illinois River was closed from Peoria, Illinois, to the confluence with the Mississippi River (152.8 miles).

In addition to river and lock closings, the Coast Guard imposed speed restrictions in many areas to protect levees from wake damage. Furthermore, draft, length-of-tow, time-of-day, and type-of-cargo restrictions were also implemented.

The waterway network was significantly affected due to lock closings on the upper Mississippi. A total of 26 locks closed from Minneapolis-St. Paul, Minnesota, to Cairo, Illinois, cutting off waterway access to 10 MSAs. From around June 29 to August 19 (approximately 52 days), lock closings occurring at various times made it impossible to tra-

FIGURE 4-22

Incident vs. Recurring Vehicle Delay: 1990

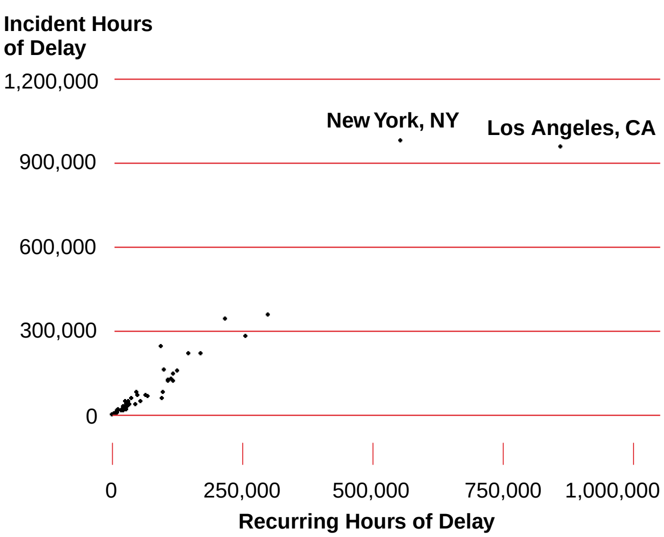
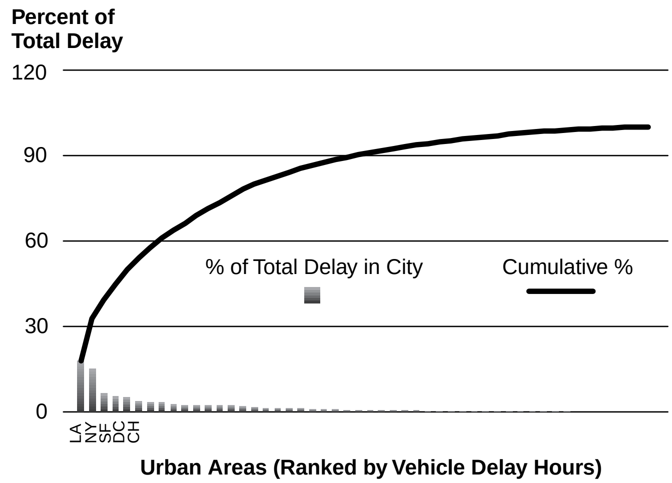


FIGURE 4-23

Cumulative Delay for 50 Urban Areas: 1990



Source: Estimates of Urban Roadway Congestion - 1990, Texas Transportation Institution Research Report 1131-5, 1993.

FIGURE 4–24

Flight Operations Arriving On-Time for All Major Air Carriers: 1988–1992

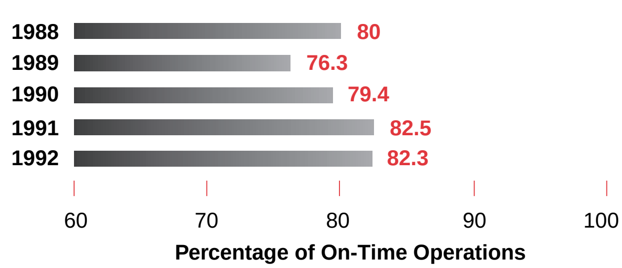


TABLE 4–9

Total Delay Hours for 50 Cities: 1986 to 1990 (In Thousands)

City	1986	1987	1988	1989	1990
Albuquerque, NM	15	15	15	20	20
Atlanta, GA	225	240	225	230	235
Austin, TX	50	45	45	45	45
Baltimore, MD	95	100	105	120	125
Boston, MA	285	270	370	350	335
Charlotte, NC	25	25	30	30	35
Chicago, IL	480	470	470	495	530
Cincinnati, OH	250	30	40	40	40
Cleveland, OH	35	40	45	45	50
Columbus, OH	30	35	35	40	40
Corpus Christie, TX	5	5	5	5	5
Dallas, TX	260	235	240	240	260
Denver, CO	110	110	115	120	135
Detroit, MI	340	345	350	360	360
El Paso, TX	10	10	10	10	10
Fort Worth, TX	95	90	90	90	95
Ft. Lauderdale, FL	65	65	70	65	70
Hartford, CT	20	20	30	35	30
Honolulu, HI	45	45	50	55	55
Indianapolis, IN	10	10	15	15	15
Jacksonville, FL	40	45	45	55	55
Kansas City, MO	20	20	25	25	30
Los Angeles, CA	1645	1715	1685	1750	1780
Louisville, KY	20	20	20	20	20
Memphis, Tn	15	15	20	20	20
Miami, FL	150	170	200	220	230
Milwaukee, WI	35	40	45	45	45
Minneapolis-St. Paul, MN	70	95	95	95	105
Nashville, TN	30	35	40	40	40
New York, NY	1190	1265	1370	1515	1510
New Orleans, LA	65	65	70	70	70
Norfolk, VA	60	70	70	75	75
Oklahoma, OK	20	20	25	20	20
Orlando, FL	60	60	60	70	70
Philadelphia, PA	250	270	275	270	275
Phoenix, AZ	145	145	185	180	180
Pittsburgh, PA	95	100	115	115	120
Portland, OR	50	60	70	75	80
Sacramento, CA	40	55	70	80	80
Salt Lake City, UT	10	15	15	15	15
San Bernadino, CA	185	190	215	230	235
San Diego, CA	95	125	145	155	155
San Antonio, TX	65	65	60	60	60
San Jose, CA	195	210	215	225	225
San Francisco, CA	540	615	625	650	645
Seattle-Everett, WA	175	210	235	255	260
St. Louis, MO	155	120	105	140	135
Tampa, FL	35	40	45	45	50
Washington, D.C.	440	475	495	540	555

TABLE 4–10

Total Delay Hours by Highway Type for 50 Urban Areas: 1990 (In Thousands)

Urban Area	Freeway/Expressway		Principal Arterial	
	Recurring	Incident	Recurring	Incident
Albuquerque, NM	2.9	3.2	7.0	7.7
Atlanta, GA	73.8	81.2	37.6	41.3
Austin, TX	17.9	19.6	4.7	5.2
Baltimore, MD	25.2	57.9	20.9	23.0
Boston, MA	61.4	214.8	29.0	31.9
Charlotte, NC	4.8	3.8	12.1	13.3
Chicago, IL	143.1	171.7	101.9	112.1
Cincinnati, OH	17.9	14.3	4.7	5.2
Cleveland, OH	17.7	12.4	8.6	9.5
Columbus, OH	14.0	9.8	7.9	8.7
Corpus Christie, TX	0.7	0.8	0.6	0.7
Dallas, TX	3.3	149.9	11.3	12.8
Denver, CO	36.2	36.2	30.0	33.0
Detroit, MI	59.3	130.6	81.3	89.4
El Paso, TX	3.6	3.9	0.9	1.0
Fort Worth, TX	30.3	54.5	5.9	6.5
Ft. Lauderdale, FL	9.2	13.8	22.8	25.0
Hartford, CT	4.6	12.3	6.5	7.1
Honolulu, HI	14.9	26.7	5.5	6.1
Indianapolis, IN	134.8	188.7	28.5	31.3
Jacksonville, FL	8.9	13.4	15.9	17.5
Kansas City, MO	3.2	10.0	7.1	7.8
Los Angeles, CA	601.8	722.1	217.3	239.0
Louisville, KY	1.8	1.9	8.1	8.9
Memphis, Tn	2.0	2.2	7.8	8.6
Miami, FL	32.6	488.9	71.1	78.2
Milwaukee, WI	14.2	14.2	8.6	9.4
Minneapolis-St. Paul, MN	34.5	31.0	17.7	19.5
Nashville, TN	6.3	6.9	13.1	14.4
New York, NY	287.5	718.8	239.3	263.2
New Orleans, LA	16.0	28.8	11.4	12.6
Norfolk, VA	16.6	41.5	7.9	8.7
Oklahoma, OK	3.4	3.8	6.7	7.4
Orlando, FL	12.5	18.7	19.4	21.3
Philadelphia, PA	25.8	54.63	93.2	102.5
Phoenix, AZ	29.4	11.8	64.9	71.4
Pittsburgh, PA	10.6	30.7	37.0	40.7
Portland, OR	17.2	34.3	12.5	13.8
Sacramento, CA	22.5	13.5	21.6	23.8
Salt Lake City, UT	4.4	2.6	3.8	4.2
San Bernadino, CA	78.6	94.3	30.5	33.5
San Diego, CA	78.0	46.8	13.3	14.6
San Antonio, TX	23.9	26.3	4.2	4.6
San Jose, CA	73.3	88.0	29.4	32.4
San Francisco, CA	232.5	302.2	52.3	57.6
Seattle-Everett, WA	83.0	116.2	29.3	32.2
St. Louis, MO	22.1	26.6	40.5	44.5
Tampa, FL	5.9	8.8	15.6	17.2
Washington, D.C.	107.5	236.5	99.5	109.5

verse the Mississippi completely. (See figure 4-29.) Although the entire Missouri River and sections of the Illinois River were closed, these rivers carry relatively fewer barges than either the Mississippi or the Ohio Rivers and had less of an effect on the waterway system.

It is estimated that more than 5,000 barges were affected by extant flooding and river closures. An estimated 1,075 barges were stranded in the Upper Mississippi River; 15 were stranded in the Missouri; and 30 were stranded in the Illinois. Other barges remained in docking bays, and many waited to travel up river.

Effects on the Waterway Infrastructure. The strong currents and turbulence resulting from the flood caused significant *silting up* of some channels in both the Mississippi and Missouri Rivers. Silt buildup in the Missouri prompted plans to dredge the river, which hadn't been dredged in 25 years. Areas of the upper and lower Mississippi also became more shallow. In some areas, silt buildup reduced the river depth to less than eight feet. As a result, the Mississippi was also dredged in several areas.

Impacts on Related Industries. Barge industry sources indicate that the economic impact on the industry is estimated at $500,000 to $1 million per day. However, it is extremely hard to derive any definitive loss figure, as impact can be calculated either in lost shipping days (loaded barges tied up) or lost opportunity (empty barges sitting idle because of no product to move). Also, the precise number of barges affected is hard to determine because the barge industry has not reported total numbers. The only estimates available have come from a Corps of Engineers' (COE) database that counted only barges that were tied up to a lock structure. COE did not include those barges that may have been holding in an operator's fleeting area. The number of barges affectedthat is, unable to deliver currently loaded cargo or get to port to load cargo for further movementmay be as high as two thousand. Some ocean-going vessels were also affected because cargoes were not readily available for loading.

In addition to waterway disruptions within the region, other parts of the waterway network were affected as well. During the flood, most of the principal U.S.-

FIGURE 4–25

On-Time Operations for All Carriers by Time of Day: 1991

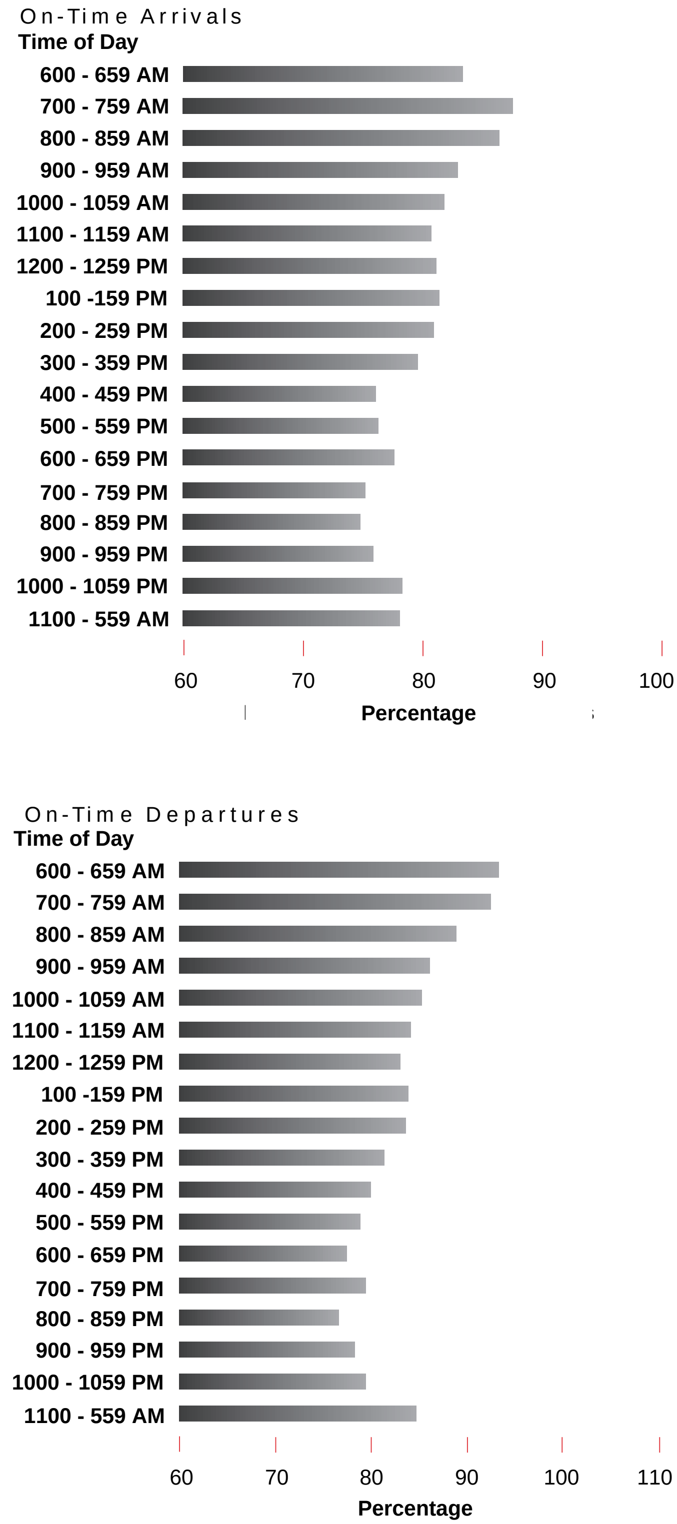


TABLE 4–11

Primary Airports Exceeding NPIAS Annual Capacity Rating

Facility	Location	NPIAS Annual Capacity	Total Operations	Percent of Capacity	NPIAS Congestion level*
Metropolitan Oakland Intl.	Oakland, CA	285,000	403,213	141.48	U
John Wayne Airport-Orange County	Santa Ana, CA	355,000	533,522	150.29	U
Burbank-Glendale-Pasadena	Burbank, CA	215,000	245,623	114.24	U
Long Beach/Daugherty Field	Long Beach, CA	370,000	462,177	124.91	U
Grand Forks Intl.	Grand Forks, ND	283,000	284,783	100.63	U
Dallas/Fort Worth Intl.	Dallas-Fort Worth, TX	557,000	693,614	124.53	S
San Francisco Intl.	San Francisco, CA	393,000	434,298	110.51	S
John F. Kennedy Intl.	New York, NY	272,000	336,731	123.80	S
Stapleton Intl.	Denver, CO	355,000	468,490	131.97	S
Miami Intl.	Miami, FL	370,000	378,302	102.24	S
La Guardia	New York, NY	200,000	355,568	177.78	S
General Edward Lawrence Logan Intl.	Boston, MA	285,000	417,111	146.35	S
Newark Intl.	Newark, NJ	280	376,789	134.57	S
Lambert-St. Louis Intl.	St. Louis, MO	340	425,257	125.08	S
Washington National	Washington, DC	273,000	316,138	115.80	S
Phoenix Sky Harbor Intl.	Phoenix, AZ	300,000	479,790	159.93	M
Honolulu Intl.	Honolulu, HI	400,000	406,110	101.53	M
Minneapolis-St. Paul Intl.	Minneapolis, MN	345,000	376,239	109.05	M
McCarran Intl.	Las Vegas, NV	225,000	378,117	168.05	M
Orlando Intl.	Orlando, FL	248,000	285,637	115.18	M
Seattle-Tacoma Intl.	Seattle, WA	285,000	327,805	115.02	M
Charlotte/Douglas Intl.	Charlotte, NC	415,000	424,017	102.17	M
Salt Lake City Intl.	Salt Lake City, UT	275,000	293,126	106.59	M
Raleigh-Durham Intl.	Raleigh/Durham, NC	195,000	272,512	139.75	M
Cleveland-Hopkins Intl.	Cleveland, OH	215,000	256,537	119.32	M
Kansas City Intl.	Kansas City, MO	195,000	239,018	122.57	M

* U = Uncongested
M = Moderately Congested
S = Severely Congested

flagged liner operators experienced delays of one to six days in cargo arriving at some West Coast ports from the east. Containers bound for Hawaii missed vessel departures from ports in Southern California. Deliveries to Chicago and further east were delayed by three to five days. Export cargo operations in the New Orleans area also slowed down, as the flow of coal and grains was drastically reduced. Also, stocks on hand at grain elevators dwindled, threatening to close several elevators.

The severe disruption of the barge industry greatly affected the movement of grain in the U.S. Between 150,000 and 300,000 tons of grain shipments that customarily move through the Gulf were diverted to the Pacific Northwest. Also, Archer Daniels Midland, the nation's largest grain processor and third largest barge operator, indicated that flood delays cost the company about $1.5 million per day. Most of their 2,000-barge fleet was tied up on the Mississippi and Illinois Rivers. As a result, shipments had to be diverted to rail at twice the cost, and, in some cases, the company used trucks, which were even more costly than rail.

FIGURE 4–27

Amtrak On-Time Performance Trends

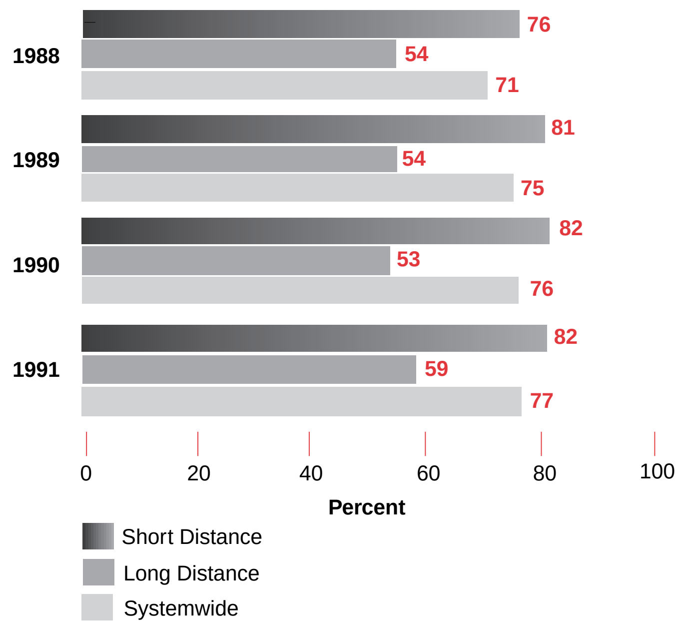
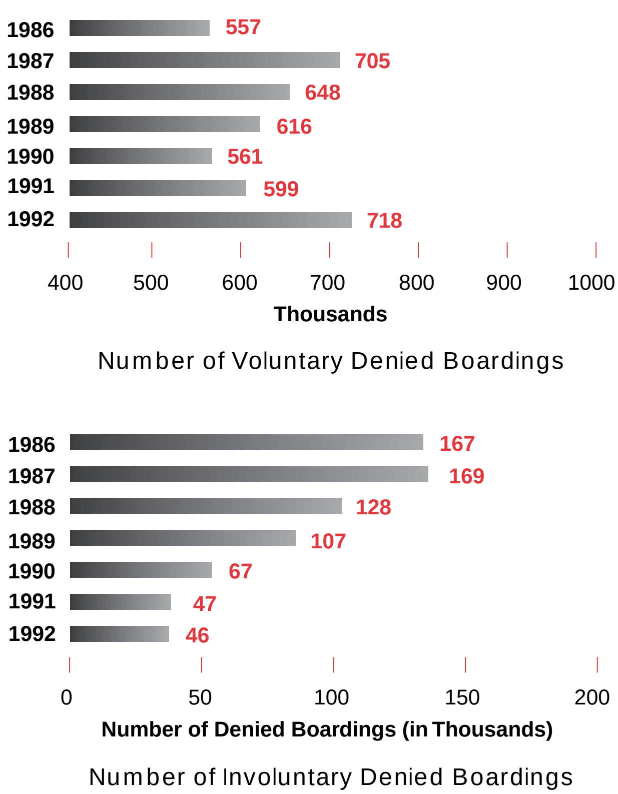


FIGURE 4–26

Total Passengers Denied Boarding by Major & National U.S. Airlines, 1986-1992



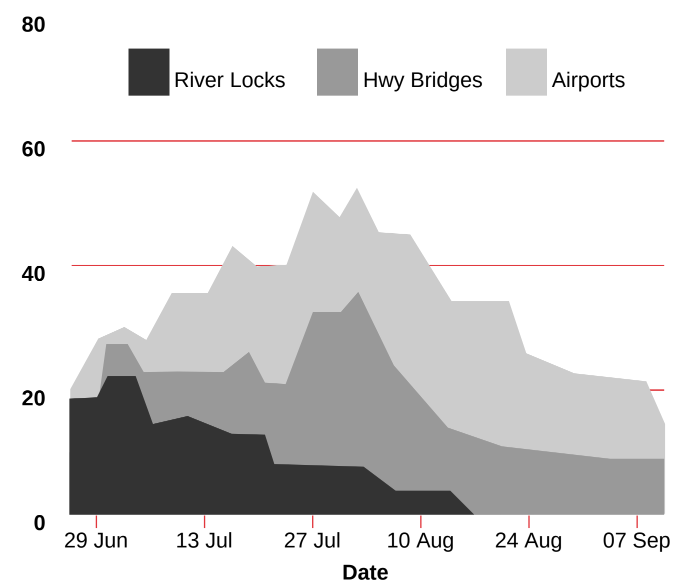
Railroads

Effects on Routing and Service. Track washouts, damaged bridges, flooded rail yards, and high water over tracks effectively shut down approximately 3,764 miles of mainline rail service in 18 MSAs. (See figure 4-30.) Still, many rail lines were open, and arrangements between rail companies allowed shipments to be diverted to operational lines. It is estimated that more than 1,000 trains were rerouted over other railroads. However, due to traffic congestion, many cars experienced delays of up to five days. The opening and closing of both freight and passenger service changed daily as water levels rose and fell and as detour routes were negotiated.

The closure of the Atchison, Topeka and Sante Fe mainline bridge over the Mississippi at Fort Madison, Iowa, was one of the most significant mainline closings during the flood. This route is a major corridor for intermodal traffic from the Ports of Los Angeles/Long Beach east and from

FIGURE 4–28

1993 Midwest Flood –
Transportation Network Closures by Date



eastern manufacturing plants to California.

Effects on Passenger Service. Some Amtrak services through the region were canceled, rerouted on alternate lines, or provided on shortened routes due to high waters and flood damage. Amtrak routes were unpredictable due to dependence upon freight route conditions, which literally changed from day to day. However, Amtrak did make arrangements with United Airlines and TWA to offer special reduced fares, subject to availability, to displaced rail passengers.

Effects on the Infrastructure. The Association of American Railroads (AAR) issued a preliminary estimate of $109.5-$200 million in rail damages to midwestern Class I railroads:

Washed out track (50-100 miles)	$50–100 million
Track under water (300-500 miles)	$30–50 million
Bridges	$15–25 million
Signals	$10–20 million
Switches	$3–5 million
Rolling stock	$1.5–2 million

Still, AAR believes that all major lines will be able to absorb the loss and that none of the costs will be passed on to the shippers through increased freight fares. However, the railroads will suggest a tax relief package.

Gateway Western Railroad, which suffered significant washouts and the collapse of a bridge across the Missouri River, estimated damages of around $12 million, approximately 40 percent of its revenue. Gateway Western Railroad did receive some federal assistance from the Local Rail Freight Assistance Program and is temporarily operating trains on tracks owned by other rail companies.

The midwest flood was responsible for the construction of at least one additional link in the rail network. In order to facilitate rerouting, the Union Pacific Railroad, in cooperation with the Atchison, Topeka, and Santa Fe Railroad, constructed a 1,600 foot section of track in Topeka, Kansas, to physically connect the two railroads.

Effects on Other Industries. Ports on the West Coast were affected as trucks and trains were delayed in arriving with export cargoes. Transportation to haul imports east from the ports were consequently in short supply. Because of this equipment shortage and the en route delay of several days in rail movements to the east, some cargo was held in the ports of Los Angeles and Long Beach, creating a backlog of cargo. Also, Ford Motor Co., which uses a just-in-time system

TABLE 4–12

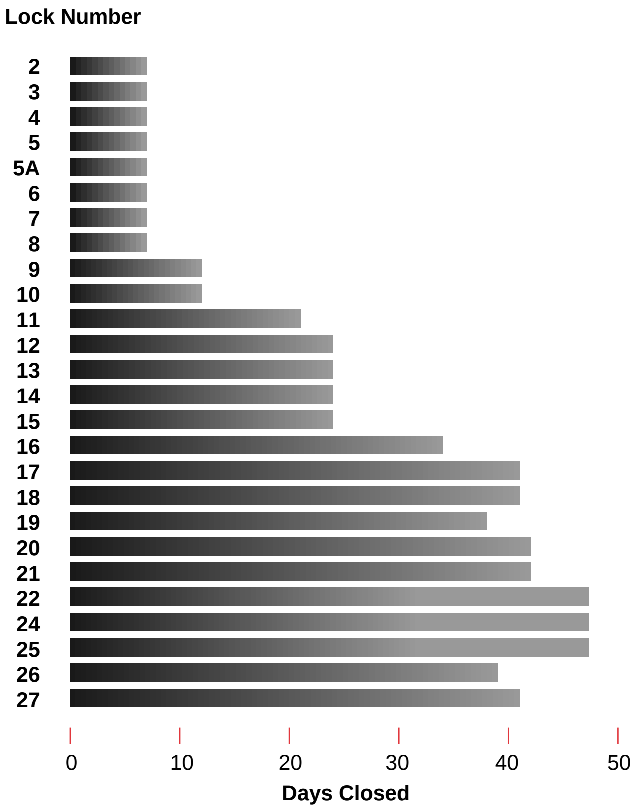
Transportation System Closures Due to Flooding

Mode	Closures	MSAs Containing Closures
Airports	34	7
Major	0	0
Commuter	0	0
Air Taxi	11	3
Foreign	0	0
General	23	6
Highways (Miles)	382.88	9
Interstate	163.67	6
U.S. Highway	190.21	7
State Highway	156.54	5
Rail-Mainline (Miles)	3,763.84	18
Waterway (Miles)	1,612.20	10

Note: The Interstate, U.S., and state miles do not sum to total because roadway sections are shared by more than one highway type.

FIGURE 4–29

Mississippi River Lock Closures



to keep its inventory costs low, used airplanes and trucks to replace deliveries that couldn't be made by rail.

Highway

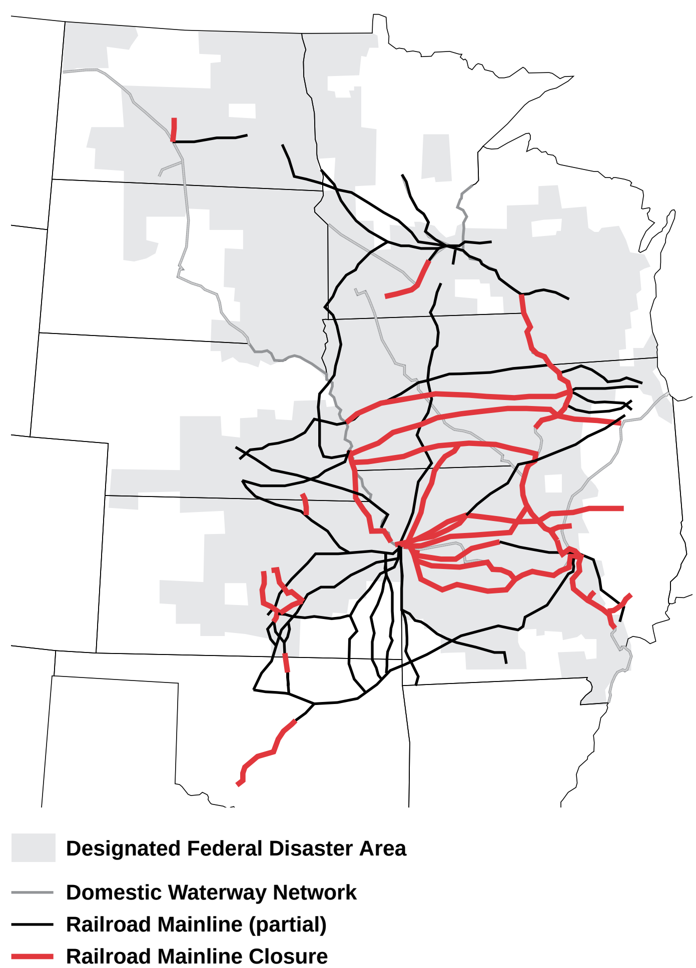
The effects on the proposed National Highway System (NHS) were minimal, while local and regional impacts, however, were more significant. At spot locations, about fifty NHS routes, hundreds of non-NHS state routes, and thousands of local roads were inundated. For example, it is estimated that 250 highways and bridges were closed at the peak flood stage in Missouri. In addition to closures due to high water and structural damage caused by flooding, some bridges were closed periodically because of dangerous debris, such as storage tanks, floating nearby or because of barges breaking loose and striking the bridge structures. (See figure 4-31.)

Significant impacts were generally the result of the closures and operational restrictions of bridges across the Mississippi and Missouri Rivers. One of the most significant closures occurred along the Missouri River between Kansas City and St. Louis, Missouri. During the flood peak, I-70 was the only route across the river. When the westbound lane of this route was closed to erect protective barriers, a traffic backup 27 miles long resulted. In other areas, some alternate routes required drivers to detour 70 miles or more out of their way to reach some destinations. Still, although travel and commerce were severely disrupted due to road and bridge closings, the need to move people and goods was adequately provided by the systems that remained open.

Organizations within the public and private sectors coped with flood closures in various ways. Road and bridge closings prompted at least one state, Missouri, to set up a toll-free telephone number for road closing information. In another

FIGURE 4–30

Railroad Closures During 1993 Midwest Flood



attempt to overcome network closings, small certified pontoon boats were used to provide ferry service across the Mississippi between La Grange, Missouri, and Quincy, Illinois. Furthermore, when it became apparent that the total capacity and travel time of these boats were inadequate to serve the communities, private companies hired or bought recreational craft to transport their employees. In fact, local parties even investigated the possibility of inaugurating air taxi services between the cities for the duration of the emergency. (See table 4-12.)

Airports

The effect of the heavy rains and flooding was almost negligible on the air transportation network. A total of 34 airports were closed (and some were evacuated) at various times during the flood, affecting seven MSAs. (See figure 4-32.) However, all of these airports were general aviation and/or privately owned airports. No major airports in the region experienced closures. In some instances, navigational aids and instrument landing systems were put out of service by rising flood waters. However, the impact of these outages was negligible.

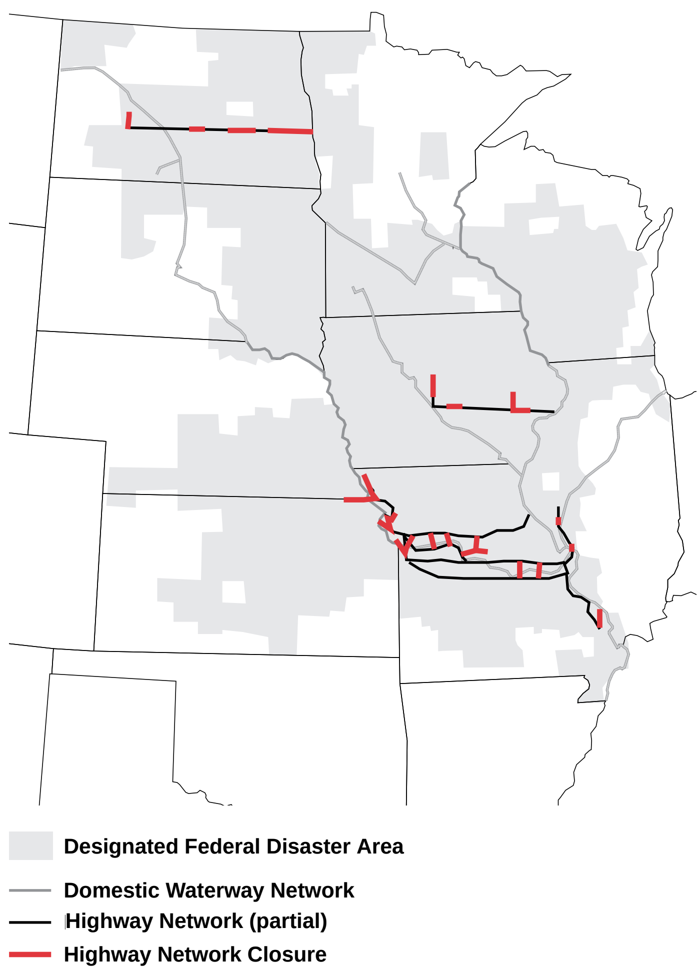
The flood did prompt increased involvement by the Federal Aviation Administration. Temporary Flight Restrictions were implemented in several areas for aircraft flying under certain altitudes, and, in at least one case, the FAA established air control services at one airport to coordinate relief flight activities in the area.

How Well Does It Work: What More We Need to Know

Although one could point to numerous, specific data deficiencies, there is a more general, urgent need to develop the science of measuring the performance of the transportation system as a whole. We need to develop a meaningful, comprehensive set of performance indicators. In the process of compiling this chapter, we have learned how little is known, not only about the statistics of accessibility and performance, but about the very concepts themselves and how best to measure them. Certainly, there are some obvious, meaningful indicators, such as hours of traffic delay and on-time arrivals of commercial aircraft, but these only partially describe the quality and quantities of services being provided. They also say little about how efficiently these services are produced and their contribution to the economy, that is to say, about the productivity of the transportation system. This is

FIGURE 4–31

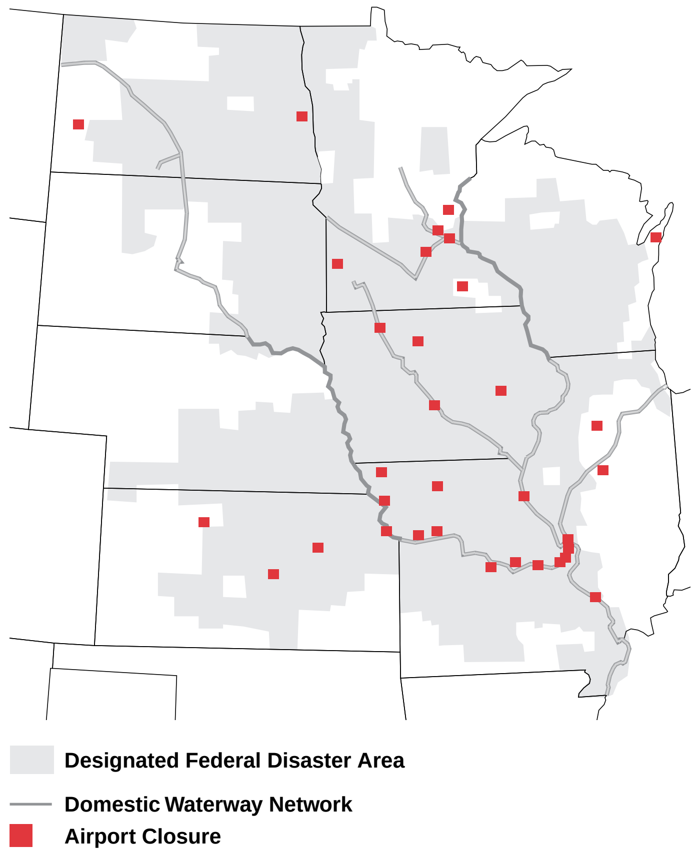
Highway Closures During 1993 Midwest Flood



especially true when it comes to the performance of the system as an integrated, intermodal whole. The Bureau of Transportation Statistics will give this subject high priority on its research agenda. Developing and refining means to measure the performance of the transportation system, as well as its contribution to our economy and our way of life, is an essential transportation data need.

FIGURE 4–32

Airport Closures During 1993 Midwest Flood



Sources

Figures

Figure 4-1-4-10: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 4-11: *Railroad Facts*, Sept 1992, Association of American Railroads: Washington, D.C.

Figure 4-12: Estimated from *Air Carriers Statistics Monthly*, U.S. Department of Transportation, Research and Special Programs, Office of Airline Statistics.

Figure 4-13 through 4-16: Estimated bawsed on data from *Transit Fact Book*; October 1992, American Public Transit Administration.

Figure 4-17: *Highway Statistics*, 1986-1991.

Figure 4-18: *National Personal Transportation Survey*, *Travel Behavior in the 90's*, Report Number HPM-40, U.S. Department of Transportation and the Federal Highway Administration, July 1992.

Figure 4-19: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 4-20 and 4-21: *Roadway Congestion Estimates and Trends*, Texas; Transportation Institute, 1990.

Figure 4-22: *Estimates of Urban Roadway Congestion 1990*, Texas : 4-23: Transportation Institute Research Report, 1131-5, 1993.

Figure 4-24 through 4-34: Oak Ridge National Laboratory, Oak Ridge, TN.

Tables

Table 4-1: Oak Ridge National Laboratory, Oak Ridge, TN. U.S. Route Airway Mileage. Includes direct low altitude and jet routes. Converted from nautical miles for comparison purposes. (Route miles operated.)

Table 4-2: Oak Ridge National Laboratory, Oak Ridge, TN.

Table 4-3: Federal Aviation Administration, U.S. Department of Transportation. *FAA Statistical Handbook of Aviation*. Washington, D.C.: Government Printing Office, 1992, pp. 4-11

Table 4-4: *FAA Statistical Handbook of Aviation: Calendar Year 1991*, Federal Aviation Administration, 1991.

Table 4-5: Oak Ridge National Laboratory, Oak Ridge, TN.

Table 4-6: *Nationwide Personal Transportation Survey*, July 1992, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management.

Table 4-7: Federal Highway Administration, *Highway Statistics 1991*.

Table 4-8: AAR, *Railroad Facts*, 1993. Note: a change in the accounting practices of Railroads after 1980 caused some changes in the definition of capital and maintenance expenditures.

Table 4-9: Air - *FAA Statistical Handbook of Aviation*. Railroad - AAR, *Railroad Facts*. Water - Eno Foundation, *Transportation in America*. Oil Pipeline - Eno Foundation, *Transportation in America*.

Table 4-10: *Estimates of Urban Roadway Congestion - 1990*, Research Report 1131-5, Texas Transportation Institute, March 1993.

Table 4-11: *Estimates of Urban Roadway Congestion - 1990*, Research Report 1131-5, Texas Institute of Transportation, March 1993.

Table 4-12: Oak Ridge National Laboratory, Oak Ridge, TN.

Table 4-13: Oak Ridge National Laboratory, Oak Ridge, TN. Airport categories indicate the number of airports closed that offer each service type. The Interstate, U.S., and State miles do not sum to the overall total because of roadway sections shared by more than one highway type.

Other Sources Used in This Chapter

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Endnotes

1. Average velocity was calculated as the number of ton-miles per train-hour divided by the number of tons per train. Average trip travel time was calculated as the average trip length divided by the average velocity.
2. Average flight stage length was calculated by dividing the number of revenue flight miles by the number of revenue departures. Average velocity was calculated by dividing the number of revenue flight miles by the air revenue hours. Average flight stage travel time was calculated by dividing the average flight stage length by the average velocity.
3. Average trip length was calculated by dividing the number of passenger-miles by the number of passenger-trips, thus yielding the average trip length taken by each passenger. Average velocity was calculated by dividing the vehicle-miles traveled by the vehicle-hours traveled. Average trip travel time was calculated by dividing the average passenger trip length by the average velocity.
4. Federal Highway Administration, Office of Highway Information Management, *Nationwide Personal Transportation Survey*, July 1992.

TRANSPORTATION *and its* COSTS

The many benefits of transportation are not without costs. Households and businesses must buy transportation services from carriers or pay for their own vehicles, craft, facilities, labor, and related services. Carriers must also provide the resources—vehicles, craft, facilities, and labor—to produce related services. Even the public at large is required to pay for certain transportation facilities (such as local streets) and services (such as air traffic control) through general taxes.

We pay for transportation not only in money and time, but through loss of life, environmental disruption, and social stress. Resources that are deployed for transportation cannot be used on other things, so foregone expenditures must be viewed as another cost of transportation. This chapter focuses, however, on monetary costs, leaving such matters as loss of life and environmental degradation for subsequent chapters.

What We Spend on Transportation

The terms *payment* and *cost* appear to be interchangeable in this chapter because the seller's price is the buyer's cost. The question of what we pay for transportation is viewed first from the buyer's perspective, which includes households, business travelers, and shippers. Because spending on transportation by consumers, businesses, and government agencies has grown dramatically over the last 30 years to roughly $1 trillion, we also ask whether we are buying more and better transportation or just absorbing higher costs for the same service. To better understand what makes up these costs, the perspective must shift from the consumer to that of the provider.

American consumers, businesses, and governments spent more than $996 billion on transportation in 1992, an eightfold increase over 1960.[1] (See table 5-1.) In contrast, the nation's economy, as measured by Gross Domestic Product (GDP) in current dollars, rose twelvefold during this period.

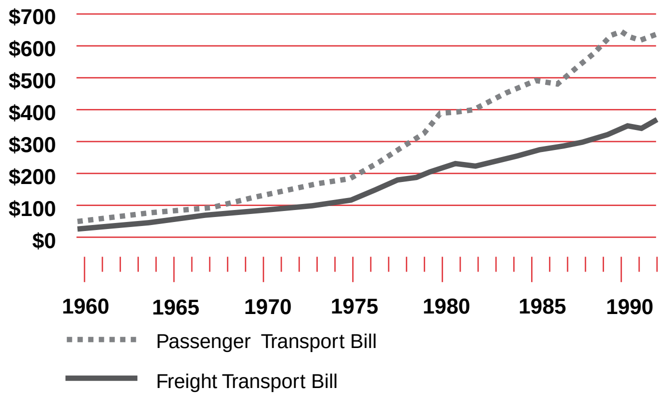
TABLE 5–1

U.S. Transportation Expenditures: 1960–1992

Year	Nation's Freight Trans-portation Bill ($Billions)	Nation's Passenger Trans-portation Bill ($Billions)	Total Transport Bill ($Billions)	Population (Millions)	Freight Bill per Capita (Dollars)	Passenger Bill per Capita (Dollars)	Transport Bill per Capita (Dollars)	Total Revenue Ton-miles of Freight (Billions)	Total Domestic Passenger Miles (Billions)	Revenue Ton-Miles of Freight Per Capita	Passenger-Miles Per Capita	Expend-itures per Ton-Mile (Cents)	Expend-itures Passenger-Mile (Cents)
1960	47.8	60.5	106.6	180.8	264	334	590	1,806	1,630	9,993	9,018	2.65	3.71
1961	49.5	58.6	104.4	183.7	269	319	568	1,876	1,660	10,212	9,033	2.64	3.53
1962	52.8	64.6	113.4	186.6	283	346	608	1,957	1,714	10,487	9,184	2.70	3.77
1963	56.2	68.0	120.0	189.3	297	359	634	2,057	1,776	10,866	9,384	2.73	3.83
1964	60.9	72.8	129.1	191.9	317	379	672	2,157	1,854	11,239	9,661	2.82	3.93
1965	64.9	82.2	144.8	194.3	334	423	745	2,256	1,931	11,607	9,936	2.88	4.26
1966	67.8	86.9	149.3	196.6	345	442	759	2,365	1,983	12,027	10,086	2.87	4.38
1967	70.6	90.7	155.5	198.8	355	457	782	2,402	2,058	12,084	10,354	2.94	4.41
1968	73.3	103.9	170.8	200.7	365	518	851	2,493	2,160	12,420	10,758	2.94	4.81
1969	78.0	113.0	184.2	202.7	385	557	908	2,581	2,237	12,730	11,036	3.02	5.05
1970	84.0	114.3	195.2	205.1	410	557	952	2,702	2,307	13,177	11,251	3.11	4.95
1971	91.2	134.4	222.0	207.7	439	647	1,069	2,738	2,411	13,184	11,610	3.33	5.57
1972	97.2	149.2	242.3	209.9	463	711	1,154	2,899	2,550	13,808	12,147	3.35	5.85
1973	107.9	163.1	266.5	211.9	509	770	1,257	3,013	2,629	14,216	12,402	3.58	6.20
1974	116.0	171.3	282.6	213.9	542	801	1,321	2,996	2,547	14,004	11,908	3.87	6.73
1975	115.8	188.2	298.9	216.0	536	871	1,384	2,883	2,608	13,346	12,076	4.02	7.22
1976	133.4	223.8	351.1	218.1	612	1,026	1,610	3,017	2,729	13,834	12,514	4.42	8.20
1977	150.8	256.6	400.9	220.3	685	1,165	1,820	3,140	2,827	14,256	12,833	4.80	9.08
1978	172.9	287.7	453.4	222.6	777	1,292	2,037	2,976	2,963	13,368	13,310	5.81	9.71
1979	193.2	317.9	503.0	225.1	858	1,412	2,235	3,586	2,933	15,932	13,030	5.39	10.84
1980	213.7	338.1	542.9	227.7	938	1,485	2,384	3,643	2,896	15,999	12,718	5.87	11.67
1981	228.4	374.0	592.5	230.0	993	1,626	2,576	3,547	2,917	15,422	12,683	6.44	12.82
1982	222.1	379.2	591.4	232.2	956	1,633	2,547	3,407	2,974	14,672	12,806	6.52	12.75
1983	243.3	410.8	643.2	234.3	1,038	1,753	2,745	3,577	3,082	15,264	13,151	6.80	13.33
1984	268.0	459.4	715.5	236.4	1,134	1,943	3,027	3,713	3,198	15,708	13,527	7.22	14.37
1985	273.6	492.2	753.1	238.5	1,147	2,064	3,158	3,667	3,272	15,376	13,720	7.46	15.04
1986	281.0	492.5	760.9	240.7	1,167	2,046	3,161	3,685	3,393	15,310	14,099	7.63	14.51
1987	294.2	528.1	807.5	242.9	1,211	2,175	3,325	3,848	3,503	15,845	14,423	7.65	15.08
1988	313.0	571.9	869.0	245.1	1,277	2,333	3,546	4,002	3,656	16,329	14,918	7.82	15.64
1989	329.1	602.7	915.2	247.4	1,330	2,436	3,699	3,969	3,717	16,045	15,025	8.29	16.21
1990	351.9	630.4	964.9	250.0	1,408	2,522	3,860	4,020	3,810	16,081	15,241	8.75	16.55
1991	355.1	613.2	951.9	252.7	1,405	2,426	3,767	4,027	3,855	15,934	15,255	8.82	15.91
1992	375.1	638.4	996.3	255.4	1,468	2,499	3,900	4,156	3,961	16,270	15,507	9.03	16.12

FIGURE 5 - 1

Passenger and Freight Transportation Spending Since 1960



Source: Eno Transport Foundation and Author's Estimates

FIGURE 5 – 2

Expenditures on Passenger Transportation

(Billions of Current Dollars)

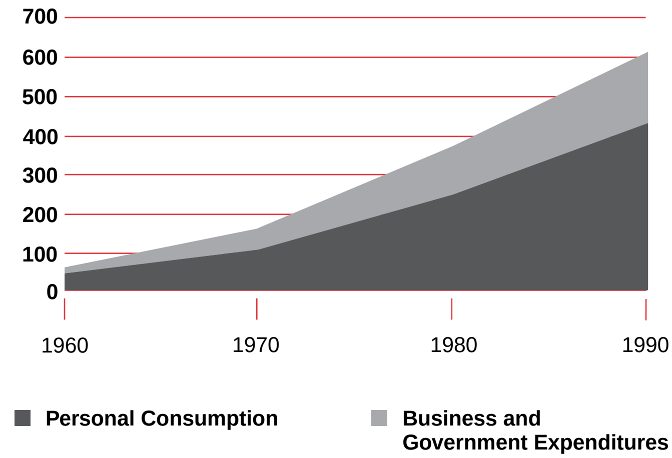
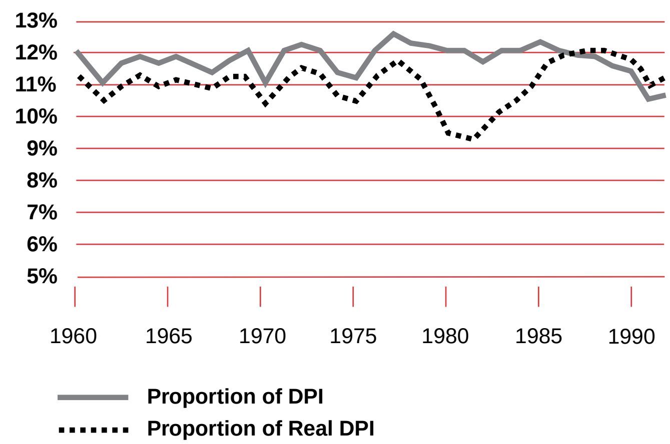


FIGURE 5 – 3

Consumer Spending on Transportation (Share of Disposable Personal Income)



U.S. expenditures on passenger transportation have grown one-third faster than expenditures on freight since 1960. (See figure 5-1.) As a result, nearly two-thirds of total transport spending was devoted to passenger transportation in 1992, both local and intercity, while the remainder was spent transporting freight. In contrast, barely 56 percent of the nation's *transportation bill* was devoted to passenger transportation in 1960.

Estimates of consumer spending on all passenger transportation since 1960, as measured in the National Income and Product Accounts, indicates that consumer spending accounts for nearly three-quarters of the nation's passenger transportation bill, and nearly one-half of the total spent on all transportation. (See table 5-2 a & b.) Consumer spending has held a 70 percent share of the passenger bill for three decades. The balance is accounted for by business and government transportation. (See figure 5-2.)

Consumer spending on transportation has declined slowly as a proportion of personal income over the last three decades. (See figure 5-3.) The brief rise in the proportion of real disposable personal income spent on transportation after the 1980-1982 recessions was propelled by purchases of new motor vehicles. These purchases, along with the other elements of user–operated transportation, now comprise more than 91 percent of the total consumer spending on transportation, down marginally from 1960. Consumers have increased the proportion of their incomes spent on motor vehicle maintenance and repair and intercity transportation somewhat since 1960. (See figure 5-4.) Adjusting for inflation, personal consumption expenditures in real terms have risen 3.1 percent annually over the 1960–1992 period, about the same rate as overall consumer expenditures. Purchases of motor vehicles other than automobiles have increased faster than all other categories. In contrast, spending on local transportation and intercity transportation by rail has declined over the period.

Since 1977, estimates of U.S. resident

TABLE 5–2a

ersonal Consumption Expenditures on Transportation: 1960–75 (In Billions of Dollars)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
nsportation Personal nsumption Expenditures	42.9	41.5	46.3	50.0	53.0	59.1	62.2	64.4	73.5	79.8	81.1	94.8	105.3	115.4	119.0	130.2
er-operated Transportation	39.5	38.1	42.8	46.5	49.2	55.1	57.8	59.5	68.0	73.3	74.2	87.1	96.7	106.1	108.4	118.9
w autos	14.0	12.1	15.0	17.2	18.3	21.4	21.0	20.0	24.5	25.1	21.9	28.2	31.6	33.9	27.0	29.3
purchases of used cars	2.6	2.6	2.9	3.2	3.4	3.8	3.9	4.3	4.6	5.0	4.8	5.3	5.9	6.4	6.6	7.4
er motor vehicles	0.6	0.5	0.7	0.9	1.0	1.3	1.5	1.6	2.3	2.8	2.7	3.9	5.6	6.9	6.4	7.7
es, tubes, accessories, l other parts	2.5	2.6	2.8	3.0	3.2	3.5	3.8	4.0	4.6	5.4	6.1	7.1	8.0	8.9	9.5	10.3
pair, greasing, washing, parking, rage, rental and leasing	5.5	5.8	6.2	6.6	7.1	7.6	8.1	8.8	9.7	10.9	12.3	13.9	15.1	15.8	17.0	19.8
soline and oil	12.0	12.0	12.6	13.0	13.6	14.8	16.0	17.1	18.6	20.5	21.9	23.2	24.4	28.1	36.1	39.7
dge, tunnel, ferry and road tolls	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8
urance	2.0	2.1	2.1	2.1	2.1	2.4	2.8	3.0	3.0	3.0	3.8	4.9	5.4	5.2	5.0	3.8
chased local transportation	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.2	2.4	2.7	3.0	3.3	3.4	3.5	3.7	4.0
ss transit systems	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.9	1.9	2.0	2.1
xicab	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.6	1.7	2.0
chased intercity transportation	1.3	1.4	1.5	1.5	1.7	2.0	2.3	2.7	3.1	3.7	4.0	4.4	5.2	5.9	6.9	7.3
lway	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
s	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7
ine	0.7	0.8	0.9	0.9	1.1	1.3	1.5	1.8	2.2	2.8	3.1	3.5	4.1	4.7	5.5	5.9
er	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.4
posable Personal Income	360.5	376.2	398.7	418.4	454.7	491.0	530.7	568.6	617.8	663.8	722.0	784.9	848.5	958.1	1,046.5	1,150.9
sonal Consumption Expenditures	332.4	343.5	364.4	384.2	412.5	444.6	481.6	509.3	559.1	603.7	646.5	700.3	767.8	848.1	927.7	1,024.9

Continued

TABLE 5–2b

ersonal Consumption Expenditures on Transportation: 1976–92 (In Billions of Dollars)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
nsportation Personal nsumption Expenditures	155.7	179.6	195.9	217.1	235.7	258.9	263.4	292.8	328.2	363.3	370.4	384.8	413.2	437.3	453.9	434.6	463.1
er-operated Transportation	142.6	164.9	180.0	199.2	214.9	236.4	240.2	268.1	300.3	333.5	339.8	351.4	376.9	399.6	414.0	395.5	423.9
w autos	38.2	44.4	48.5	49.3	46.4	50.7	53.3	66.2	77.6	87.4	100.3	93.5	101.0	99.9	96.6	79.5	87.3
purchase of used cars	9.7	10.4	11.1	11.3	10.8	12.8	13.6	15.9	21.2	24.3	25.4	28.2	30.5	32.5	33.1	36.7	39.5
er motor vehicles	12.1	15.9	19.1	16.6	11.8	12.8	15.6	21.9	28.6	37.6	40.8	43.0	45.6	51.7	50.3	46.0	53.9
es, tubes, accessories, I other parts	11.4	12.9	13.5	14.4	14.9	15.4	15.2	16.6	17.3	18.1	18.4	18.8	20.7	21.4	22.9	23.3	23.7
pair, greasing, washington, parking, rage, rental, and leasing	22.1	25.7	28.4	32.0	33.7	36.7	37.9	42.5	49.7	57.7	60.7	65.7	73.5	79.1	82.6	82.4	89.5
soline and oil	43.0	46.9	50.1	66.2	86.7	97.9	94.1	93.3	94.5	96.9	79.7	84.7	86.9	96.2	108.4	102.9	103.4
dge, tunnel, ferry and road tolls	0.9	0.9	1.0	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.8	2.0	1.8	2.1	2.0	2.0	2.1
urance	5.3	7.8	8.4	8.5	9.4	8.9	9.2	10.4	10.1	10.0	12.7	15.5	16.8	16.8	18.1	22.7	24.6
chased local transportation	4.4	4.8	4.8	4.8	4.8	5.0	5.4	6.0	6.7	7.4	7.9	8.0	8.3	8.1	8.9	9.1	9.2
ss transit systems	2.2	2.4	2.5	2.8	2.9	3.3	3.8	4.0	4.2	4.4	4.9	5.1	5.4	5.3	5.7	5.7	5.9
xicab	2.2	2.4	2.2	2.0	1.9	1.7	1.5	1.9	2.5	2.9	3.0	3.0	2.9	2.8	3.2	3.4	3.3
chased intercity transportation	8.6	9.9	11.1	13.1	16.1	17.5	17.9	18.7	21.1	22.4	22.7	25.3	28.0	29.5	30.9	30.0	30.0
lway	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.7
s	0.8	0.8	0.9	1.1	1.4	1.6	1.7	1.6	1.6	1.6	1.5	1.9	2.2	1.7	1.4	1.5	1.5
ine	7.1	8.3	9.3	10.9	13.5	14.6	14.7	15.4	17.7	18.7	19.0	21.0	23.0	24.7	26.4	25.6	25.7
er	0.5	0.6	0.6	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.9	2.2	2.4	2.3	2.2	2.2
posable Personal Income	1,264.0	1,391.3	1,567.8	1,753.0	1,952.9	2,174.5	2,319.6	2,493.7	2,759.5	2,943.0	3,131.5	3,289.5	3,548.2	3,787.0	4,050.5	4,230.5	4,500.2
sonal Consumption Expenditures	1,143.1	1,271.5	1,421.2	1,583.7	1,748.1	1,926.2	2,059.2	2,257.5	2,460.3	2,667.4	2,850.6	3,052.2	3,296.1	3,523.1	3,761.2	3,906.4	4,139.9

TABLE 5-3

U.S. Resident Expenditures Trips 100 Miles or More Away from Home (In Billions of Dollars)

Year	Public Transportation[1]	Auto Transportation[2]	Total Transportation
1977	19.9	26.1	46.0
1978	22.8	29.3	52.1
1979	26.1	37.7	63.8
1980	30.5	46.6	77.1
1981	33.4	49.0	82.4
1982	34.2	48.1	82.2
1983	37.8	47.2	85.0
1984	45.1	44.1	89.2
1985	49.3	46.0	95.3
1986	50.9	42.3	93.2
1987	57.2	45.7	102.9
1988	63.6	49.1	112.6
1989	64.6	50.5	115.1
1990	67.6	53.5	121.1
1991	69.0	53.3	122.3
1992[3]	70.4	53.4	123.8

[1]includes travel by air, bus, rail and ship
[2]includes personal motor vehicles and rental automobiles
[3]preliminary

spending on transportation while traveling 100 miles or more away from home, a common definition of tourism activity, indicate that spending on tourism transportation has grown faster than total U.S. passenger transportation spending. Tourism spending now comprises more than 19 percent of total passenger trans-

FIGURE 5-4

Transportation Consumption Items (Share of Personal Income)

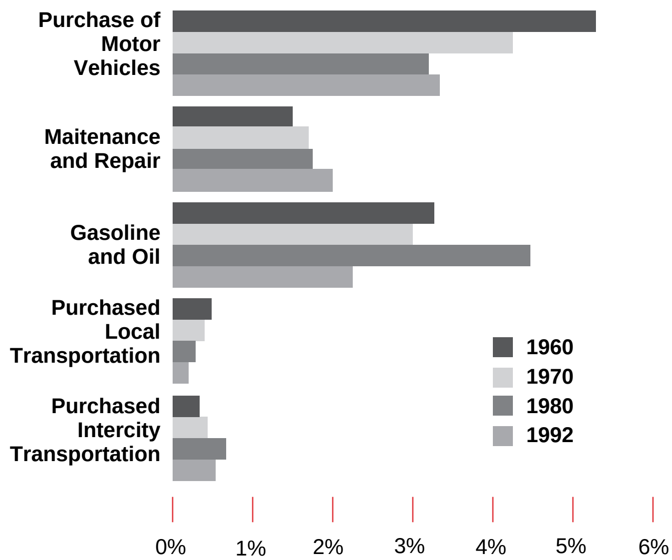


TABLE 5-4

Nation's Freight Transportation Bill Components: 1960–1991

Component	1991 Value (In Millions of Dollars)	Percent of Total	Compound Annual Rate of Growth 1960–1991	Rate of Growth 1990–1991
Intercity Truck	167,400	46.6%	7.5%	3.1%
Local Truck	110,500	30.8%	6.8%	2.0%
Intercity Bus	131	0.0%	3.7%	4.0%
Railroad	29,852	8.3%	3.9%	–1.8%
International water carriers	12,705	3.5%	6.6%	–7.8%
Coastal and inland waterways	7,962	2.2%	5.1%	12.3%
Oil pipeline	8,096	2.3%	7.4%	–3.5%
Air	14,270	4.0%	12.7%	4.1%
Other Carriers	4,267	1.2%	8.2%	5.6%
Other shipper costs	3,804	1.1%	3.4%	1.9%
TOTAL	358,987	100.0%	6.7%	2.0%

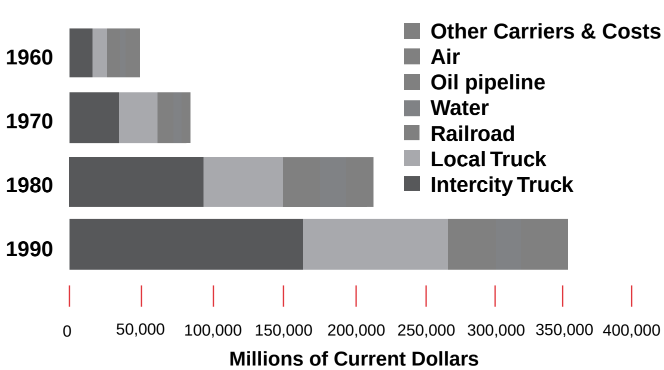
portation outlays, include transportation expenditures on travel away from home for both leisure and business purposes. (See table 5-3.)

If the calculations of the nation's transportation bill and consumer spending are accurate, then the nation's six million business establishments and 83,000 governmental units account for 30 percent of expenditures on passenger transportation and nearly all expenditures for freight transportation. Anecdotal evidence suggests that business and government expenditures on passenger transportation are dominated by purchases of tickets from airlines and other intercity carriers; rental of passenger vehicles while on business trips; and the purchase and operation of passenger vehicle fleets primarily for local travel. Businesses and government spending on freight transportation overwhelms household spending in every category except portions of expenditures for household goods movers and parcel delivery services. Household goods movers account for only one percent of the freight bill, and even in that industry businesses and governments are major purchasers.[2]

U.S. expenditures on freight transportation have increased nearly eightfold since 1960. (See figure 5-5.) Expenditures on air freight transportation grew at the highest rate over 31 years, followed by spending on intercity truck freight transport. (See table 5-4.) Growth in expenditures during the most recently available annual period (1990–1991) have uniformly been lower than the compound annual growth rates for the previous three decades.

FIGURE 5-5

Freight Transportation Bill by Mode



Although the figures and tables in this chapter are based on the best available estimates of the passenger and freight transportation bills, substantial care should be exercised in their use. Calculations of the transportation bill require a number of assumptions and allocations based on incomplete data. For example, more than half of the intercity trucking revenue estimates and all of the local trucking revenue estimates are based on the assumption that vehicle-miles of travel by the average revenues per mile for the truck types are dominant in each category.[3] The assumptions used in these estimates cannot be tested—nor can alternative estimation methods be developed with reasonable likelihood of validation—until the Bureau of the Census provides better measures of expenditures by business establishments of all kinds on transportation by mode. This is especially critical for own-account transportation, including private trucking and corporate aviation. For-hire trucks account for less than half of all loaded vehicle miles of travel by trucks weighing more than 26,000 pounds; shipper-owned trucks account for the balance.

Sources of Change in Expenditures

The substantial growth of expenditures on transportation begs the question, "why?" Have expenditures grown because there are more people to move or ship goods, because people on average are traveling more or shipping freight farther, or because transportation costs are going up? Are cost increases due to inflation, inefficiency, or greater quality of service? The answers to this last question are central to our understanding of whether the nation's transportation system is getting better or worse.

Increased expenditures on transportation since 1960 are clearly due in part to population growth, the expansion of economic activity, and increasing geographic dispersion of homes, jobs, schools, and recreational opportunities. The 39 percent growth in population, 134 percent growth in passenger-miles of travel, and 61 percent growth in ton-miles for the three decades since 1960 indicate that there are more people traveling and shipping goods, and that the quantity of passenger and freight transportation consumed per person is increasing.

Demand-driven increases in transportation expenditures from a growing population and increases in consumption of transportation per person are more than matched by supply-driven increases from the cost of moving a mile per person or per ton. Of the three factors for passenger transportation, changing cost per passenger-mile contributes far more to total expenditure increases than population growth or passenger-miles per person. (See figure 5-6.) Of the three factors for freight transportation, changing cost per ton mile contributes far more to total expenditure increases than growth in population or ton-miles per person. (See figure 5-7.) However, the method used to identify the contribution of each individual factor also shows that the interaction among the supply and demand factors explains more than half of the growth in total expenditures. We can say that the cost of supplying transportation services and facilities is a greater contributor to increased expenditures for transportation than growth in demand, but the precise difference has not been pinpointed.[4]

Why are expenditures per unit of transportation going up? One explanation is inflation throughout the economy and in the transportation industries. Inflation is commonly reported through the Consumer Price Index (CPI), published monthly by the U.S. Bureau of Labor Statistics. This is a fixed weight price index, designed to represent inflation due only to changes in the prices posted by retailers. A similar measure, the Producer's Price Index (PPI), is published to reflect prices paid by manufacturers and wholesalers. The alternative price index for discerning transportation cost trends is the Implicit Price Deflator (IPD), developed from GDP data. The deflator reflects shifts in preferences and spending patterns in the economy as purchasers respond to changing prices and the availability of substitute products. In contrast to CPI, which represents posted prices, IPD summarizes prices taken or actually paid by consumers and others.

For most of the past 32 years, expenditures per passenger-mile have increased more than either CPI or IPD, while expenditures per ton-mile have increased less than either PPI or IPD. (See figures 5-8 and 5-9.) Passenger transportation expenditures increased less than either CPI or IPD in the 1990s.

On the basis of posted transportation prices, represented by CPI, private or user-operated transport costs have risen more

FIGURE 5-6

Sources of Change in U.S. Expenditures—Passenger Transportation: 1960 - 1990

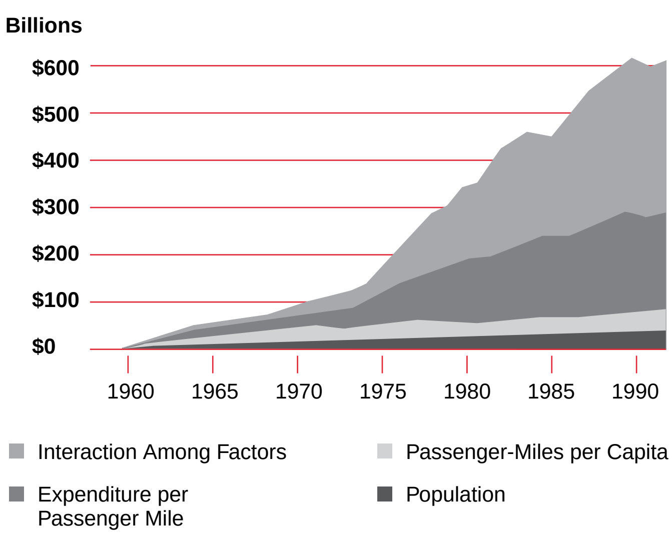
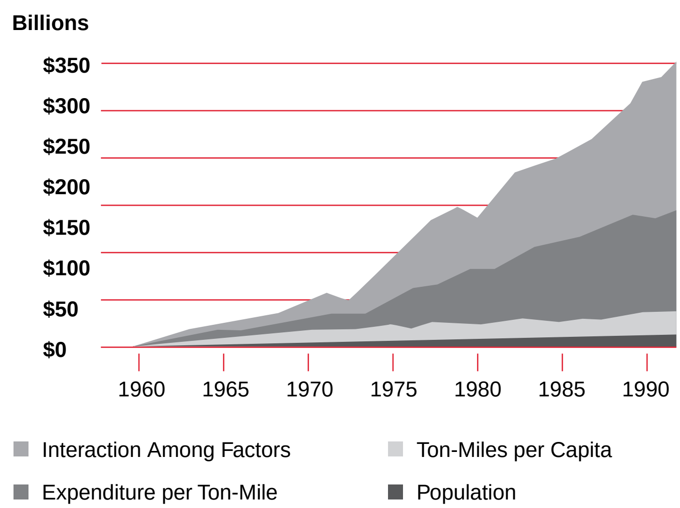


FIGURE 5-7

Sources of Change in U.S. Expenditures—Freight Transportation: 1960 - 1990



slowly than public transportation costs. The same pattern is evident in the comparison of these two categories on the basis of transport prices taken, as indicated by trends in the implicit price deflator for transportation consumption. (See table 5-5.) This measure reflects the changing composition of personal consumption purchases, often in response to changes in posted prices. For example, IPD reflects the change in average airline fares as passengers flock to discount fares, while CPI registers only the increase, if any, in regular and discount fares. Both measures suggest transport price increases have risen more slowly than overall consumer prices over the last 32 years. In the last year, transport prices have slowed to 2-3 percent for most categories, led by declines in the cost of motor fuels. Some of these price increases may have been the result of exchange rate fluctuations or voluntary import quotas.

The price of buying a new car has increased 7.6 percent a year over the past 22 years, and now approaches $18,000. (See table 5-6.) In fact, money spent on the purchase of new cars in the U.S. comprises nearly 20 percent of all consumer spending on transportation. Imported vehicles surpassed domestic categories in average price in 1983, and their prices have grown one-third faster than domestic vehicle prices over the last two decades.

Operating costs of automobiles in the U.S. now account for more than half of consumer spending on transportation. Automobile operating costs have nearly tripled over the last 18 years, to total more than 54 cents per mile. Fixed costs, including insurance, license fees, and depreciation, have led the categories, growing 7.7 percent a year to now comprise 82 percent of total operating costs. Gasoline and oil costs have contributed little to rising costs, and now account for only 10 percent of the total. (See table 5-7.)

Although the cost of operating an automobile has grown 7.7 percent a year over the last two decades, scheduled air transportation fares have increased at one-third this rate. (See table 5-8.) Moreover, the cost of traveling an airline passenger mile has risen only about one-half as fast as intercity rail and bus travel over the last three decades.

FIGURE 5–8

Passenger Transportation Costs versus Other Consumer Price Measures

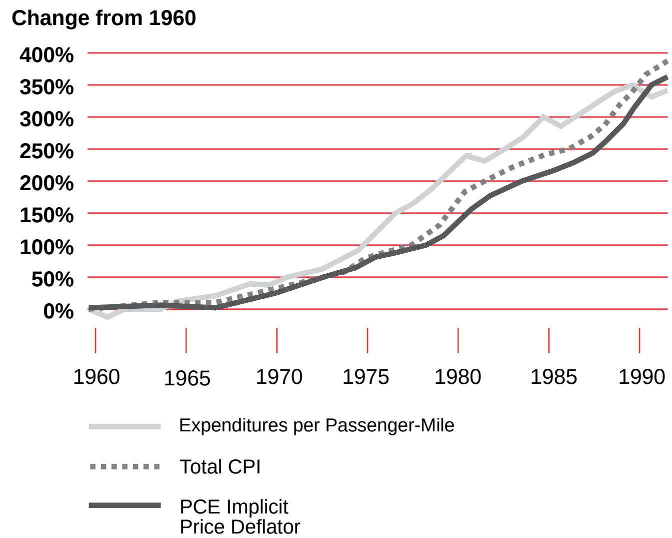
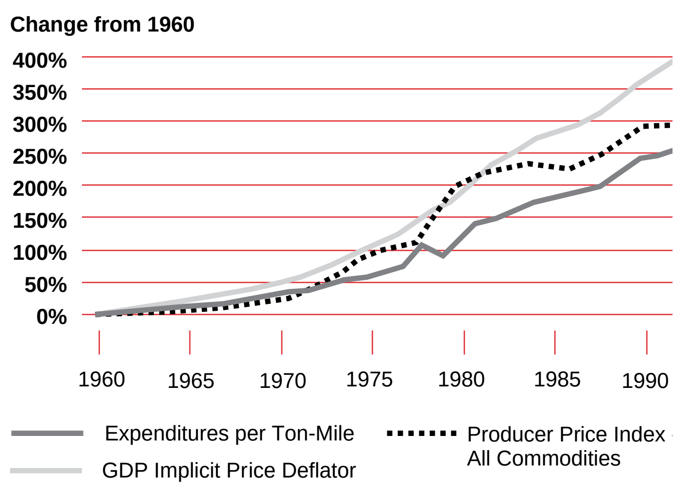


FIGURE 5–9

Freight Transportation Costs versus Other Producers' Prices



If airline trips are more circuitous today than before the hub-and-spoke system became dominant, the increase in price of an airplane trip has risen even less, because such trips now entail more passenger-miles. On the other hand, a circuitous trip with time spent changing planes may also require more passenger time en route; however, the trade-off of greater flight frequency may be of impor-

TABLE 5–5

Changes in Passenger Transportation Costs

	Period	Component Annual Rate of Change over Period	Rate of Change 1991–92
Overall Expenditure per Passenger-Mile	1960–91	4.7%	1.3%
Consumer Price Index for All Urban Workers			
All Transportation Consumer Price Index (CPI)	1960–92	4.6%	2.2%
Private Transportation (CPI)	1960–92	4.5%	2.2%
Motor Fuel (CPI)	1960–92	4.5%	–0.4%
Automobile Maintenance and Repairs (CPI)	1960–92	5.4%	3.9%
Other Private Transportation (CPI)	1967–92	5.7%	2.7%
Automobile Insurance (CPI)	1967–92	6.7%	7.3%
Automobile Finance Charges (CPI)	1978–92	2.5%	–12.1%
Automobile Registration, Licensing and Inspection Fees (CPI)	1978–92	6.1%	7.4%
State Automobile Inspection Fees (CPI)	1960–92	4.6%	8.6%
Other Automobile Related Fees (CPI)	1978–92	6.3%	2.2%
Public Transportation (CPI)	1960–92	6.2%	1.7%
Airline Fares (CPI)	1964–92	6.9%	0.0%
Other Intercity Public Transportation (CPI)	1978–92	7.1%	2.3%
Intracity Public Transportation (CPI)	1978–92	6.9%	5.8%
Consumer Price Index-All Urban Workers	1960–92	5.0%	3.0%
Personal Consumption Expenditure Implicit Price Deflator (IPD)			
Transportation (IPD)	1960–92	4.5%	2.3%
New autos (IPD)	1960–92	4.4%	2.4%
Net purchases of used cars (IPD)	1960–92	2.9%	2.5%
User-operated transportation (IPD)	1960–92	7.4%	4.9%
Other motor vehicles (IPD)	1960–92	3.2%	3.0%
Tires, tubes, accessories, and other parts (IPD)	1960–92	2.6%	1.3%
Repair, greasing, washing, parking, storage, rental & leasing (IPD)	1960–92	5.4%	3.6%
Gasoline and oil (IPD)	1960–92	4.5%	-0.5%
Bridge, tunnel, ferry and road tolls (IPD)	1960–92	3.6%	5.0%
User-operated transportation insurance (IPD)	1960–92	5.1%	9.1%
Mass transit systems (IPD)	1960–92	6.0%	5.3%
Taxicab (IPD)	1960–92	5.9%	5.7%
Purchased Local Transportation (IPD)	1960–92	5.8%	0.8%
Railway (IPD)	1960–92	5.2%	1.6%
Bus (IPD)	1960–92	6.0%	20.0%
Airline (IPD)	1960–92	6.0%	0.0%
Other purchased intercity transportation (IPD)	1960–92	4.2%	1.8%
Purchased Intercity Transportation (IPD)	1960–92	6.1%	0.0%
All Personal Consumption Expenditures (IPD)	1960–92	4.8%	3.3%

tance to the business traveler. Overall, airline, bus, and rail fares have been converging in recent years to about 13 cents per passenger-mile despite the very different operating characteristics and service quality of these three modes. (See figure 5-10.)

If increasing expenditures on transportation are due solely to increasing costs for the same service, then we can conclude that the transportation system is getting worse from the perspective of our pocketbooks; however, that conclusion is not warranted if we are paying for a higher quality of service. Many analysts contend that recent shifts in transportation mode usage are driven by speed and reliability rather than by price. Their views are

FIGURE 5–10

Common Carrier Passenger Costs Have Converged

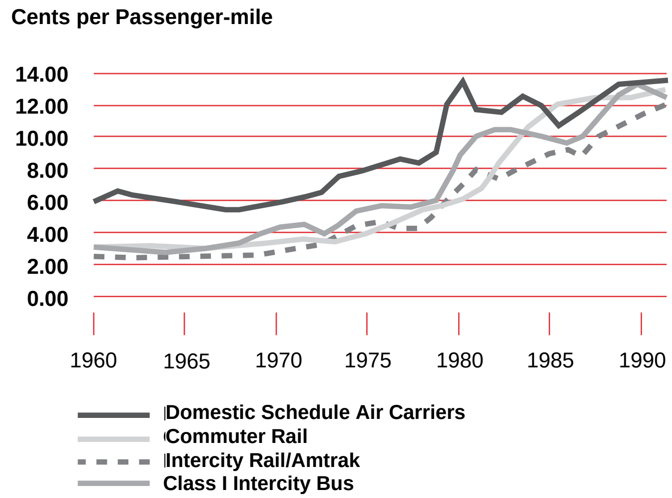


TABLE 5–6

Average Price of a New Car (In Current Dollars)

Year Sold	Domestic	Import	Total
1970	3,708	2,648	3,542
1971	3,919	2,769	3,742
1972	4,034	2,994	3,879
1973	4,181	3,344	4,052
1974	4,524	4,206	4,440
1975	5,084	4,384	4,950
1976	5,506	4,923	5,418
1977	5,985	5,072	5,814
1978	6,478	5,934	6,379
1979	6,889	6,704	6,847
1980	7,609	7,482	7,574
1981	8,912	8,896	8,910
1982	9,865	6,657	9,890
1983	10,559	10,873	10,640
1984	11,172	12,354	11,450
1985	11,733	12,875	12,022
1986	12,526	13,815	12,894
1987	13,239	14,602	13,657
1988	14,029	15,537	14,468
1989	14,937	16,126	15,278
1990	15,682	17,543	16,148
1991	16,412	17,713	16,778
1992	17,068	19,912	17,784

TABLE 5–7

Automobile Operating Costs (Current Cents Per Mile)

Year	Gas & Oil	Maintenance	Tires	Fixed costs	Total
1975	4.8	1.0	0.7	11.9	18.3
1976	n/a	n/a	n/a	n/a	n/a
1977	4.1	1.0	0.7	14.4	20.2
1978	n/a	n/a	n/a	n/a	n/a
1979	4.1	1.1	0.6	18.1	24.0
1980	5.9	1.1	0.6	20.3	27.9
1981	6.3	1.2	0.7	23.7	31.9
1982	6.7	1.0	0.7	23.2	31.7
1983	6.6	1.0	0.7	25.0	33.4
1984	6.2	1.0	0.6	23.5	31.3
1985	6.2	1.2	0.7	19.2	27.2
1986	4.5	1.4	0.7	23.1	29.6
1987	4.8	1.6	0.8	25.4	32.6
1988	5.2	1.6	0.8	25.8	33.4
1989	5.2	1.9	0.8	30.3	38.2
1990	5.4	2.1	0.9	32.6	41.0
1991	6.7	2.2	0.9	33.8	43.6
1992	6.0	2.2	0.9	45.4	54.5
1993	6.0	2.4	0.9	44.9	54.2

anecdotally supported by the enormous growth in express parcel delivery services and countless articles on just-in-time delivery. Members of households often express a similar demand for speed or comfort when they travel by air or rail rather than car for intercity trips. The recent emphasis on safety features in automobile advertisements also suggests a perceptible concern among consumers with quality as well as price.

We are clearly spending more for transportation, but we also appear to be getting a higher value in return. Whether we are better off or not requires a more thorough analysis of whether the costs of producing transportation equipment, facilities, and services are increasing faster

TABLE 5–8

Measures of Average Passenger Revenue

Year	Passenger Revenue per Passenger-Mile (Cents)				Average Passenger Fare per Trip (Dollars)				
	Scheduled air carriers in domestic service	Commuter rail	Intercity rail/Amtrak[1]	Intercity Class I[2]	Scheduled air carriers in domestic service	Commuter rail	Intercity rail/Amtrak[1]	Intercity bus, Class I[2]	Local transit all modes unlinked
1960	6.09	2.92	3.03	2.71	$34.12	$0.64	$4.22	$2.46	$0.14
1961	6.22	3.07	3.08	2.69	34.15	0.65	4.21	2.48	0.14
1962	6.45	3.13	3.10	2.72	34.18	0.66	4.20	2.50	0.15
1963	6.17	3.17	3.18	2.78	34.22	0.67	4.00	2.52	0.15
1964	6.12	3.20	3.16	2.80	34.13	0.68	3.86	2.55	0.15
1965	6.06	3.30	3.14	2.88	34.12	0.71	3.92	2.73	0.16
1966	5.83	3.33	3.13	2.89	33.41	0.72	3.83	2.71	0.16
1967	5.64	3.36	3.13	2.98	33.16	0.72	3.48	2.79	0.17
1968	5.61	3.49	3.33	3.18	33.70	0.75	3.16	2.91	0.19
1969	5.79	3.55	3.63	3.39	37.52	0.78	3.15	3.55	0.21
1970	6.00	3.75	4.02	3.60	40.65	0.84	3.19	3.81	0.22
1971	6.32	3.92	4.38	3.83	43.13	0.87	9.58	4.19	0.23
1972	6.40	4.19	4.42	3.98	43.87	0.93	9.31	4.25	0.24
1973	6.63	4.25	4.44	4.05	45.72	0.95	9.85	4.73	0.25
1974	7.52	4.41	5.29	4.41	51.43	1.00	12.20	5.13	0.27
1975	7.68	4.57	5.71	4.85	53.64	1.04	12.96	5.46	0.27
1976	8.16	5.00	5.62	5.14	57.47	1.15	12.88	5.76	0.27
1977	8.61	5.63	5.83	5.12	60.67	1.16	12.90	6.48	0.28
1978	8.49	5.96	6.08	5.61	61.07	1.20	13.16	6.89	0.29
1979	8.95	6.32	6.59	6.21	63.81	1.25	14.93	7.71	0.29
1980	11.49	6.70	8.18	7.26	84.55	1.41	17.72	10.57	0.30
1981	13.08	7.28	9.38	8.35	95.42	1.70	21.25	10.30	0.33
1982	12.18	8.13	10.19	8.18	92.08	1.89	22.38	10.90	0.38
1983	12.10	9.94	10.65	8.40	92.17	2.31	23.78	10.66	0.39
1984	12.70	11.01	10.91	9.05	97.10	2.92	24.80	11.09	0.50
1985	12.21	12.08	10.48	9.91	92.53	2.85	25.78	11.02	0.53
1986	11.08	12.14	10.60	10.45	84.99	3.07	26.35	12.35	0.58
1987	11.42	12.20	10.58	10.07	88.95	3.18	27.39	12.28	0.59
1988	12.31	12.39	11.46	10.73	96.67	3.35	30.31	17.15	0.60
1989	13.08	12.56	12.62	11.18	103.65	3.41	35.17	18.62	0.61
1990	13.21	13.44	12.85	11.55	107.86	3.70	36.96	20.18	0.67
1991	13.24	12.46	12.83	12.03	106.69	3.76	36.68	21.86	0.70
1992	12.86				103.99				

[1]Amtrak service began in 1971
[2]in regular route intercity service

than the value of transportation provided. This analysis requires consideration of the consumer's perspective in addition to the provider's perspective.

Expenditures and Revenues of Transportation Industries

As described in earlier chapters, no single industry provides all transportation services, equipment, and facilities, rather suppliers are scattered throughout the economy. Major players include carriers, transportation brokers, and others who support carriers, transportation equipment manufacturers, and construction establishments.

Since 1960, total revenues for the various segments of the transportation industry have grown tenfold, with passenger transportation revenues growing faster than freight transportation. (Table 5-8.) The fastest growing sector is domestic air transportation, with increases topping 11 percent per year. Intercity motor carriers of property follow closely with double-digit growth as well. In contrast, inland and coastal water transportation regulated by the Interstate Commerce Commission (ICC) had negligible growth over the three decades.

Since airline deregulation began in 1978, the average fare per passenger-mile has grown 3.5 percent annually, while airline costs per unit of transportation have risen 5.1 percent a year. Travel agent commissions and landing fees have led the increase. (See table 5-9.) Fuel costs have contributed little to the rise, and actually declined in 1992 from the previous year.

For-hire trucking companies are the only providers of transportation service for which the Bureau of the Census collects detailed annual information on costs and revenues. The Annual Survey of Motor Freight Transportation and Public Warehousing—also known as WATS for warehousing and trucking survey—was developed in response to the decline in available information following deregulation. WATS covers establishments with payrolls classified in Standard Industrial Classification (SIC) major group 42, which are establishments primarily engaged in

TABLE 5–9

Airline Cost Index (1982=100)

Year	Labor	Fuel	Landing Fees	Interest	Traffic Commissions	Passenger Meals	Advertising and Promotion	Composite Cost Index[1]
1978	71.9	40.1	75.7	80.3	47.8	79.0	51.7	60.9
1979	77.1	58.8	82.1	75.9	55.2	84.3	55.9	70.0
1980	98.8	91.6	90.0	88.7	77.3	94.3	69.5	86.3
1981	93.1	106.1	97.7	98.0	96.2	101.5	86.6	97.2
1982	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1983	107.8	90.5	100.3	103.7	106.7	103.6	101.9	101.8
1984	108.0	86.3	101.4	109.0	116.7	106.5	100.0	102.7
1985	111.1	81.4	101.2	105.5	117.6	102.0	99.8	103.1
1986	108.8	56.4	112.6	100.8	119.5	102.4	103.4	96.6
1987	110.2	56.8	121.5	5.0	128.9	105.6	90.9	98.4
1988	115.0	54.2	129.1	99.6	148.3	111.9	69.9	102.4
1989	118.4	61.2	137.1	111.5	163.4	122.8	105.0	109.0
1990	121.1	78.7	148.1	107.3	176.8	132.6	107.6	117.1
1991	127.6	68.9	161.9	88.3	193.5	141.4	97.9	119.8
1992	134.1	64.1	179.4	84.8	192.2	144.1	89.8	121.9

[1]includes other costs not shown in details.

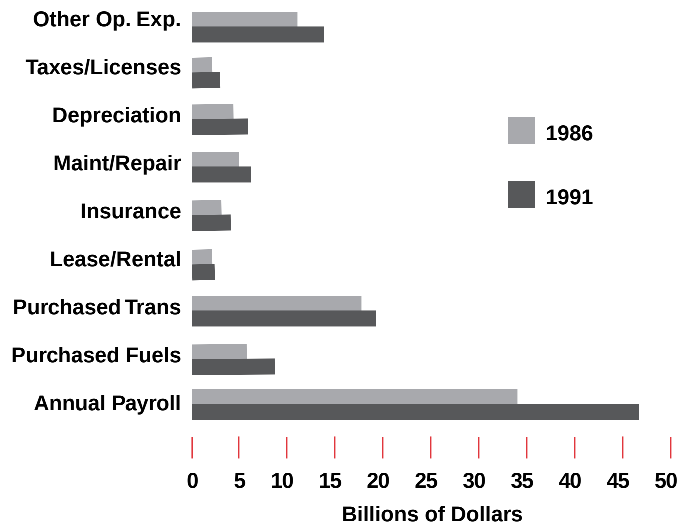
for-hire trucking and public warehousing. WATS does not cover independent owner-operators who do not have a payroll, trucking auxiliaries of establishments in other lines of work, or shipper-owned truck operations.

For the eight years covered by the survey ending in 1991, WATS measured a 39.3 percent increase in revenues and a 37.9 percent increase in operating expenses of the trucking companies sampled. Of nearly $115 billion in operating expenses for the industry in 1991, $109 billion was in trucking and courier services. The remainder was in the public warehousing and storage part of the industry.

Operating expenses for the trucking and courier part of the industry, which is largely composed of the carriers regulated in the past by the ICC, grew 27.3 percent from 1986 to 1991, with payroll and fringe expenses and purchased fuels accounting for more than two-thirds of the increase. (See table 5-10.) Within the payroll and fringe category, payroll alone grew by 35 percent and social security and other fringe expenses grew by 56 percent. The purchased fuel category includes both vehicle fuels and heating fuel for buildings. These relative increases are much greater than the 20 percent growth of tons and the 23 percent growth in ton kilometers for ICC-regulated trucking reported in Transportation in America for the same period.

FIGURE 5–11

For-Hire Trucking Industry Operating Expense Trends: 1988-1991



The long term patterns of trucking expenses make evident the large increases in payroll and fuels compared to the stability of the other categories. (See figure 5-11.) The category of purchased transportation actually increased only through 1988, and declined afterwards. A lion's share of purchased transportation is attributable to leasing trucks with drivers, which is an indicator of owner-operator activity. (See table 5-11.)

Payroll and fringes have increased from 39 percent of total expenses in 1986 to 43 percent in 1991. (See figure 5-12.)

TABLE 5–10

Operating Expense Change for For-Hire Trucking and Public Warehousing: 1986-1991 (In Billions of Current Dollars)

Expense Category	1986	1991	Percent Change
Annual Payroll and Fringes	33.7	46.9	39.2
Purchased Fuels	5.8	8.7	50.0
Purchased Transportation	18.2	19.3	6.0
Lease/rental	1.8	2.2	22.2
Insurance	3.1	4.0	29.0
Maintenance and Repair	4.9	6.1	24.5
Depreciation	4.5	5.6	24.4
Taxes and Licenses	2.0	2.42	0.0
Other	n/a	13.9	n/a
TOTAL	85.8	109.2	27.3

TABLE 5–11

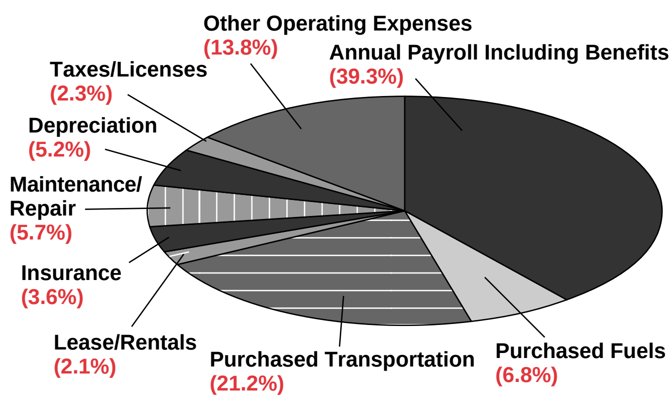
Trends in Purchased Transportation by Trucking Companies: 1986-1991
(In Billions of Current Dollars)

	1986	1991	Percent Change
Leased Trucks With Drivers	13.4	13.2	-1.5
Leased Trucks Without Drivers	2.3	3.6	56.5
Air, Rail, and Water Transportation and Other Motor Carriers	2.5	2.6	4.0
TOTAL	18.2	19.3	6.0

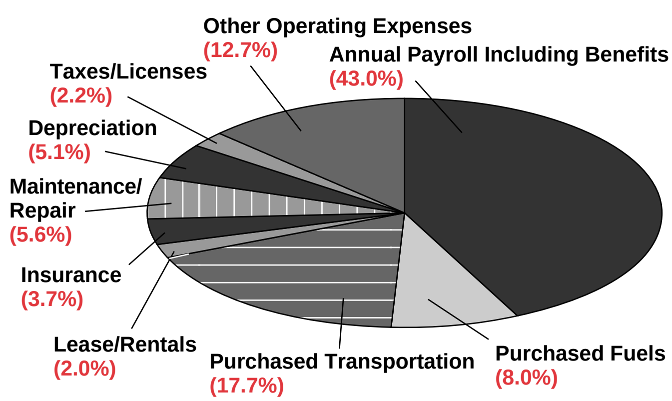
FIGURE 5–12

For-Hire Trucking Industry
Operating Expense Trends

1986



1991



Purchased fuel increased from a 6.8 percent share to 8.0 percent. Purchased transportation declined slightly, and other categories held fairly stable.

The Bureau of the Census does not collect similar statistics on railroads because the dominant carriers report extensive data to the ICC and the Association of American Railroads. (See table 5-12.) These statistics cover the Class I railroad systems, which are the large interregional carriers. The U.S. subsidiary of the Canadian National Railroad is included, but the smaller subsidiary of the Canadian Pacific is not. These statistics do not cover Amtrak and commuter railroads. Similar statistics are not collected for regional carriers and *short line* railroads, which provide local links to the national network.

Annual revenue and expenditure statistics for water transportation carriers, intercity bus operators, school bus operators, the taxicab industry, and arrangers of freight and passenger transportation are not collected on a comprehensive basis. Plans to cover these industries in annual surveys by the Bureau of the Census await funding.

Although the popular conception of the transportation industry is focused on for-hire carriers, the largest piece of the transportation bill by industry is attributed to transportation equipment manufacturers. The transportation equipment industry alone accounts for more than 2 percent of GDP, generating $111.5 billion of the $5.2 trillion total in 1990.[5] This includes automobiles, motorcycles, trucks, truck trailers, and motor homes, as well as parts and accessories. It also includes aircraft, guided missiles and space vehicles, ships, boats, railroad equipment, and other miscellaneous transportation equipment. In total, more than 9,400 transportation equipment establishments, employing

TABLE 5-12

Transportation Manufacturing Summary: 1992

Industry	Number of Establishments	Employees (1000)	Value of Shipments (In Millions of Dollars)
Motor Vehicles and Equipment	3,867	616	112,270
Aircraft and Parts	1,471	539	52,027
Ship and Boat Building and Repairing	2,566	205	13,326
Railroad Equipment	200	35	3,457
Motorcycles, Bicycles and Parts	273	13	1,341
Guided Missiles and Space Vehicles	105	146	14,398
Miscellaneous Transportation Equipment	961	43	14,398

TABLE 5-13

Revenues and Income of the Big Three

	Operating Revenues (In Billions of Dollars)	Net Income (In Billions of Dollars)
General Motors	122.1	-4.9
Ford	88.3	-2.3
Chrysler	28.2	-0.5

TABLE 5-14

Sales and Value of the Vehicle Market

	Number of Vehicles Sold	Value of Output (In Billions of Dollars)
Passenger Cars	8,174,686	$151.6
Domestic Production	6,136,787	95.3
Sale of Imports	2,037,899	56.3
Light Trucks	3,143,788	62.0(est.)
Domestic Production	3,605,779	54.0 (est.)
Sale of Imports	538,009	8.0 (est.)

nearly 1.6 million workers, and with shipments valued at more than $201 billion, contributed to the U.S. economy in 1992.

Motor vehicle manufacturers in the U.S., whether foreign-owned or domestic, produced cars and light trucks worth about $235 billion in revenues in 1991. The Big Three U.S. automobile manufacturers (General Motors, Ford, and Chrysler) produced about 4.1 million cars, while seven foreign transplants produced, domestically, almost 1.4 million cars.

Total production of the Big Three U.S. automakers for the world market in 1990 was about 9.8 million, and accounted for 27 percent of world production of automobiles. Japan accounted for the largest national share at 32 percent, and Western Europe accounted for 31 percent.

The industry went through difficult times in the 1980s, with some reasonably good years in the middle of the decade. In 1991, the consolidated income statement for the Big Three reached $238.6 billion. (See table 5-13.) The total number of vehicles produced by both domestic and foreign industry for the U.S. market reached 23,636,948. (See table 5-14.)

Corporate profits, the bottom line of revenues and expenditures, have varied significantly above and below the break-even point since 1980. (See figure 5-13.) The domestic industry lost more than $8 billion in 1991, as corporate downsizing and restructuring activities were accelerated. Labor costs, retooling needs, price increases in materials, and government regulations have resulted in higher manufacturing costs over the years. Of similar concern for automakers are health care costs and unfunded pension liabilities. It has been reported that health care costs at General Motors amount to $1,500 per vehicle produced, while Ford and Chrysler were at $700-$750 per vehicle. Unfunded pension liabilities are between $14 and $19 billion at General Motors.[6]

Aircraft producers make up another transportation equipment manufacturing industry of national concern, particularly because of their significant contribution to the balance of trade. Trends that now define the industry include lower demand and declining orders, reduced military spending, and competitive pressures from European manufacturers which are often government supported enterprises.

The U.S. aircraft manufacturing industry includes the two major producers of large civilian planes: Boeing and McDonnell-Douglas. Shipments of large aircraft (more than 70 seats) declined from 3,675 to 2,444 between 1989 and 1992.[7] In recent years, sales of exported aircraft increased from $14.4 billion in 1989 to $23.1 billion in 1992. For 1992, operating revenues for these two producers totaled $47.6 billion, cost reached $43.7 billion, and unit deliveries totaled 572. (See table 5-15.)

The industry may be headed toward stronger growth in the next several years. Airbus Industrie, an aggressive European manufacturer, delivered 157 aircraft to U.S. carriers in 1992. In 1993, major orders were received for 30 Boeing 767 freighters from United Parcel Service and 20 737s from the Republic of China; Southwest has just placed an order for the new 737-x. The forecasted value of imports in 1993 is $5.9 billion, while exports are predicted to be $23.3 billion, making this industry a major contributor toward achieving a positive balance of trade.[8]

TABLE 5–15

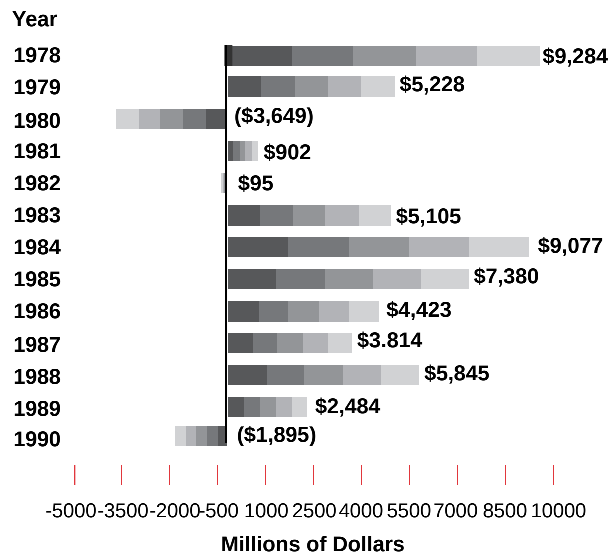
Major U.S. Aircraft Manufacturers: 1992

	Revenues (In Billions of Dollars)	Cost (In Billions of Dollars)	Unit Deliveries
Boeing	30.2	28.1	446
McDonnell-Douglas	17.4	15.6	126

Construction of transportation facilities is another key part of the broadly defined transportation industry. The 1987 Census of Construction reports the value of construction, which represents total value of construction work, as well as the transportation components of these values. Summing those transportation-related items across construction industries gives a total of almost $39 billion spent on all transportation construction in 1987. (See table 5-16.)

FIGURE 5–13

Corporate Profits Before Taxes: 1978-90 Motor Vehicles & Equipment Industry



An alternative measure of activity is the value of new construction put in place. By this measure, construction was relatively flat for the years 1989-1991. Preliminary figures for 1992 show a significant upturn in new construction. (See table 5-17.)

Transportation construction costs are most closely tracked by the U.S. Department of Transportation (DOT) for highways. The cost of highway construction has increased more than 5 percent a year since 1960, while the cost of highway maintenance and operation grew 5-8 percent annually. (See table 5-18.) This price inflation has slowed considerably since 1985, however, with highway construction up less than one percent annually and maintenance rising only 3.2 percent a year.

Expenditures and Revenues of Public Agencies

Most expenditures for transport services and equipment are made directly by consumers and the private business sector in the United States, but federal, state and local governments play significant roles in supporting the provision of infrastructure for a number of the modes of transportation. These governments make expenditures to build, maintain and administer a major portion of the nation's transporta-

TABLE 5–16

Transportation Construction: 1987

	Highway and Street Construction (SIC 1611)	Construction of Bridges, Tunnels, and Elevated Highways (SIC 1622)	Heavy Construction Not Elsewhere Classified (SIC 1629)
Establishments	10,986	1,159	14,532
Employees	284,380	47,494	297,618
Value of Construction ($ thousands)	$34,161,427	$5,480,936	$25,632,969
Highways, Streets, and Related Facilities	28,123,431	387,161	923,313
Airport Runways	123,809	-	-
Bridges, Tunnels, and Elevated Highways	1,152,276	4,476,501	532,104
Marine Construction	88,785	29,291	1,379,611
Harbor and Port Facilities	-	53,509	431,507
Mass Transit	54,092	-	780,781
Pipelines (Except Water)	-	-	249,086
Buildings and Other Construction	4,619,034	534,474	21,336,567

TABLE 5–17

Value of New Construction Put in Place (In Millions of Dollars)

	1989	1990	1991	1992 (preliminary)
Highways and Streets	28,837	31,155	29,918	32,884
Public transit systems, airfields, open parking facilities, power generating facilities, etc.	8,254	8,616	8,077	9,449

tion facilities and services, funding highways, airports, transit systems, and water transport facilities, among others. Governments also play a role—for the most part a secondary one—in funding the operating costs or the operating loses of modes in which there is an important public interest. Government expenditures reached nearly $108 billion in fiscal year 1991, the most recent period for which data are available.[9] Total spending by federal, state, and local governments has equaled one-tenth the size of the total transportation bill since 1960.[10]

This section broadly describes the tax and user-fee revenue sources applied by governments to transportation in the U.S. It points out how those governments made their transportation expenditures and compares 1991 figures with a decade earlier expenditures and revenues in 1981. The section concludes with a description of the role of trust funds in the financing process (indicating changes over time in the balances of those trust funds), defines the role of tolls in transportation finance, and reports the figures for the DOT budget for the most recent year.

Government Transportation Expenditures

Government transportation expenditures were 4.5 percent of all government expenditures in fiscal year 1991: They amounted to 0.9 percent of all federal expenditures, 10.3 percent of state expenditures, and 8.3 percent of expenditures at the local level.[11] (See table 5-19) The growth of total expenditures over the last decade has been driven primarily by state and local spending, although the increase

The 1993 Budget of the U.S. Department of Transportation

In fiscal year 1993 the U.S. Department of Transportation's (DOT) budget totaled $34 billion. This sum was applied to infrastructure support, administrative expenses, and research and development. About half the total spending authority was accounted for by the Federal Highway Administration; the Federal Aviation Administration ranked second, with a quarter of DOT's expenditure authority; water-related activities were third, with an eighth of the Department's total (the Coast Guard and the Maritime Administration, combined, had expenditure authority of $3.1 billion, 12 percent of the total); and rail was last among the modal operating administrations.[13]

U.S. Department of Transportation Expenditure Authorizations: FY 1993

	Amount (In Millions of Dollars)	**Percent***
Federal Highway Administration	15,753	46.1
Federal Aviation Administration	8,918	26.1
Federal Transit Administration	3,800	11.1
U.S. Coast Guard	3,585	10.5
Federal Railroad Administration	950	2.8
Maritime Administration	564	1.6
National Highway Traffic Safety Administration	270	0.8
All Other DOT Organizations	338	1.2
TOTAL	34,178	100.0

*Percentages rounded, do not total to 100%.

Figures from DOT's budget do not account for all the federal government's authority to spend in any particular fiscal year because other agencies' budgets reflect expenditures on infrastructure, maintenance, administration, and research for transportation. To give but a few examples, the overall federal total encompasses dollars spent by: the Corps of Engineers on the waterways; the Department of Agriculture for forest roads, the Department of Energy on vehicle research, and the regulatory agencies—the Interstate Commerce Commission, the Federal Maritime Commission and Federal Energy Regulatory Commission—on economic and safety administration.

The DOT budget figures reflect indirect expenditures as well as direct ones, because while a portion of the total goes to federal salaries and equipment (for example, to support traffic control, safety regulation, and navigation assistance) a major share of DOT's authorizations is expended as intergovernmental transfers, made to state and local governments. The states and localities, in turn, make the actual payments for operations, or for facility expansion, restoration, or repair.

TABLE 5–18

Price Indices for Federal Highway Construction and Maintenance (1987=100)

Year	Composite Price of Federal-Aid Highway Construction	Total Cost of Highway Maintenance and Operation	Total Cost 1977=100
1960	23.0	19.1	38.6
1965	25.0	21.8	44.2
1970	34.8	28.4	57.6
1971	36.8	29.9	60.5
1972	38.6	32.0	64.9
1973	42.5	34.5	69.9
1974	57.9	38.6	78.2
1975	58.1	42.1	85.2
1976	56.3	45.8	92.7
1977	59.8	49.4	100.0
1978	70.7	53.2	107.8
1979	85.5	58.4	118.2
1980	97.2	66.5	134.6
1981	94.2	72.2	146.3
1982	88.5	79.0	160.0
1983	87.6	82.1	166.3
1984	92.6	85.9	173.9
1985	102.0	91.0	184.4
1986	101.1	95.7	193.7
1987	100.0	100.0	202.5
1988	106.6	104.1	210.8
1989	107.7	108.2	219.1
1990	108.5	112.7	228.2
1991	107.5	109.9	222.6
1991/1960	4.67	5.77	
CARC 1960-91	5.1%	5.8%	
CARC1985-91	0.9%	3.2%	

is not dramatic when adjusted for inflation. (See figure 5-14.)

Unquestionably the highway field has the greatest expenditures, just as highway users generated the most government revenues. The growth of expenditure has been higher, though, in air transport and in transit. The rate of growth was much lower in water transport, and there was a decline in spending for rail freight and passenger activity. In the case of rail freight the expenditures in 1981 were largely for Conrail, which has since been privatized, but in the 1970s and the 1980s the federal government spent major sums to improve Conrail's track and operations.

Federal expenditures for transportation. The federal share of the $108 billion expended by all governments on transport in fiscal year 1991 amount to $32.3 billion, or 30 percent, of all transport expenditure (slightly less than the 34-percent federal share of revenues). Federal revenues increased in dollar terms from 1981 to

1991 by $6.5 billion (25.4 percent), but in constant dollars they declined by 1.21 percent annually. The major federal focus of expenditure was highways, followed by transit. Highway grants more than doubled from 1981 to 1991, while transit grants were virtually static. The major gainer was air transportation, more than tripling over the period.[12] (See table 5-20.)

State government expenditures for transportation. The states spent $44.9 billion on transportation in fiscal year 1991, up 93 percent from the $23.3 billion spent in 1981. The great bulk of these dollars—$38.9 billion—went for highways, with transit in second place at $4.7 billion, and airports third at $0.8 billion. Highway expenditures were up 88 percent from 1981, transit was up 181 percent, but water expenditures at $487 million in l991 were actually down 4 percent from $509 million in 1981.[14]

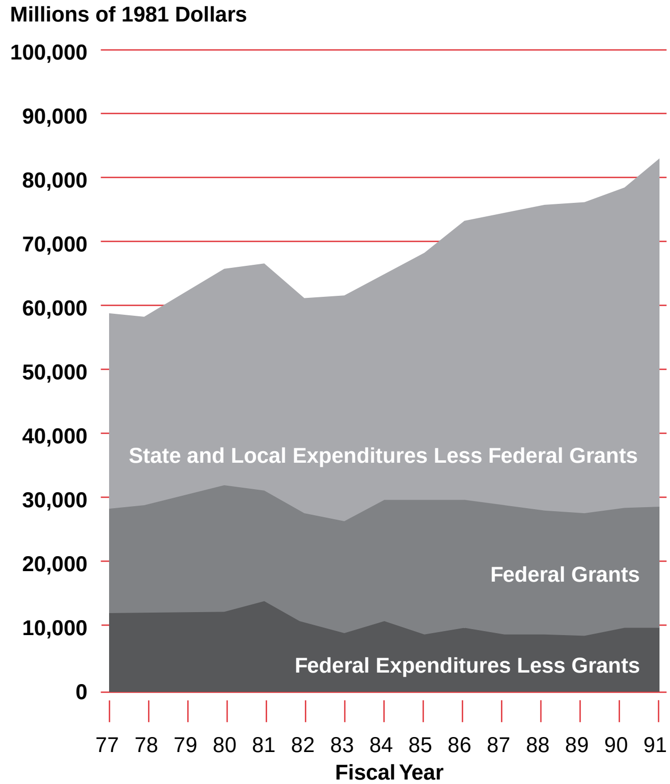
Local government expenditures for transportation. Total transport expenditures of cities, counties and other local governments in 1991 were $50.9 billion, up from $25.9 billion in fiscal year 1981, and the highest expenditures for any of the three categories of government. The increase over the period equaled 97 percent compared with the 93 percent state increase and a 25 percent increase in federal expenditures. The largest modal expenditures were $26.9 billion for highways ($26 billion) and parking ($0.9 billion), followed by $16 billion for transit and $6.5 billion for airports. The greatest rise in local expenditures—167 percent—came for airports, with transit rising 96 percent and highways (plus parking) up 88 percent.[15]

Government Transportation Revenues

Government transport expenditures are supported in large part by tax revenues supplied directly or indirectly by users of transportation. Governments generate these revenues from quite a variety of charges paid by users either on a periodic or occasional basis (such as license fees and excises), or as the users consume infrastructure services (such as fuel taxes and tolls). From the user's standpoint some of these fees operate as fixed costs of doing business, while others are variable

FIGURE 5–14

Government Expenditures for Transportation In Constant (1981) Dollars



Government Expenditures for Transportation In Current Dollars

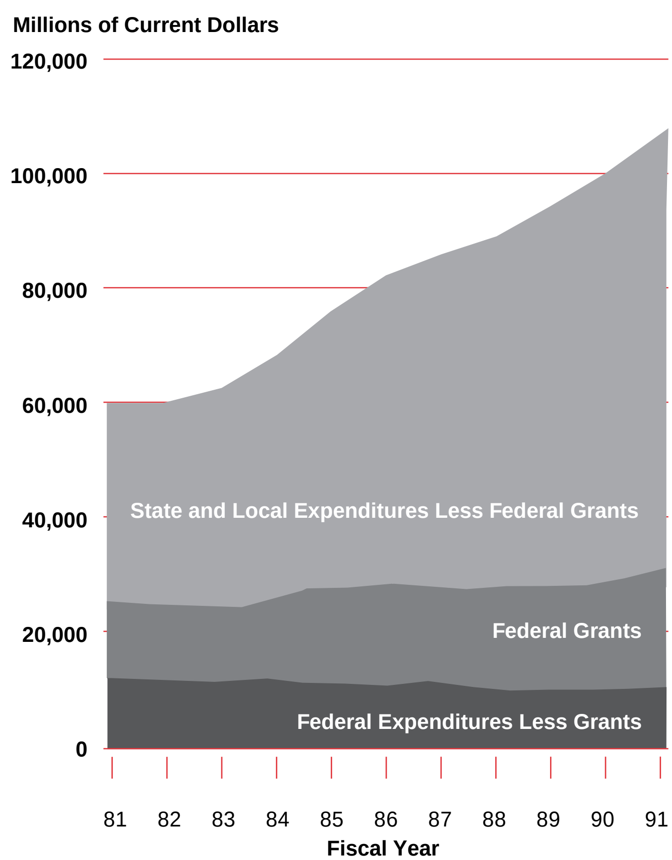


TABLE 5–19

Federal, State, and Local Transportation Expenditures by Mode, and Percent Change: 1981 and 1991

	Fiscal Year 1981 (In Millions of Current Dollars)	Fiscal Year 1991 (In Millions of Current Dollars)	Percent Change
Transit	9,899	20,792	+110
Highways (including parking)	35,878	66,480	+85
Air	6,124	13,879	+129
Water	4,399	5,728	+30
Rail Freight	2,760	42	–98
Rail Passenger	1,094	741	–32
Pipeline	8	26	+225
Unallocated	186	190	+2
TOTAL	60,348	107,878	+79

TABLE 5–20

Federal Transportation Grants, by Program, and Percent Change: 1981-1991

	FY 1981 (In Millions of Current Dollars)	FY 1991 (In Millions of Current Dollars)	Percent Change
Highway	10,181.0	14,751.0	102.7
Air	469.0	1,541.0	228.6
Transit	3,860.0	3,881.0	0.6
Rail Freight	52.0	8.0	(84.2)
Rail Passenger	0.5	—	—
Pipelines	3.5	9.2	163.6

costs paid only when an incremental amount of transportation is produced or consumed.

Additionally, government supports a significant minority share of infrastructure cost through the application of general tax revenues. For example, local governments spend local property tax receipts on transit and streets, or earmark special local sales taxes for transportation purposes; some state income taxes go to support rail and intercity bus services; the federal government spends general treasury funds on waterway construction, operation and maintenance, and the salaries of air traffic controllers. Most transportation businesses and users pay the same general taxes and most transportation activity is treated as any other activity for the purpose of applying general tax instruments (with some important exceptions, such as states that exempt gasoline from general sales taxes, or place motor vehicle sales tax receipts in a special transportation trust fund, rather than in the general fund with other sales tax receipts).[16] Overall, general tax revenues support about 30 percent of all public transportation expenditures, with transport-related revenues providing the majority support.[17]

U.S. transportation revenues equaled $77.4 billion in fiscal year 1991, some 3.6 percent of all government revenues.[18]

Those revenues included amounts collected from user charges (from sources such as gasoline and diesel taxes, registration and licensing fees, and airport facility charges); excise taxes; and fares paid by transport consumers such as transit riders, plus other operators' revenues. The transportation revenue total does not include amounts from government general funds (supported by income from general taxes such as sales, income, and property levies), or subsidies from other governments (intergovernmental revenues). Overall, government transportation revenues were growing at a compound rate of 8.6 percent annually from 1981 to 1991.[19]

The number of transportation revenue sources is too great to recite, but federal user charges for motor vehicles indicate the variety that is utilized: gasoline tax of 17.4 cents per gallon, diesel fuel tax of 23.4 cents per gallon, excise tax on trucks and trailers of 12 percent of value, a weight-based tax on tires and tubes, and an annual heavy vehicle tax based on registered gross vehicle weight.[20] At various times, the federal government has employed many other transportation revenue measures for highways (such as excise taxes on automobile sales values). Both state and local governments use motor vehicle taxes similar to those named above, in addition to utilizing a number of other kinds of taxes.[21] Other modes have similar varieties of revenue sources.

In both 1981 and 1991, revenues were exceeded by expenditures, but the trend was to reduce the gap to 72 percent of expenditures covered by revenues in 1991 versus 56 percent coverage in 1981. The lowest coverage in 1991 occurred in transit, 42 percent, but the ratio had increased from 31 percent in the earlier period. The highest coverage ratio in 1991 was the 86 percent found in air transport, up from 64 percent in 1981. The great majority of all transportation revenues were highway-related ($53 of the $77 billion, or 70 percent), and revenues for highways covered 81 percent of expenditures. (See table 5-21.)

Although highway sources bring in by far the largest share of all transport revenues (more than $50 billion annually in recent years), the greatest percentage change in revenues from 1981 to 1991, as calculated for the major modes, took place in the nonhighway fields—air transport accounted for 204.7 percent, followed by revenue increases in transit (185.4 percent) and water transport (114.2 percent). Highway revenues increased the least (108.9 percent).[22]

Federal transport-related revenues. The federal share of the nation's $77.4 billion in 1991 transportation revenues—$26.0 billion—was slightly more than one-third of the total—33.6 percent. This federal share increased from 28.5 percent in 1981. In current dollar terms federal revenues rose at a 6.6 percent rate from 1981 to 1991 (up 105 percent).[23] (See table 5-22.) Both air and water receipts more than tripled over the period; federal high-

TABLE 5–21

Federal, State, and Local Government Transportation Revenues, Percent Change and Ratio of Transportation Revenues to Expenditures, by Mode: 1981 and 1991 (In Millions of Current Dollars)

	Revenues, FY81	Revenues, FY91	Percent change	Revenues to Expenditures Ratio, FY81	Revenues to Expenditures Ratio, FY91
Transit	3,076	8,778	+185	31	42
Highways	25,334	52,914	+109	71	81
Air	3,913	11,924	+205	64	86
Water	1,335	2,860	+114	30	50
Parking	369	924	+150	n/a	n/a
Pipeline	—	10	—	0	39
TOTAL	34,028	77,410	+127	56	72

Toll Financing

Toll facilities for motor vehicle traffic—automobiles motor carriers, pedestrians—and for waterborne traffic are wide-spread in the United States, although these facilities are in the minority compared to facilities financed through general user fees and taxes. The total extent of toll roads, toll bridges, and toll tunnels as of January 1993 equaled 4,400 miles. Revenues accruing to state and local government agencies from highway toll facilities in 1991 totaled $4.5 billion, up 136 percent from $1.9 billion in 1981.

Today's highway toll facilities are owned and operated by numerous entities, mostly public sector authorities, districts, or agencies of general government. They were often financed by issuing bonds and using toll proceeds to provide for operating and maintenance expenses as well as for the purpose of retiring the bonds when due. Many of the country's toll roads were built in the period after the Second World War and before the Federal-Aid Highway Act of 1956, which authorized the Interstate Highway program. After 1956 relatively few toll roads were built, but the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has given new impetus to toll finance by making toll facilities broadly eligible for federal-aid highway funds, and quite a number of new roads are under construction or in the planning stage.

In 1993 some seven new facilities were underway in California (supported by the California Transportation Commission), two were planned in Colorado (by the W-470 Public Highway Authority and by the Front Range Toll Road Company), one each were proposed in Delaware and Florida by the state DOTs, seven were under construction or planned in Kansas by the Kansas Turnpike Authority, the South Carolina Department of Highways and Public Transportation had three projects, and in Texas the Texas Turnpike Authority had three projects while Camio Columbia, Inc. had one in Laredo. In Virginia the Department of Transportation had a project, the Southeastern Expressway, and the Toll Road Corporation of Virginia had another, the Dulles Toll Road Extension. The number of new highway projects underway or proposed in the 3 years since passage of ISTEA far exceeds the number implemented in the decades since the Interstate Program began, suggesting that toll financing could be of great importance in the years to come.

way receipts doubled.

State government transport-related revenues. State governments obtained $36.6 billion in transport revenue in fiscal year 1991, up from $17.8 billion in 1981 (a 99.5 percent increase). Almost all of these receipts were from highway users: Fuel taxes were $20.6 billion; vehicle license fees totaled $10.1 billion; toll highway revenues were $2.8 billion; and vehicle operator license taxes equaled $0.9 billion. Highway revenues totaled $34.4 billion while other sources brought in $2.1 billion: airport charges equaled $0.6 billion; water transport charges were $0.4 billion; and transit charges were $1.1 billion.[24]

Local government transport-related revenues. Total transport receipts of cities, counties, and other local governments in 1991 were $14.8 billion, up from $6.5 billion in fiscal year 1981, but still the lowest of the three categories of government in both periods. The increase over the years equaled 128 percent, a greater percentage rise than for either the federal government (105 percent) or the states (99.5 percent).

Unlike the case of national and state governments, which rely on highway sources for the great bulk of their transportation revenues, the key local funding sources were airport charges at $5.1 billion, followed closely by transit charges at $4.5 billion.[25] Highway tolls come next at $1.7 billion while motor fuel and vehicle licensing charges together were $1.5 billion, with parking at $0.9 billion—giving the highway sector a total of $4.1 billion in revenues for third place among the modes. However, the increase in local highway revenues from 1981 to 1991 was 172 percent (with the highest increase of 194 percent coming in the category of tolls). The large percentage gain in the highway category was almost matched by increased air revenues at 170 percent. Local transit increases trailed with an 82-percent rise.[26]

The Balance Sheet

Total government expenditures and revenues for transportation have increased every year in current dollars over the past 15 years. (See figure 5-15.) In constant dollars, revenues declined in the late

1970s, but they began to rise in the mid-to-late 1980s, ending about 40 percent higher in fiscal year 1991 than they were in 1977. Constant-dollar expenditures grew from 1977 to high points in 1981 and 1982, then declining until 1985 when it began a steady climb. By fiscal year 1991, expenditures were a quarter higher than in 1977. (See figure 5-16.)

Revenue-to-expenditure ratios rose across the board for all the modes over the period, but in every case were less than one. Government revenues were always exceeded by government transport expenditures. The differences were made up by borrowings or by payments from general fund accounts.

In 1991 about 62 percent of all government expenditures were made for highways and parking, while 70 percent of all government transportation revenues came from highway sources. The mode in second place as to expenditures was transit (19 percent, and with 11 percent of the revenues). Third in expenditure was air transport (13 percent, but with 15 percent of the revenues). Water transportation had 5 percent of the expenditures and 4 percent of the revenues.[27]

One can also view modal expenditures in light of the jurisdiction that makes direct expenditures for that mode. For example, state governments spent $38.9 billion on highways in 1991, while local government spent $26.9 on highways and parking. The federal government spent only $693 million because most federal highway funding was passed through to the other levels of government.[28] (The federal government has only minor numbers of federal park and government facility roads under its direct jurisdiction.)

In the case of transit, local governments spent $16 billion and states $4.7 billion in 1991, while direct federal expenditures were just $36 million. (In this case, some state revenues were passed through to local governments as well.) With regard to airports, local expenditures totaled $6.5 billion, federal expenditures were $3.7 billion, and state government spent $759 million. Water transport expenditures were $3.7 billion by the federal government, $1.6 billion by local governments (ports and related facilities), and $487 million directly.[29]

The Bottom Line: Implications for the National Economy

How does this varied picture of expenditures and revenues translate into an answer to the question: "Is the cost of transportation getting better or worse?" The traditional response is based on measures of productivity, which in theory identify the amount of transportation we are getting for each dollar spent. Traditional measures of productivity indicate that we are getting more transportation than other business activity for the dollar over time. Productivity trends for five transportation activities (pipelines, rail, air, buses, and trucking) indicate that, with one exception, transportation productivity has outpaced the overall

TABLE 5–22

Federal Transportation Revenues, by Mode: 1981 and 1991
(In Millions of Current Dollars)

	FY81	FY91	Increase	Percent Change*
Highway Trust Fund Transit Account	0	3,149	3,149	—
Highway Trust Fund	7,434	15,303	7,869	105.9
Airport/airways Trust Fund	1,815	6,206	4,391	241.9
Water Receipts	431	1,325	894	207.4
Pipeline Safety Fund	0	11	11	—

*Percent change, shown only for accounts established by FY81.

FIGURE 5-15

Transportation Expenditures and User Charges in Current Dollars

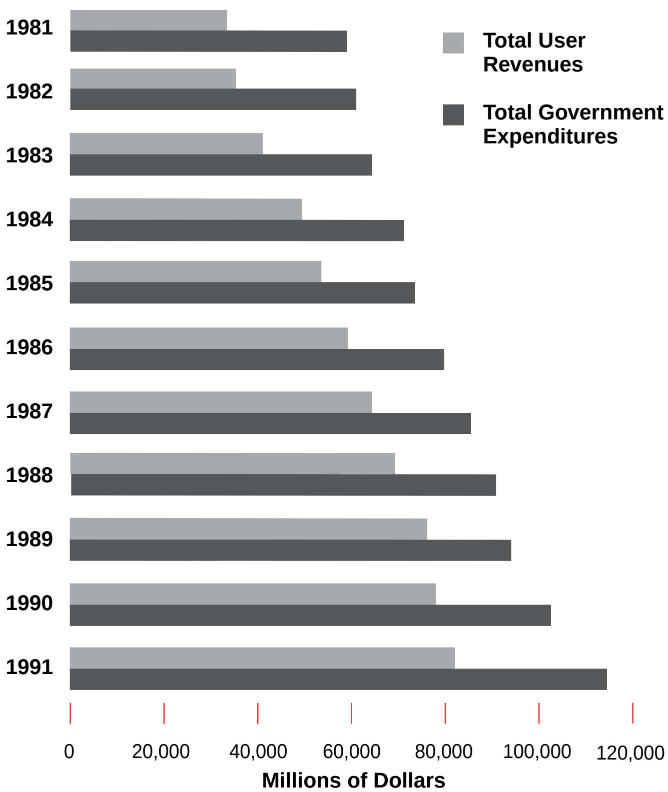
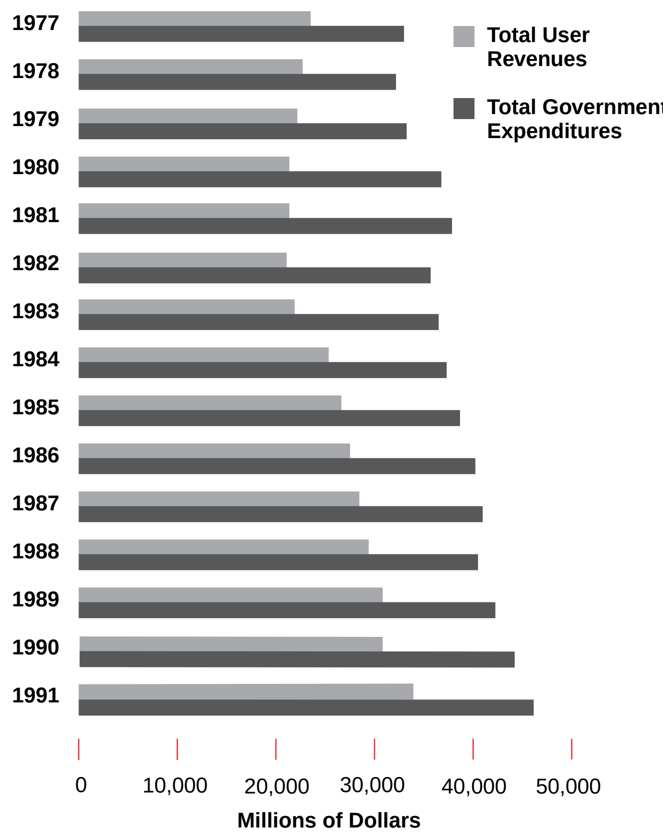


FIGURE 5-16

Transportation Expenditures and User Charges in Constant (1981) Dollars



business sector including agriculture. (See table 5-23.) Indeed, rail transportation output per employee-hour has grown at the extraordinary rate of 6 percent a year, three times the average for the total business sector. The exception to these growth trends is in output per employee-hour in the intercity bus industry, which has shown no measured growth over the last three decades. This assessment of improved transportation productivity must be tempered, however, with the sobering problems of productivity measurement. As noted in a recent symposium, we have neither the data nor the constructs to state without strong reservations that we are getting more or less transportation output for the dollar.[30] Productivity is supposed to be a ratio of inputs to outputs, holding the economic value of the output constant. Although the inputs are relatively easy to measure (such as labor hours and equipment costs), no one has successfully advanced a satisfying measure of output that captures the quality or diversity of transportation. The traditional measures of ton-miles and passenger-miles do not differentiate transportation requirements by commodities carried or trip purpose served. Even if a measure such as ton-miles can be disaggregated and refined to the point of acceptance, current data sources are inadequate to meet the precision required for productivity measurement.

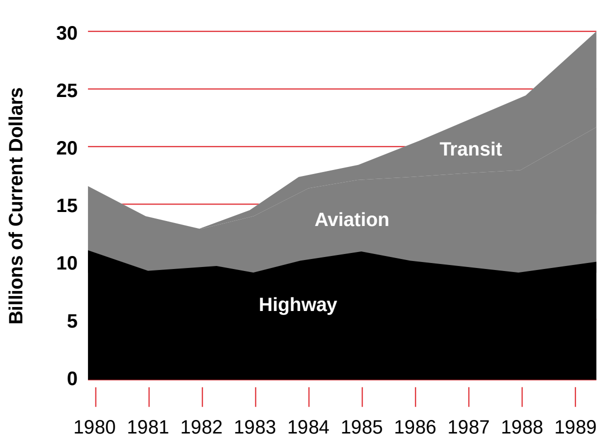
Productivity is only a part of the bottom line. What we pay for transportation has consequences for international competitiveness, regional economic development, and the economic health of American households. The distribution of transportation costs is as important as the average. Some areas that incur high local transportation costs because of difficult terrain, low population density, and economic obsolescence are often home to impoverished populations who are least able to afford the price.

Transportation Trust Funds and Federal Trust-Fund Balances

The accounting device of the trust fund is an important feature of much government transportation expenditure. User fees and other revenue related to a particular mode of transportation is gathered and placed in a special government account, with the cumulated proceeds (and sometimes the interest earnings on those proceeds) dedicated or earmarked for expenditures to benefit that transport mode. Trust funds began in highway finance in the states, sometimes with state constitutional requirements that all highway funds, as defined, be spent for highway purposes. Today there are four modal areas for transportation trust funds at the national level—highways, airports and airways, transit, and water transportation.[31]

Trust funds usually build up unspent balances, partly because much transport finance is pay-as-you-go, requiring funds to be available before expenditures are made. There are other reasons for unspent balances, such as controversy over transportation projects leading to delays or inhibiting expenditures, or macroeconomic policy decisions not to spend because spending would add to budgetary imbalance or inflationary pressures.

End of Year Trust Fund Balances



Transportation and Its Costs: What More We Need to Know

Our understanding of what we pay for transportation, what individual costs contribute to what we pay, and how what we pay affects the economic health of the nation and its citizens is severely limited by data, analysis, and concepts. We lack basic revenue and expenditure data for many segments of the transportation industry, and must contend with inconsistent accounting of expenditures and revenues for the remaining segments. We have inadequate models of the relationships between transportation and economic activity, whether by industry or geography, to support analyses of the consequences of transportation. We lack a consensus on basic concepts such as productivity and what constitutes the economic output of transportation. And we have barely begun to consider international comparisons of economic performance or the consequences of NAFTA for distinguishing between international and domestic transportation. These topics are not of idle academic interest; calculations of vital statistics such as the balance of trade can be affected.

North American and intercontinental issues raise the need to distinguish between a national and a domestic perspective. The former includes the activity of U.S. citizens, including corporations, whether operating within our geographic borders or in other countries. The latter concept includes those activities occurring within our borders, whether by foreign citizens or corporations or U.S. citizens. This concept is embodied in GDP, which now represents the total output of our nation rather than Gross National Product.

Several deficiencies in attempts to measure the role of transportation activity in generating GDP have already been identified. Moreover, the appropriate deflators for certain international account items are not currently published but should be secured to determine transportation's true role in real national economic activity.

We need more complete modal data. We lack basic cost data on private trucking and other forms of own-account transportation, as well as data on self-employed providers of transportation service. We know very little about the expenditures and revenues of intercity and school bus operators, the taxicab industry, short line railroads, and much of water transportation.

In addition to data needs for an industrywide perspective, we need data on specific topics such as employer-provided parking. We lack consistent, nationwide data on the size and distribution of park-

TABLE 5–23

Measures of Transportation Productivity (1982=100)

Year	Petroleum Pipelines Output per Employee-Hour	Railroad Transportation Revenue Traffic Output per Employee-Hour	Bus Carriers, Class I, Output per Employee-Hour	Air Transportation Output per Employee	Trucking Local Output per Employee	Total Business Sector Output per Employee-Hour
1960	36.6	38.9	97.2	29.9	61.5	65.5
1961	39.0	42.0	99.1	31.6	62.3	68.0
1962	40.7	45.1	108.5	35.1	64.2	70.4
1963	44.9	47.3	110.0	38.6	67.3	73.2
1964	48.7	50.4	111.1	42.3	69.0	76.4
1965	57.8	56.2	117.7	47.3	71.5	78.5
1966	65.1	60.6	120.2	53.1	75.2	80.7
1967	72.7	62.3	116.2	56.7	72.5	82.7
1968	77.0	65.6	114.5	59.2	77.0	85.3
1969	83.2	68.2	111.2	60.8	78.9	85.7
1970	89.2	67.0	108.6	62.1	77.4	86.9
1971	92.4	69.8	106.0	66.2	82.1	89.8
1972	104.1	75.9	108.0	73.0	87.7	92.6
1973	109.7	83.1	107.4	74.5	89.5	95.0
1974	106.6	80.9	111.5	75.3	86.4	93.2
1975	107.1	77.3	98.2	76.1	82.6	95.4
1976	106.8	82.3	94.9	83.0	92.9	98.2
1977	112.1	86.4	101.1	87.0	92.6	99.8
1978	114.0	90.2	97.9	95.1	106.7	100.4
1979	114.0	90.4	99.5	98.5	108.0	99.3
1980	104.4	92.6	102.1	92.4	99.7	98.6
1981	96.4	96.1	91.8	91.4	107.6	99.9
1982	100.0	100.0	100.0	100.0	100.0	100.0
1983	106.5	122.4	96.4	110.4	121.2	102.2
1984	117.9	131.9	92.0	114.8	125.5	104.6
1985	118.5	139.7	88.3	118.8	120.6	106.1
1986	121.0	153.8	87.9	119.9	124.6	108.3
1987	118.7	178.3	91.9	126.9	128.7	109.4
1988	124.3	195.3	99.2	122.5	135.7	110.4
1989	122.4	207.4	96.2	118.3	140.9	109.5
1990	121.6	218.1	n/a	113.7	n/a	109.7
1991	117.6	236.2	n/a	115.3	n/a	110.1

ing costs. Such data would be valuable in ongoing discussions of taxation and environmental policies.

We collect extensive data on household travel by trip and traveler characteristics, but very little on the costs of that travel by those characteristics. Our information on the costs of business travel is particularly limited.

The data problems are exacerbated by a continuing divergence between the published price of transportation and the prices that people pay. Deregulation of freight carriers has been followed by a dramatic increase in the use of contract rates rather than published tariffs. On the passenger side, a large percentage of travelers pay contract rates negotiated by their employers or highly volatile discount rates. Frequent flyer bonuses and free travel from overbooking make prices even harder to determine. The involvement of travel agents, tour operators, and others adds further complexity by increasing the number of players to monitor and by mixing transportation and other costs into package deals.

Transportation productivity is a key element to a healthy transportation sector, and one that is contributing to economic growth. Yet current measures do not cover all forms of transportation; nor, are they based on adequate data. It is critical that we have valid productivity measures for all major passenger and freight transport modes. Data series describing transportation's contribution to productivity in other industries would vastly improve our understanding of where additional transportation-related investment is warranted.

The relationships among transportation investments, productivity changes, and GDP growth has been debated, often with assumptions and data variability that dwarf the conclusions of analysis.[32] Analyses of these relationships should be performed once the worst productivity measurement issues are resolved and we have a wider consensus on the portion of the economy represented by transportation.

Although a good deal of data about government transport revenues and expenditures is to be found, extensive analyses and data development related to flows of public funds and cost allocation are also needed. Much transportation finance is based on a user-pays principle; yet, only highway investments have been continually analyzed to determine relationships between user charges and public costs.

Transportation spending is sometimes targeted at specific geographic areas or types of programs to generate employment. Yet the relationships between spending and job creation are not well known across all modes. For example, we have not followed major locally targeted investments to determine how much geographic dispersion of the spending occurs through out-of-town subcontractors. Further, although we know the element of public income statements for publicly supported transportation, we do not have satisfactory information on balance sheets. Financial data on both the value of facility inventories and the cost of supplying inventory replacements of an appropriate nature are missing.

The Bureau of Transportation Statistics will not lack for challenges, either to meet basic data needs, define fundamental measures of economic performance, or conduct needed analyses. The largest challenge will be to set priorities among many overdue initiatives for better data collection and analysis.

Sources

Figures

Figure 5-1: Eno Transportation Foundation, *Transportation in America 1993*.

Figure 5-2: Based on *Transportation in America* and author's estimates.

Figures 5-3 and 5-4: U.S. Department of Commerce.

Figure 5-5: *Transportation in America*.

Figures 5-6 and 5-7: author's estimates.

Figures 5-8 and 5-9: U.S. Department of Labor, U.S. Department of Commerce, and author's estimates.

Figure 5-10 U.S. Department of Transportation.

Figures 5-11 and 5-12 *WATS*, U.S. Bureau of the Census.

Figure 5-13: Moody's Industrials, 1993.

Figure 5-14: Office of Economics, U.S. Department of Transportation, Office of the Secretary.: 5-17.

Tables

Table 5-1: Eno Transportation Foundation, *Transportation in America 1993*, p. 38, and

Sept. 1993 revisions. Total bill is the sum of the freight and passenger bills less duplicated expenditures included in each.

Table 5-2: Bureau of Economic Analysis, U.S. Department of Commerce. *See* "NIPA PCE Transport" for details.

Table 5-3: U.S. Travel Data Center. See "Finalteim" for details.

Table 5-4: Eno Transportation Foundation, *Transportation in America 1993*, p. 40, See "Freight components" for details.

Table 5-5: Bureau of Labor Statistics, U.S. Department of Labor, Bureau of Economic Analysis, U. S. Department of Commerce. *See* "CPI-PPI" and "NIPA imp. price def." for details.

Table 5-6: Motor Vehicle Manufacturers' Association *Motor Vehicle Facts and Figures* annual. *See* "Transport Costs" for details.

Table 5-7: American Automobile Association, "*Your Driving Costs*" annual. *See* "Transport Costs" for details.

Table 5-8: U.S. Department of Transportation, *National Transportation Statistics Annual Report*, September 1993. *See* "Fares" for details.

Table 5-9: Air Transport Association of America, *Airline Cost Index*, *Second Quarter 1993*. *See* "Transport Costs" for details.

Table 5-10: *Transporation In America*.

Table 5-11: WATS, U.S. Bureau of the Census.

Table 5-12: *Statistical Abstract of the U.S.*, 1993, p. 747

Table 5-13: Moody's Industrials, 1993.

Table 5-14: Number of Vehicles from *MVMA Facts and Figures 1992*, pp. 16-17. Value of output from BLS, *Survey of Current Business*, August 1993, pp. 112-113. Estimates by Volpe National Systems Transportation Center, DOT.

Table 5-15: *Moody's Industrials*, 1993.

Table 5-16: Bureau of Transportation Statistics.

Table 5-17: *Statistical Abstract*, 1993, p. 715

Table 5-18: Federal Highway Administration, *Highway Statistics 1991*, Tables PT-1 and PT-5, pp. 69 and 72.

Table 5-19: *Federal State and Local Transportation Financial Statistics*, *Fiscal Years 1981-1991*, Washington, D.C.: U.S. Department of Transportation, 1993, 19.

Tables 5-20 through 5-22: *Federal State and Local Transportation Financial Statistics*, Fiscal Years 1981-1991 Washington, D.C.: U.S. Department of Transportation, 1993, 26-32.

Table 23: Office of Productivity and Technology, U.S. Department of Labor. *See* "Productivity" for details.

Endnotes

1. This is sometimes called the nation's *transportation bill.* In contrast to the proportion of Gross Domestic Product attributable to transportation activities discussed in chapter 1, this includes purchases of transportation by business and government as services intermediate to producing for final demand.
2. Divide household goods moving revenues from *1987 Census of Transportation Geographic Area Series*, Selected Transportation Industries Summary, TC-87-A-1 by 1987 freight bill from Eno, TIA.
3. Eno Foundation, *Transportation in America*, 1993, page 40.
4. For this analysis, transportation spending is decomposed into three parts: population, activity per capita, and expenditure per unit.

   TS = P * TA/P * TS/TA

   where:

   TS = U.S. expenditures on transportation

   P = U.S. population

   TA = U.S. transportation activity, expressed in passenger-miles or freight ton-miles.

   The second term on the right (TA/P) is a measure of average transportation activity per capita. The last term on the right (TS/TA) is average expenditure per unit of transportation activity, a surrogate measure of cost. This surrogate is used because comprehensive cost data for transportation are not available.
5. Bureau of Labor Statistics, *Survey of Current Business*, May 1993, p. 51.
6. Value Line Survey, 9/17/93, p.101.
7. *Statistical Abstract of the United States*, 1993, pp. 640- 642.
8. *U.S. International Trade Administration, U.S. Industrial Outlook*, 1993, p.20-7.
9. *Federal, State, and Local Transportation Financial Statistics, Fiscal Years 1981-1991* (Washington, D.C.: U.S. Department of Transportation, 1993), 7.
10. Eno Foundation, *Transportation in America*, 1993. Divide transport bill on page 38 by total expenditures on page 73.
11. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit.*, 7.
12. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit.*, 16, 19, 26.
13. *Chief Financial Officer's 1992 Annual Report* (Washington, D.C.: U.S. Department of Transportation, 1993), 8.
14. *Federal State and Local Transportation*

Financial Statistics, Fiscal Years 1981-1991, *op. cit*., 24.

15. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991*, op. cit., 24.
16. Although there are differences, such as the tax-free status of public transportation infrastructure when it comes to property tax payment.
17. Note that this 70/30 ratio changes from year to year (with an increasing share of transport-related revenue in recent years), and that the ratio between revenues and expenditures in any given period is only roughly unity, due to fluctuations in trust-fund balances and in the condition of the transport facilities.
18. Ibid. The 3.6 percent of revenues contrasts with 4.5 percent of all government expenditures made for transportation (see page 118).
19. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit*., 9. When the growth rate is compounded and measured in terms of 1981 dollars, it falls to 4.5 percent.
20. Federal Highway Administration, U.S. Department of Transportation, *Highway Statistics, 1991* (Washington, D.C.: U.S. Government Printing Office, 1992), 53.
21. For state detail on taxes and tax rates *see* Federal Highway Administration, U.S. Department of Transportation, *Highway Taxes and Fees, How They Are Collected and Distributed, 1993* (Washington, D.C.: U.S. Government Printing Office, 1993). State-by-state comparisons of road-user and property taxes levied on a group of 15 selected vehicles (chosen to illustrate a variety of weight classes and vehicle types) were made in Federal Highway Administration, U.S. Department of Transportation, Road User and Property Taxes On Selected Motor Vehicles, 1982 (Washington, D.C.: U.S. Government Printing Office, 1982).
22. Perhaps one reason was the increasing proportions of alcohol-based highway fuel subject to lower tax rates. These rates vary by type of fuel, but equaled 11.9 cents for gasohol, ethanol and methanol, 17.9 cents for diesel, and 10.3 cents per gallon for fuels from natural gas.
23. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit*., 14, 16, 19. Amounts rounded.
24. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit*., 29. Figures rounded.
25. Local airport revenues are higher yet in 1993, due to the wider-spread adoption of airport facility charges.
26. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991*, op. cit., 29.
27. *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit*., 22.
28. Calculated from *Federal State and Local Transportation Financial Statistics, Fiscal Years 1981-1991, op. cit*., 24.
29. Ibid.
30. Federal Highway Administration, An Examination of Transportation Productivity Measures, *Searching for Solutions* Number 8, July 1993.
31. Water transport has an Inland Waterways Trust Fund, established by the Inland Waterways Revenue Act of 1978; a Harbor Maintenance Trust Fund set up under the Harbor Maintenance Revenue Act of 1986; and, an Oil Spill Liability Trust Fund, established under the Omnibus Budget Reconciliation Act of 1989, and with consolidated funding as provided in the Oil Pollution Act of 1990.
32. Federal Highway Administration, Assessing the Relationship Between Transportation Infrastructure and Productivity, *Searching for Solutions* Number 4, August, 1992.

TRANSPORTATION *and* SAFETY

Although we have made enormous progress over the past two decades in reducing accident rates per mile of travel, the problem of deaths and injuries during travel is far from solved. Much remains to be done both in terms of research to better understand transportation accidents and in devising means to prevent them. Despite the continued downward trend in transportation fatalities, transportation-related accidental deaths continue to account for half of all accidental deaths in this country. (See table 6-1.) Although deaths due to cancer and heart disease—the two leading causes of death in this country—far outnumber deaths due to injury, more years of life are actually lost due to deaths by injury. This is a result of the ages at which these types of death occur. (See figure 6-1.) Of the approximately 140,000 deaths by injury in the United States each year, 40,000 to 45,000 are due to traffic accidents. Nearly three million people incur minor or moderate injuries due to transportation accidents.

Accident Experience by Transportation Modes

Transportation safety concerns encompass travel on the streets of neighborhoods and communities; travel on highways, in the air, on railroads, and on boats and ships; releases of hazardous materials in transportation accidents; and criminal or terrorist actions against travelers and the transportation system.

The number of safety incidents, accidents, or crashes is difficult to compare across modes and over time. Different definitions are used, even for the same mode.

TABLE 6–1

Accidental Deaths: 1981-1982

Year	All Causes	Transportation Related	% Transportation Deaths of Total Deaths
1981	100,704	53,510	53.1
1982	94,082	48,105	51.1
1983	92,488	46,425	50.2
1984	92,911	47,923	51.6
1985	93,457	47,756	51.1
1986	95,277	49,505	52.0
1987	95,020	49,960	52.6
1988	97,100	50,534	52.0
1989	95,028	49,150	51.7
1990	91,983	48,125	52.3
1991	87,300	44,730	51.2
1992	83,000	42,272*	50.9
Average Annual% Change 1981-1992	–1.7	–2.1	

**Does not incluide waterborne commerce*

For example, motor vehicle accidents as defined by the National Safety Council and reported in *National Transportation Statistics* are two-to-three times higher than the police-reported crashes measured by the National Highway Traffic Safety Administration (NHTSA), while the National Safety Council's data on injuries show half of NHTSA's numbers. Definitions and reporting systems also change over time.

By any measure, accident statistics are dominated by motor vehicles. According to data for the year 1988, motor vehicle accidents are the leading cause of accidental death for individuals younger than 78 years.[1] The greatest number of motor vehicle fatalities occur to persons age 18. Motor vehicles accounted for 91-93 percent of all transportation fatalities over the past 12 years. (See table 6-2.) Similarly, motor vehicle accidents have accounted for the majority of the transportation accidents and injuries in the same period. (See tables 6-3 and 6-4.) Recreational boating and general aviation are the next most hazardous activities, accounting for less than 5 percent of transportation-related fatalities in 1992. Rail rapid transit, hazardous materials transport, and pipelines are the three safest transportation activities. Together, they accounted for less than 0.3 percent of total transportation fatalities in 1992.

Especially in the highway mode, serious injuries are a problem comparable in magnitude to accidental deaths. Occupants *not* wearing restraints were almost three times as likely to be severely or fatally injured as occupants wearing restraints. Seat belt usage has been increasing steadily. Forty-three states now have seat belt laws, and all 50 plus the District of Columbia have child restraint laws. Accidents in which alcohol was involved are more than three times as likely to produce severe or fatal injuries as those in which alcohol was not reported as a factor.

All other things being equal, the more a person uses the transportation system the greater the likelihood that person will be involved in a traffic accident. Modal comparisons based solely on the absolute numbers of fatalities or accidents fail to take into account different levels of accident exposure experienced by different modes. Different measures are typically used for different modes to estimate exposure. For example, one typical way of measuring highway traffic exposure is the number of miles traveled by motor-vehicles. Accident exposure in air transportation is measured by the number of miles

FIGURE 6–1

Preretirement Life Lost
and the Research Expenditure
(Three Major Causes of Death)

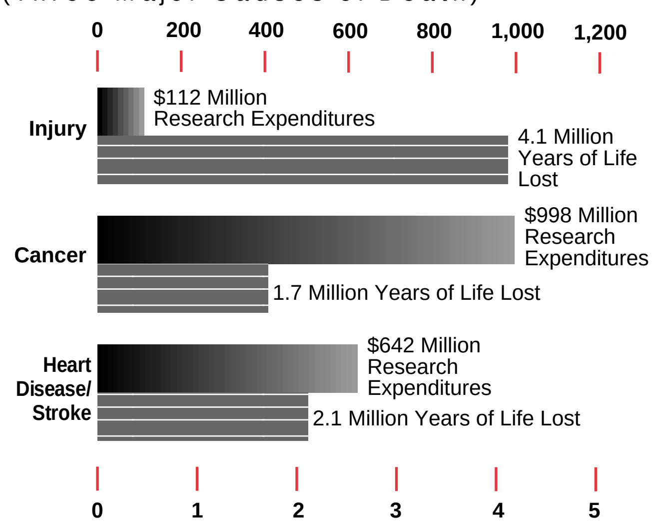


TABLE 6–2

Trends in Fatalities by Transportation Mode: 1981-1992

Year	Air Carrier*	General Aviation	Motor Vehicle	Railroad	Rail-Highway Grade Crossings	Rapid Transit	Waterborne Transport	Recreational Boating	Pipeline	Hazardous Materials	TOTAL
1981	132	1,282	49,301	556	728	103	154	1,208	21	25	53,510
1982	321	1,187	43,945	512	607	87	223	1,178	32	13	48,105
1983	88	1,069	42,589	498	575	50	289	1,241	18	8	46,425
1984	104	1,042	44,257	598	649	55	113	1,063	35	7	47,923
1985	639	955	43,825	454	582	15	131	1,116	31	8	47,756
1986	77	967	46,087	475	616	41	133	1,066	26	17	49,505
1987	356	838	46,390	541	624	34	119	1,036	12	10	49,960
1988	365	800	47,087	510	689	17	81	946	20	19	50,534
1989	392	768	45,582	523	801	45	96	896	39	8	49,150
1990	449	763	44,599	599	698	51	85	865	8	8	48,125
1991	222	746	41,508	586	608	82	30	924	14	10	44,730
1992	120	812	39,235	592	577	84	—	816	20	16	42,272**

* Includes air carriers, commuter carriers and air taxis.
** Does not include waterborne transport.

TABLE 6–3

Trends in Accidents/Incidents by Transportation Mode: 1981-1992

Year	Air*	Motor Vehicle	Railroad**	Rapid Transit	Waterborne Transport	Recreational Boating	Pipeline	Hazardous Materials
1981	3,714	6,457,000	15,076	6,271	3,503	5,208	1,864	10,010
1982	3,411	5,825,000	12,352	3,759	3,174	5,377	1,911	6,599
1983	3,259	5,861,000	11,067	n/a	4,704	5,567	1,741	5,815
1984	3,201	5,906,000	11,181	2,202	3,275	5,700	1,205	5,764
1985	2,933	6,081,000	10,191	1,054	3,439	6,237	514	6,019
1986	2,737	6,390,000	9,016	3,683	3,366	6,407	422	5,758
1987	2,659	n/a	8,903	3,156	3,496	6,746	466	6,137
1988	2,535	6,887,000	9,469	3,068	3,593	6,718	454	6,169
1989	2,390	6,653,000	9,423	2,891	3,852	6,063	418	7,558
1990	2,367	6,471,000	8,592	n/a	3,613	6,411	376	8,853
1991	2,280	6,117,000	8,044	n/a	2,222	6,573	449	9,093
1992	2,172	6,387,000	n/a	n/a	n/a	6,048	416	9,294

* Includes air carriers, general aviation, commuter carrier and air taxes.
** Includes deaths at rail-highway grade crossings.

TABLE 6–4

Trends in Injuries by Transportation Mode: 1981-1992

Year	Air*	Motor Vehicle	Railroad**	Rapid Transit	Waterborne Transport	Recreational Boating	Pipeline	Hazardous Materials
1981	679	3,474,000	55,003	6,272	141	2,474	111	640
1982	718	3,192,000	40,294	3,907	271	2,682	272	125
1983	615	3,371,000	34,819	1,977	209	2,913	254	189
1984	662	3,563,000	38,570	2,147	134	2,709	248	259
1985	606	3,363,000	34,300	1,039	172	2,757	124	253
1986	612	3,896,000	26,923	3,642	137	2,847	138	316
1987	550	n/a	26,031	3,122	191	3,501	121	331
1988	590	3,416,000	27,054	3,050	130	3,476	106	171
1989	511	3,284,000	26,715	2,846	168	3,635	116	330
1990	477	3,231,000	25,143	n/a	175	3,822	74	423
1991	503	3,097,000	22,796	n/a	110	3,967	97	438
1992	455	3,404,000	20,351	n/a	n/a	3,683	125	125

* Includes air carriers, general aviation, commuter carriers and air taxes.
** Includes deaths at rail-highway grade crossings.

flown by aircraft. To develop long-term safety plans for a transportation system, it is important to measure and analyze accident rates and trends to gain insights into the factors contributing to accidents. To increase compatibility and meaningfulness of comparisons from one year to the next and among modes, accident statistics in individual modes are converted into accident rates by using a common unit of exposure. (See table 6-5.)

Highway

Despite the continued increase in the number of vehicles registered, the number of licensed drivers, and the amount of driving, the 1992 fatality rate for all highway modes combined was 1.34 per 100 million vehicle miles of travel, the lowest rate recorded in the past 12 years. (See table 6-6 and figure 6-2.) The improvement in highway safety can be attributed to a number of factors, including safer highways, increased use of safety belts, increased market penetration of air bags and other safety equipment, and aggressive anti-drunk driving programs.[2]

Traffic Fatalities by Vehicle Type. Fatality rates for every type of highway vehicle continue to show a downward trend. (See figure 6-3 and table 6-7.) Although motorcycle fatalities account for only 6.1 percent of total traffic fatalities in 1992, the motorcycle is by far the most hazardous mode of highway transportation when taking into account accident exposure. Passenger cars and trucks have similar fatality rates. However, different sizes of trucks experience considerably different traffic fatality rates. The fatality rate for occupants in light trucks is almost three times the fatality rate for occupants

TABLE 6–5

Injury by Person Type
(In Thousands)

Person Type	Injury Severity Minor or Moderate Number	Percent	Severe or Fatal Number	Percent	Total	Percent
Driver	1,832	86%	309	14%	2,141	100%
Passenger	882	85%	151	15%	1,033	100%
Pedestrian	78	72%	31	28%	109	100%
Pedalcyclist	65	84%	12	16%	77	100%
Other*	8	89%	1	11%	9	100%
Total	2,864	85%	504	15%	3,368	100%

* Occupant of nonmotor vehicle transport device or motor vehicle not in transport.

TABLE 6–6

Trends in Fatality Rates by Transportation Mode: 1981-1992

Year	U.S. Air Carrier (per million miles flown)	General Aviation (per 100,000 hours flown)	Motor Vehicle (per 100 million vehicle-miles)	Railroad (per 100,000 train miles)	Recreational Boating (per 100,000 boats)
1981	0.001	3.48	3.2	0.82	8.0
1982	0.080	4.01	2.8	0.89	7.6
1983	0.005	3.72	2.6	0.89	7.9
1984	0.001	3.58	2.6	1.01	6.5
1985	0.054	3.37	2.5	0.80	6.7
1986	0.001	3.56	2.5	0.84	6.2
1987	0.053	3.11	2.4	0.93	5.9
1988	0.063	2.91	2.3	0.84	5.1
1989	0.028	2.75	2.2	0.84	4.7
1990	0.008	2.67	2.1	0.98	4.4
1991	0.010	2.74	1.9	1.02	4.6
1992	0.007	2.98	1.8	0.99	4.0

TABLE 6–7

Motor Vehicle Fatalities by Major Vehicle Type: 1981-1992

Year	Passenger Cars		Trucks		Motorcycles		Pedalcyclists	Total Non-Occupant
	Deaths	Death Rate*	Deaths	Death Rate*	Deaths	Death Rate*	Deaths	Deaths
1981	26,645	2.4	7,343	1.8	4,906	45.9	936	8,877
1982	23,330	2.0	7,303	1.8	4,453	44.9	883	8,299
1983	22,891	1.9	7,184	1.6	4,265	48.7	839	7,746
1984	23,621	1.9	7,570	1.6	4,608	52.5	849	7,973
1985	23,214	1.8	7,666	1.5	4,564	50.2	890	7,782
1986	24,944	1.9	8,243	1.6	4,566	48.6	941	7,853
1987	25,132	1.9	8,910	1.6	4,036	41.0	948	7,825
1988	25,808	1.8	9,217	1.6	3,662	36.5	911	7,917
1989	25,046	1.7	9,402	1.6	3,143	30.1	832	7,495
1990	24,092	1.6	9,306	1.5	3,244	33.9	859	7,465
1991	22,385	1.4	9,052	1.5	2,806	30.6	843	6,768
1992	21,366	1.3	8,666	1.4	2,394	25.1	722	6,366

** Per 100 million vehicle miles of travel.*

FIGURE 6–2

Trends in Motor Vehicle Statistics and Fatality Rate: 1981-1992

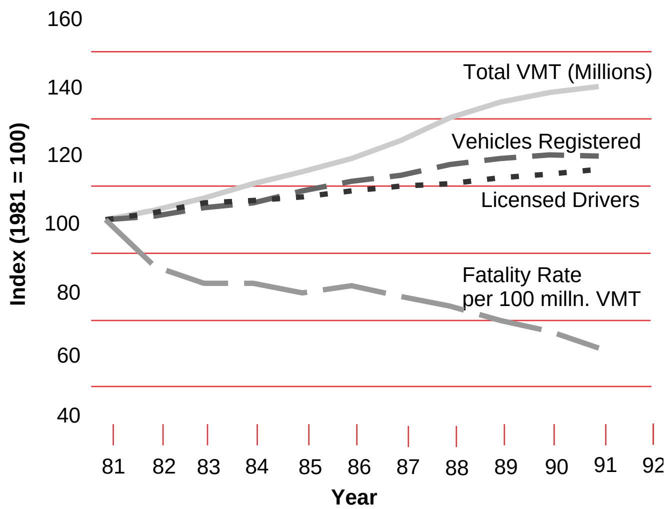
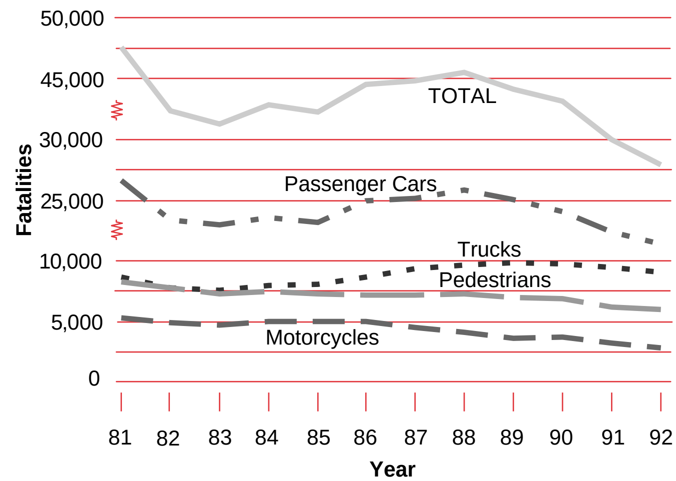


FIGURE 6–3

Highway Fatalities of Different Vehicle Types and Pedestrians: 1981-1992



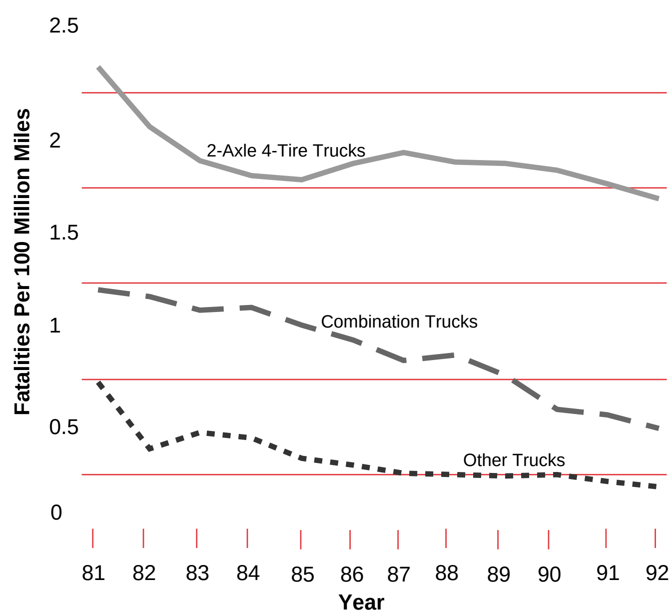
in heavy trucks, 1.77 vs. 0.56 per 100 million vehicle miles of travel in 1992, respectively.[3] (See figure 6-4.)

Motor-Vehicle Crashes. The number of motor vehicle crashes decreased by 6 percent from 1988 to 1990. About two-thirds of all motor vehicle crashes resulted in only property damage, and 6 percent resulted in serious or fatal injury. Although the number of property-damage-only crashes and the number of crashes resulting in serious or fatal injury both decreased by 8 percent from 1988 to 1990, the number of crashes resulting in minor or moderate injury remained the same. In 1990, multi-vehicle crashes outnumbered single-vehicle crashes by two to one. The proportion of single-vehicle crashes resulting in severe or fatal injury (9 percent) was almost twice that for multi-vehicle crashes resulting in similar injury (5 percent).

Risk Factors Contributing to Motor-Vehicle Crashes. Drinking and driving, failure to use safety belts, and vehicle condition contribute to motor vehicle crashes. Alcohol was reported by police as being present in 7 percent of the crashes in 1990. The percentage of police-reported alcohol involvement was greatest for crashes resulting in severe or fatal injury (20 percent.) The alcohol involvement rate for severe or fatal injury crashes was four times that for property-damage-only crashes. The rate of police-reported alcohol involvement was lowest for crashes

FIGURE 6–4

Fatality Rates By Truck Type: 1981-1992



involving medium and heavy truck drivers and bus drivers. The rate was the highest for motorcycle drivers.

When involved in crashes, drivers not using restraints were one and a half times more likely to be severely or fatally injured than those using restraints. This ratio was two and a half times for passengers. (See table 6-8.)

In a study conducted by the National

Transportation Safety Board, deficient brakes were cited in 5 percent of the fatal accidents involving heavy single-unit trucks, and in 3 percent of the fatal accidents involving combination trucks in 1990. (See table 6-9.)

Accidents on Different Highway Systems. Although fewer fatal accidents occurred on urban highway systems than on rural highways, nonfatal accidents occurred on urban highways two and one-half times more often than they did on rural highways. (See table 6-10.) After controlling for the variation in accident exposure among highway types, the likelihood of involvement in a *fatal* accident on rural highway systems is greater than that on urban highway systems. On the other hand, the likelihood of

TABLE 6–8

Motor Vehicle Vehicle Crashes by Severity: 1990
(Numbers in Thousands)

	Property Damage		Minor or Moderate Injury		Severe or Fatal Injury		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Crash Type								
Single Vehicle	1,235	29	631	35	176	46	2,043	32
Multiple Vehicle	3,020	71	1,194	65	205	54	4,419	68
TOTAL	4,255	100	1,825	100	382	100	6,462	100
Alcohol Involvement								
Yes	220	5	173	9	77	20	469	7
No	4,036	95	1,652	91	305	80	5,993	93
TOTAL	4,255	100	1,825	100	382	100	6,462	100
Drivers Restraint Usage								
Yes	5,812	64	1,142	62	130	42	7,084	63
No	1,312	14	382	21	145	47	1,840	16
Unknown	1,988	22	307	17	34	11	2,330	21
TOTAL	9,112	100	1,832	100	309	100	11,253	100
Passenger Restraint Usage								
Yes	n/a	n/a	480	54	49	32	528	51
No	n/a	n/a	304	35	89	59	393	38
Unknown	n/a	n/a	98	11	13	9	111	11
TOTAL	n/a	n/a	882	100	151	100	1,033	100

TABLE 6–9

Fatal Truck Accidents Involving Deficient Brakes: 1988-1990

	1988	1989	1990	Total
Fatal Accidents Involving Medium/Heavy Single-Unit Trucks	1,104	1,056	973	3,043
Deficient Brakes Cited	34 (3.4%)	44 (4.2%)	50 (5.1%)	128 (4.2%)
Fatal Accidents Involving Combination Trucks	3,798	3,467	3,207	10,472
Deficient Brakes Cited	111 (2.9%)	102 (2.9%)	88 (2.7%)	301 (2.9%)

TABLE 6–10

Motor Vehicle Injury Accidents by Highway System: 1992

Highway Categories	Fatal Number	Fatal Rate	Nonfatal Number	Nonfatal Rate
Rural				
Interstate	2,076	1.01	41,758	20.37
Other Principal Arterial	3,452	1.76	83,599	42.62
Minor Arterial	3,760	2.56	108,069	73.66
Major Collector	5,400	2.93	166,276	90.21
Minor Collector	1,437	2.88	55,885	111.89
Local	3,601	3.64	174,406	176.19
Subtotal-Rural	19,726	2.24	629,993	71.50
Urban				
Interstate	1,670	0.55	118,050	39.08
Other Freeways & Expressways	1,039	1.75	88,374	64.06
Other Principal Arterial	5,246	1.52	488,228	141.85
Minor Arterial	2,895	1.11	366,879	140.83
Collector	1,023	0.88	141,143	122.06
Local	3,329	1.68	383,578	193.38
Subtotal-Urban	15,202	1.12	1,586,252	116.74
TOTAL	34,928	1.56	2,216,245	98.95

involvement in a *non-fatal* accident on rural highway systems is lower than that on urban highway systems.

Within areas of similar land use patterns, highways built to higher standards are generally safer than other types of highways. For example, the Interstate System, with its full access control, wide lanes, full shoulders, and other better geometric design standards, was by far the safest highway system. Rural local roads, on the other hand, with poorer geometric design, absence of shoulders and generally poorer emergency response time, had the highest fatality rates.

Air

Fatal Accidents. Analyzing accident trends in aviation is difficult, because not all aviation sectors carry passengers for revenue. Therefore, fatality rates, instead of the number of fatalities, are more meaningful measures of safety performance, and miles or hours flown are better measures of exposure than passenger-miles flown. A comparison of fatality rates for all four aviation components (air carrier, general aviation, air taxi, and commuter air carrier) shows that all aviation components show downward trends in fatality rates except for general aviation. (See figure 6-5.) Air carrier continued to be the safest aviation component.

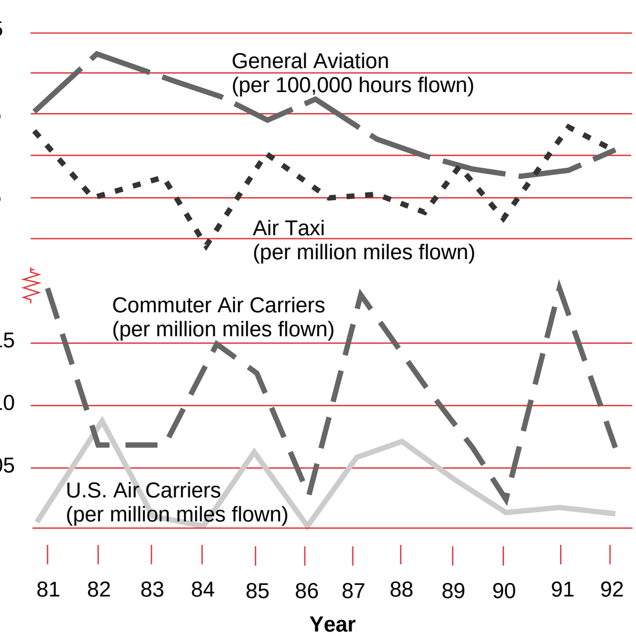
Contributing Factors for Accidents. Specific safety hazards in aviation include lack of experience, insufficient training, inadequate maintenance, aging aircraft, and traffic control operational errors. Human errors (not aboard aircraft) and pilot errors were cited most frequently as the general causes of accidents for scheduled air carriers. (See table 6-11.) Pilot error was cited in all five scheduled air carrier fatal accidents in 1989 as the general cause of the accident. Weather and runway conditions also contributed to a considerable number of air carrier accidents.

For nonscheduled air carriers and general aviation, pilot error, runway conditions, and weather conditions were the most cited causes of accidents. (See tables 6-12 and 6-13.)

Near-Midair Collisions. The number of near-midair collisions has been on a continuing downward trend since 1987. In

FIGURE 6–5

Air Fatality Rates: 1981-1992



fact, the number of near-midair collisions in 1992 was less than one-third that in 1987. (See table 6-14.) More than half of the near collisions were characterized as potentially hazardous, meaning that an incident would probably have resulted in a collision if pilots had taken no action. Typically, cases with a closest proximity of less than 500 feet would be classified as potentially hazardous.

Terrorism. Terrorism is the single most feared threat against the transportation system. Historical data show that terrorism and hijacking of aircraft typically occur enroute to or from foreign countries, rather than within the continental United States.

Despite a still significant number of bomb threats against U.S. aircraft and airports, the situation has improved in 1992, with 218 bomb threats against U.S. aircraft and 233 threats against U.S. airports. (See table 6-15.) Both figures are down from the highs in 1989 (479 threats) and 1991 (498 threats). The numbers of hijackings of American and foreign aircraft have also decreased.

In the past decade, four U.S. air-carrier sabotages took place, the most recent case occurring in 1988. The 1988 case of the bombing of a Pan American flight over Lockerbie, Scotland, killed 270 people. (See table 6-16.)

Airport Security. There is also a downward trend in the number of firearms discovered via passenger screenings. (See table 6-17.) In 1987, an average of 1.44 persons was arrested for carrying firearms and/or explosives for every one million persons screened. This rate improved to less than one arrest for every one million persons screened in 1991.

Waterborne. Waterborne transportation includes recreational boating, commercial freight, passenger-for-hire, and the fishing industries. As mentioned previously, recreational boating is the second most hazardous mode of transportation,

TABLE 6–11

Broad Cause/Factor Assignments in All Accidents for Scheduled U.S. Air Carriers: 1989 and 1984-1988*

Broad Cause/Factor	All Accidents 1989 Number	All Accidents 1989 Percent	All Accidents 1984-1988 Mean	All Accidents 1984-1988 Percent	Fatal Accidents 1989 Number	Fatal Accidents 1989 Percent	Fatal Accidents 1984-1988 Mean	Fatal Accidents 1984-1988 Percent
Pilot	12	63.2	16.8	76.4	5	100.0	4.4	78.6
Other Person (Not Aboard)	13	68.4	8.0	36.4	2	40.0	2.8	50.0
Weather	8	42.1	5.8	26.4	5	100.0	1.8	32.1
Terrain Runway Condition	6	31.6	5.2	23.6	4	80.0	1.2	21.4
Propulsion System and Controls	0	5.3	4.8	21.8	0	0.0	1.4	25.0
Systems/Equipment/Instruments	1	10.5	4.2	19.1	0	0.0	1.4	25.0
Object (Tree, Wires, etc.)	2	31.6	3.0	13.6	0	0.0	0.6	10.7
Light Conditions	6	0.0	2.6	11.8	1	20.0	0.8	14.3
Landing Gear	0	5.3	2.4	10.9	0	0.0	0.0	0.0
Airframe	1	5.3	1.4	6.4	1	20.0	0.4	7.1
Airport/Airways Facilities, Aids	1	5.3	1.0	4.5	0	0.0	0.4	7.1
Flight Control System	1	5.3	0.6	2.7	1	20.0	0.6	10.7
Other Person (Aboard)	1	5.3	0.2	0.9	0	0.0	0.2	3.6
Total Aircraft	19		22.0		5		5.6	
NTSB Determined Probable Cause	19		21.6		5		5.4	

**Multiple Causes and factors for each accident.*

TABLE 6–12

Broad Cause/Factor Assignments in All Accidents for Nonscheduled U.S. Air Carriers: 1989 and 1984-1988*

Broad Cause/Factor	All Accidents 1989 Number	All Accidents 1989 Percent	All Accidents 1984-1988 Mean	All Accidents 1984-1988 Percent	Fatal Accidents 1989 Number	Fatal Accidents 1989 Percent	Fatal Accidents 1984-1988 Mean	Fatal Accidents 1984-1988 Percent
Pilot	77	68.8	96.0	77.0	17	68.0	25.4	85.8
Other Person (Not Aboard)	22	19.6	21.4	17.2	6	24.0	7.8	26.4
Weather	42	37.5	37.2	29.9	8	32.0	13.2	44.6
Propulsion System and Controls	19	17.0	8.4	2.8	5	20.0	4.4	14.9
Systems/Equipment/Instruments	8	7.1	10.2	8.2	1	4.0	3.2	10.8
Object (Tree, Wires, etc.)	19	17.0	19.4	15.6	4	16.0	5.4	18.2
Light Conditions	15	13.4	21.2	17.0	4	16.0	8.6	29.1
Landing Gear	3	2.7	12.0	9.6	0	0.0	0.4	1.4
Airframe	5	4.5	6.0	4.8	2	8.0	1.8	6.1
Airport/Airways Facilities, Aids	1	0.9	2.2	1.8	0	0.0	0.4	1.4
Flight Control System	5	4.5	2.6	2.1	2	8.0	1.4	4.7
Other Person (Aboard)	0	0.0	0.2	0.2	0	0.0	0.0	0.0
Total Aircraft	112		124.6		25		29.6	
NTSB Determined Probable Cause	108		123.6		25		29.6	

**Multiple Causes and factors for each accident.*

TABLE 6–13

Broad Cause/Factor Assignments in All Accidents for General Aviation: 1989 and 1984-1988*

Broad Cause/Factor	All Accidents 1989 Number	All Accidents 1989 Percent	All Accidents 1984-1988 Mean	All Accidents 1984-1988 Percent	Fatal Accidents 1989 Number	Fatal Accidents 1989 Percent	Fatal Accidents 1984-1988 Mean	Fatal Accidents 1984-1988 Percent
Pilot	1832	81.7	2263.4	85.0	394	90.4	447.2	91.0
Other Person (Not Aboard)	214	9.5	236.0	8.9	57	13.1	49.4	10.0
Weather	612	27.3	668.8	25.1	146	33.5	177.8	36.2
Terrain Runway Condition	611	27.3	740.8	27.8	74	17.0	92.0	18.7
Propulsion System and Controls	542	24.2	598.0	22.4	51	11.7	62.2	12.7
Systems/Equipment/Instruments	100	4.5	127.8	4.8	20	4.6	22.4	4.6
Object (Tree, Wires, etc.)	418	18.6	486.8	18.3	63	14.4	83.4	17.0
Light Conditions	173	7.7	199.6	7.5	61	14.0	86.0	17.5
Landing Gear	78	3.5	145.0	5.4	0	0.0	2.2	0.4
Airframe	36	1.6	62.0	2.3	17	3.9	23.8	4.8
Airport/Airways Facilities, Aids	23	1.0	27.8	1.0	4	0.9	5.4	11
Flight Control System	30	1.3	45.0	1.7	10	2.3	13.6	2.8
Other Person (Aboard)	16	0.7	16.8	0.6	2	0.5	4.8	1.0
TOTAL AIRCRAFT	2,242		2,664.2		436		491.6	

**Multiple Causes and factors for each accident.*

TABLE 6–14

Reported Near Midair Collisions by Degree of Hazard: 1979-1992

Classification	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Critical	127	118	84	56	98	127	180	162	190	110	93	74	85	38
Potential	311	319	232	191	283	317	423	473	605	442	322	266	197	177
No Hazard	99	122	76	64	84	115	133	198	263	158	135	114	99	61
Unclassified	3	9	3	0	10	30	22	7	0	0	0	0	0	0
Open	0	0	0	0	0	0	0	0	0	0	0	0	0	53
TOTAL	540	568	395	311	475	589	758	840	1,258	710	550	454	348	329

Critical: A situation where collision avoidance was due to chance rather than an act on the part of the pilot. Less than 100 feet of aircraft separation would be considered critical.
Potential: An incident which would probably have resulted in a collision if no action had been taken by either pilot. Closest proximity of less than 500 feet would usually be required.
No Hazard: When direction and altitude would have made a midair collision improbable regardless of evasive action taken.
Open: Incidents that are still under investigation.

TABLE 6–15

Air Bomb Threats and Hijackings: 1981-1992

Year	Bomb Threats Against U.S. Airports	Bomb Threats Against U.S. Aircraft	Hijackings United States	Hijackings Foreign
1981	1,084	400	7	22
1982	887	203	9	12
1983	442	188	18	15
1984	437	139	5	20
1985	477	153	4	22
1986	617	376	4	9
1987	401	238	4	13
1988	372	256	2	13
1989	479	487	2	14
1990	338	448	4	39
1991	388	498	1	23
1992	233	218	0	14

TABLE 6–16

U.S. Carrier Suicide/Sabotage Cases: 1982-1991

Date	Location	Operator	Total Fatalities	Fatalities Aboard
8/11/82	Honolulu, HI	Pan American	1	1
4/2/86	Near Athens, Greece	Trans World	4	4
12/7/87	San Louis Obispo, CA	Pacific Southwest	43	43
12/21/88	Lockerbie, Scotland	Pan American	270	259

accounting for 816, or 1.9 percent, of the total fatalities in 1992. Like motor vehicles, the boating fatality rate has been decreasing in recent years, from 8.0 per 100,000 boats in 1981 to 4.0 in 1992, despite an increase in the number of boats. (See figure 6-6.)

Rail. Rail is a relatively safe transportation mode, accounting for about 1.4 percent of the total transportation fatalities (592 in 1992). Railroad fatalities include those resulting from train accidents, train incidents, and non-train incidents. Railroad accident rates show a continuing downward trend over the past 12 years, from 8.6 per million train miles in 1981 to 3.9 in 1992. (See figure 6-7.) More than half of all train accidents are caused by mechanical and electrical failures or track defects, while 30 percent are attributable to human factors.

Safety Regulations and Market Penetration of Safety Equipment

As of 1992, all 50 states and the District of Columbia had set the legal drinking age at 21 and had enacted child safety seat laws. (See table 6-18.) Mandatory seat belt use laws are in effect in 42 states and the

TABLE 6–17

Airline Passenger Screening Results: 1972-1991

Year	Persons Screened (Millions)	Weapons Detected: Firearms	Handguns	Long Guns	Other	Explosive/ Incendiary Devices	Persons Arrested: Carrying Firearms/ Explosives	Giving False Information
1972	n/a	1,313	n/a	n/a	n/a	n/a	774	244
1973	202	2,162	n/a	n/a	n/a	n/a	736	658
1974	201	2,450	n/a	n/a	n/a	n/a	1,147	1,465
1975	97	2,343	n/a	n/a	n/a	n/a	1,364	27
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1978	580	2,058	1,827	67	164	3	896	64
1979	593	2,151	1,962	55	144	3	1,060	47
1980	585	2,022	1,878	36	108	8	1,031	32
1981	599	2,255	2,124	44	87	11	1,187	49
1982	630	2,676	2,559	57	60	1	1,314	27
1983	709	2,784	2,634	67	83	4	1,282	34
1984	776	2,957	2,766	98	91	6	1,285	27
1985	993	2,987	2,823	90	74	12	1,310	42
1986	1055	3,241	2,981	146	114	11	1,415	89
1987	1096	3,252	3,012	99	141	14	1,581	81
1988	1055	2,773	2,591	74	108	11	1,493	222
1989	1113	2,879	2,397	92	390	26	1,436	83
1990	1145	2,853	2,490	59	304	15	1,337	16
1991	1015	1,919	1,597	47	275	94	893	28

TABLE 6–18

Summary on 1992 State Legislation

	Number of States* Having Legislation: Yes	No
Alcohol Legislation		
Drinking Age of 21	51	0
Open Container	27	24
Blood Limit Alcohol Concentration		
0.10%	46	0
0.08%	5	0
Mandatory Belt Use Law	43	8
Child Safety Seat Law	51	0
Motorcycle Helmet Law	48	3
65 Speed Limit	42	9

*Includes District of Columbia

TABLE 6–19

Percent of Factory Installations of Anti-Lock Braking Systems and Driver Air Bags: 1985-1992 Model Years

	Automobiles		Light Trucks	
1985	0.6%	0.0%	0.0%	0.0%
1986	1.7%	0.0%	0.0%	0.0%
1987	4.5%	0.0%	15.5%	0.0%
1988	5.1%	0.0%	27.9%	0.0%
1989	11.1%	0.0%	66.2%	0.0%
1990	11.1%	28.2%	71.4%	0.0%
1991	17.1%	36.0%	77.8%	0.0%
1992	32.2%	48.9%	50.1%	17.6%

FIGURE 6–6

Recreational Boating Fatality Rate: 1981-1992

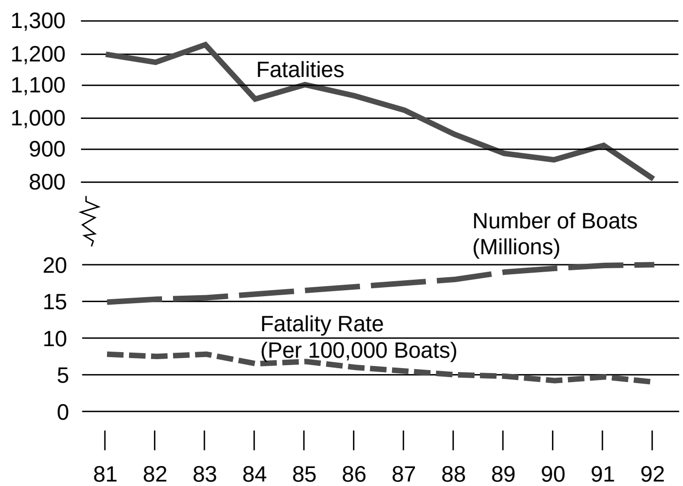
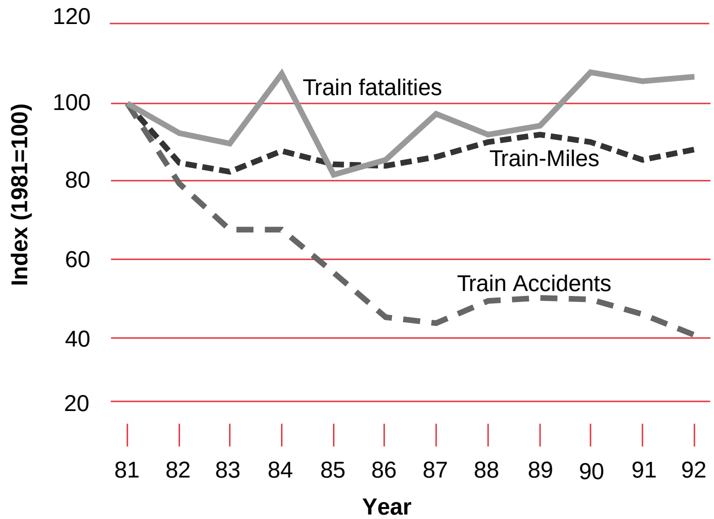


FIGURE 6–7

Rail Statistics: 1981-1992



Rail Fatality Rate: 1981-1992

District of Columbia, and the 65 mph speed limit is allowed on certain portions of rural Interstate in 42 states.

The consumer's interest in motor vehicle safety is reflected in a growing demand for optional and sometimes costly safety equipment. Almost one-third of all 1992 automobiles have anti-lock braking systems installed (up from 0.6 percent in 1985), about half of them have driver-side air bags. The market penetration of anti-lock braking systems is greater in light trucks than in automobiles. (See table 6-19.) Driver-side air bags have been installed in light trucks only since 1992. The purchase price increments for adding safety and emissions' equipment decreased by 46 percent from 1981 to 1991. (See table 6-20.)

International Comparison of Transportation Fatalities

The United States has a far greater number of transportation fatalities when compared to many other countries. (See table 6-21.) However, after taking into account accident exposure (in this case, distance driven), our transportation system is one of the safest in the world. In 1989, the United States, Sweden, and the United Kingdom had the lowest fatality rate of 24 countries investigated with just two per 100 million vehicle miles of travel, while many other countries had a fatality rate of five or more.

Transportation and Safety: What More We Need to Know

Transportation safety data needs for all modes tend to fall in three broad areas: (1) the need for more uniform reporting of accident statistics throughout the nation; (2) the need for better information about environmental conditions (weather, lighting, road conditions) and other potentially contributory factors; and (3) the need for more accurate and detailed measures of exposure.

Comparability of accident statistics

TABLE 6–20

New Car Price Comparisons with Safety and Emissions Equipment: 1981-1991 (Estimated New Car Price for a 1967 "Comparable Car")

Year	With Added Safety & Emissions Equipment	Without Added Added Safety & Emissions Equipment	Price Difference for Added Safety & Emissions Equipment
1981	$11,152	$8,224	$2,928
1982	10,581	7,938	2,643
1983	10,248	7,825	2,423
1984	9,995	7,668	2,327
1985	9,743	7,518	2,225
1986	9,395	7,259	2,136
1987	8,984	6,958	2,026
1988	8,685	6,742	1,943
1989	8,387	6,544	1,843
1990	8,078	6,350	1,728
1991	7,700	6,115	1,585
1990	8,078	6,350	1,728

across different data systems is hampered by inconsistent definitions. For example, states use a variety of criteria for determining when police are required to report a crash. Most states use the cost of damage done with thresholds ranging from $50 to $500.

When analyzing accident statistics, it is almost always essential to have some measure of the degree of exposure of persons or vehicle types. Although exposure can be defined in many ways, it generally refers to the amount of use of the type of transportation in question. Perhaps the two most basic measures of exposures are vehicle (or person) miles of travel and person (or vehicle) hours of travel. In general, data on miles or hours of travel, when broken down by vehicle type and other dimensions such as time of day and highway type, are simply not accurate enough to be used in rigorous statistical analyses of accident statistics.[4] This lack of accurate exposure measures hinders progress in understanding the factors influencing transportation accidents.

Sources

Figures

Figures 6-1 through 6-7: Oak Ridge National Laboratory, Oak Ridge, TN.

Tables

Table 6-1: Death of all causes - *Accident Facts: 1993 Edition*, National Safety Council, 1993; Transportation related deaths - *National Transportation Statistics 1993*, John A. Volpe National Transportation Systems Center.

Tables 6-2 through 6-4: *National Transportation Statistics 1993*.

Table 6-5: National Highway Traffic Safety Administration General Estimates System 1990.

Table 6-6: *National Transportation Statistics 1993*.

Table 6-7: Deaths - Fatal Accident Reporting System data published in *National Transportation Statistics*; VMT-*Highway Statistics*, Federal Highway Administration.

Table 6-8: *General Estimates System*, 1990. National Highway Traffic Safety Administration.

Table 6-9: *A Safety Study on Heavy Vehicle Air Brake Performance*, National Transportation Safety Board, April 1992.

Table 6-10: *Highway Statistics, 1991*.

Table 6-11 through 6-13: *Annual Review of Aircraft Accident Data*, U.S. General Aviation, Calendar Year 1989, National Transportation Safety Board.

Table 6-14: *FAA Safety Statistical Handbook*, Feb 1993, reprinted in National Transportation Statistics.

Table 6-15: *National Transportation Statistics, 1993*.

Tables 6-16 and 6-17: *FAA Statistical Handbook on Aviation*, Calendar Year 1991, Federal Aviation Administration

Table 6-18: *Accident Facts: 1993 Edition*, National Safety Council, 1993. Note three states have different legal limits for minors. The age requirement below which riders are required to wear helmets varies by state.

Table 6-19: *Ward's Automotive Yearbook 1993*, and annual *Ward's Communication, 1993*.

Table 6-20: *Facts and Figures '92*, American Automobile Manufacturers Association, 1992.

Table 6-21: *Indicators for the Integration of Environmental Concerns into Transport Policies*, Organization of Economic Co-Operation and Development, 1993.

TABLE 6–21

Road Transportation Fatalities: 1975-1989

	Number of Fatalities				Index 1975=100				Fatalities per 100 Million Miles			
Country	**1975**	**1980**	**1985**	**1989**	**1975**	**1980**	**1985**	**1989**	**1975**	**1980**	**1985**	**1989**
Canada	6,061	n/a	4,365	4,071	100	n/a	72	67	6	n/a	4	3
United States	**45,500**	**51,077**	**43,795**	**45,555**	**100**	**112**	**96**	**100**	**4**	**3**	**2**	**2**
Japan	10,792	8,760	8,261	11,086	100	81	86	103	6	4	3	3
Australia	3,674	3,272	2,937	n/a	100	89	80	n/a	6	5	3	n/a
New Zealand	628	596	747	n/a	100	95	119	n/a	6	6	6	n/a
Austria	2,203	1,742	1,361	1,400	100	79	62	64	12	8	6	4
Belgium	2,346	2,396	1,801	1,993	100	102	77	85	10	8	6	6
Denmark	827	690	772	695	100	83	93	84	5	4	4	3
Finland	910	551	541	734	100	61	59	81	6	3	3	3
France	13,170	12,543	10,448	10,527	100	95	79	80	9	7	5	5
West Germany	14,824	13,041	8,400	7,995	100	88	57	54	9	6	4	3
Greece	1,323	1,519	1,829	1,511	100	115	138	114	16	12	10	7
Iceland	33	25	24	28	100	76	73	85	5	3	3	3
Ireland	586	564	410	460	100	96	70	78	8	5	4	3
Italy	9,511	8,537	7,042	6,939	100	90	74	73	8	6	4	4
Luxembourg	115	95	79	58	100	83	69	50	11	7	5	3
Netherlands	2,321	1,997	1,438	1,456	100	86	62	63	7	5	3	3
Norway	589	362	402	381	100	61	68	65	6	4	3	3
Portugal	2,728	2,328	1,875	2,374	100	85	69	87	28	18	11	12
Spain	4,487	5,116	4,883	7,188	100	114	109	160	13	11	10	12
Sweden	1,172	848	686	770	100	72	59	66	5	3	2	2
Switzerland	1,243	1,268	908	924	100	102	73	74	7	5	3	3
Turkey	5,125	n/a	5,680	6,332	100	n/a	111	124	62	n/a	48	38
United Kingdom	6,366	5,953	5,209	5,052	100	94	82	79	5	4	3	2

Endnotes

1. National Safety Council, *Accident Facts, 1992 Edition*. Illinois.
2. U.S. Department of Transportation, *National Transportation Strategic Planning Study*. March 1990. Washington, D.C.
3. National Highway Traffic Safety Administration, *General Estimates System, 1990*. DOT HS 807 781. U.S. Department of Transportation, Washington DC. November 1991.
4. This is most true of privately operated transportation modes, such as highway, recreational boating, etc. It is much less an issue for commercial air travel and rail passenger travel, for example.

TRANSPORTATION, ENERGY, *and the* ENVIRONMENT

As essential as it is to the functioning of our society, transportation also generates significant unintended and undesirable impacts. In large part, these unwanted side effects are produced by the combustion of fossil energy in transportation vehicles. But other impacts arise because of requirements for land for transportation networks and facilities, because of the generation of vehicle noise, and because we expect the transportation system to move the wastes and hazardous materials our society produces. In this chapter we examine the state of the transportation system with respect to its effects on national energy security and the environment. Although the chapter treats energy first and then environmental issues, the two are closely linked by their relation to the use of fossil fuels.

Energy

The problems created by current patterns of energy use are multidimensional, they include: (1) political, strategic, and national security issues stemming from dependence on imported petroleum; (2) economic costs caused by price shocks and monopoly influence on the world oil market; (3) the build-up of greenhouse gases in the atmosphere due to combustion of fossil fuels; and (4) pollution of the air, surface, water, and ground water by motor fuel combustion and spills. Following the first oil price shock in October 1973, the transportation sector made tremendous improvements in energy efficiency in almost every mode, passenger and freight. As a result, total transportation energy use, which had been growing at an average rate of more than 3.5 percent per year since 1950, increased by only 0.5 percent per year until the oil price collapse of 1986. The energy efficiency improvements that held the growth of energy use in check for a decade and a half have slowed to a crawl, stopped, and in some cases been reversed. Statistics for highway travel which accounts for almost three-fourths of transportation energy use, show a slight *decline* in overall vehicle miles per gallon.[1] Although new cars and light trucks continue to meet the federal fuel economy standards, the fuel economy of light duty vehicles has not improved significantly since 1982.[2]

Although other sectors of the economy reduced their dependence on petroleum during the 1970s and 1980s, transportation remains nearly totally dependent on oil. Residential and commercial oil use fell from 18 percent in 1973 to 7 percent in 1992, oil's share of industrial energy use declined slightly from 29 percent to 27 percent over the same period, and petroleum as a share of electric utility energy use dropped from 17 percent in 1973 to only 3 percent in 1992. In 1973 petroleum supplied 96 percent of total transportation energy use; in 1992 it accounted for 97 percent.[3] Despite price shocks and other stimuli, petroleum remains the dominant transportation energy source.

On September 29, 1993, the President and the Vice President joined with Ford, Chrysler, and General Motors to announce a partnership to develop cars of the future that might ultimately be three times as energy efficient as the cars of today. It also called for the development of near-term technologies to improve efficiency, safety, and emissions. The program's objective is to achieve major technological breakthroughs that will make traditional regulatory interventions irrelevant. Since 1989, major legislative initiatives have been enacted to create an impetus for alternative fuel use in transportation. The Alternative Motor Fuels Act of 1989 and the 1992 Energy Policy Act provide both incentives and fleet mandates for alternative fuel vehicle purchase and use. The 1990 Clean Air Act Amendments set forth clean fuels requirements for nonattainment areas, and allow states to opt in to the California Clean Fuels Vehicle Program, a program that requires 10 percent of car sales to be Zero Emission Vehicles by 2003 (battery powered electrics are the only vehicles that currently qualify). Although these laws are aimed at least as much at emissions and greenhouse gas reduction as they are at substituting for petroleum fuels, they could have far-reaching effects on transportation energy sources and technology.

In the meantime, increased vehicle travel is likely to mean increased petroleum use, oil dependence, and greenhouse gas emissions. The President's Climate Change Action Plan noted that transportation produced 32 percent of U.S. greenhouse gas emissions. It identified transportation as the fastest growing source of carbon dioxide (CO_2) emissions through 2000 and addressed the need to curb growth of emissions by slowing travel demand growth and enhancing the market for more efficient vehicles and cleaner fuels.[4] Continued growth of vehicle miles traveled (VMT) also poses problems for environmental quality goals.

Energy Security

More than one-fourth of all energy consumption in the United States is attributable to the transportation sector, which is almost totally dependent on petroleum fuels. (See table 7-1.) With a slight decrease in total U.S. petroleum use in recent years, transportation's share of petroleum use shows an upward trend, accounting for 65 percent of all U.S. petroleum use in 1991. (See table 7-2.)

If the transportation sector is an energy problem, it is not one of exhausting world energy reserves. Rather, it is a problem of dependence on imported petroleum. In the last decade, imported crude oil and petroleum products continued to account for a larger share of total U.S. petroleum use, rising from 33.2 percent in 1983 to 46.1 percent in 1992. (See table 7-3 and figure 7-1.) Not since 1976 has domestic crude oil production exceeded transportation petroleum use. Even if all other sectors ceased to use petroleum, substantial imports of petroleum would be necessary to satisfy transportation's needs.

The ability of the sector to switch to alternative fuels in the event of a petroleum-supply disruption or price shock is very limited. Based on its 1989 report, the U.S. Department of Energy estimated that the transportation sector's short-term ability to substitute for petroleum ranges from 0.5 to 3 percent of the total fuel use.[5] By comparison, petroleum users in other sectors have greater potential for using petroleum substitutes; residential potential ranges from 10 to

TABLE 7–1

Consumption of Total Energy by End-User Sector: 1970-1992
(Quadrillion Btu)

Year	Transportation	Percentage Transportation of Total	Residential and Commercial	Industrial	Total
1970	16.07	24.2	21.71	28.65	66.43
1975	18.24	25.9	23.90	28.40	70.54
1980	19.70	25.9	25.65	30.61	75.96
1985	20.07	27.17	26.70	27.21	73.98
1990	25.54	27.7	28.79	29.93	81.26
1992	22.53	27.4	29.23	30.59	82.36
Average Annual Percentage Change					
1970-1992	1.5%		1.4%	0.3%	1.0%
1982-1992	1.7%		1.3%	1.6%	1.5%

TABLE 7–2

Consumption of Petroleum by End-User Sector: 1973-1992
(Quadrillion Btu)

Year	Transportation	Petroleum Transportation of Total	Industrial	Residential and Commercial	Electric Utilities	Total	Total in Millions of Barrels per Day
1975	17.61	53.8%	3.81	8.15	3.17	32.74	15.47
1980	19.01	55.6	3.04	9.53	2.63	34.21	16.16
1985	19.5	63.1	2.52	7.81	1.09	30.92	14.62
1990	21.81	65.0	2.17	8.32	1.25	33.55	15.85
1992	21.78	65.1	2.22	8.53	0.95	33.48	15.81
Average Annual Percentage Change							
1973-1992	0.9%		-3.1%	-0.3%	-5.8%	-0.2%	
1982-1992	1.7%		-1.0%	0.9%	-4.9%	1.0%	

TABLE 7–3

United States Petroleum Production and Consumption: 1970-1992
(Million Barrels per Day)

Year	Domestic Crude Oil Production	Gross Imports			U.S. Petroleum Consumption	Imports as a Percentage of U.S. Petroleum Consumption	Transportation Petroleum use as a Percentage of Domestic Production
		Crude Oil	Petroleum Products	Total			
1970	9.64	1.32	2.10	3.42	14.70	23.3	n/a
1975	8.37	4.10	1.95	6.05	16.32	37.1	99.4
1980	8.60	5.26	1.65	6.91	17.06	40.5	104.4
1985	8.97	3.20	1.87	5.07	15.73	32.2	102.6
1990	7.36	5.89	2.12	8.02	16.99	47.2	140.0

35 percent, commercial from 5 to 25 percent, and industrial from 5 to 10 percent.

Energy Use and Energy Efficiency

Highway. Highway energy use has increased at an annual rate of 1.6 percent over the past two decades. (See table 7-4.) Highway vehicles dominate transportation energy use. (See figure 7-2.) Light truck energy use has grown at a rate 24 times faster than the automobile rate because of the steadily increasing popularity of light trucks as passenger vehicles. In 1991, the highway mode accounted for 73 percent of the total transportation energy use, with automobiles accounting for 40 percent and trucks 33 percent.

Highway Passenger Modes. Transportation has become substantially more energy efficient in the past 20 years. Gains in energy efficiency for automobiles have outweighed the increases in travel and have slowed the growth in motor gasoline consumption. (See figures 7-3 and 7-4.) For 2-axle trucks, however, the energy efficiency gains were not sufficient to prevent fuel use gains due to increased numbers of trucks and increased truck travel. New car fuel efficiency has significantly increased, from an average of 17.2 miles per gallon (mpg) in 1976 to an estimated 27.6 mpg in 1992.[6] Light truck fuel economy also has increased from 15.6 mpg in 1976 to 20.4 mpg in 1992. A study published by the Oak Ridge National Laboratory stated that improvements in vehicle technology, such as front-wheel drive, fuel injection, advanced transmissions, better aerodynamics, and electronic engine control have permitted dramatic fuel economy improvements without sacrificing vehicle performance and roominess.[7]

Another indicator of energy efficiency is the energy intensity, typically measured in British thermal units (Btu's) per vehicle- or passenger-mile. Automobile and intercity bus both improved their energy intensities during the past 12

FIGURE 7–1

Transportation Use as a Percentage of U.S. Crude Oil Production

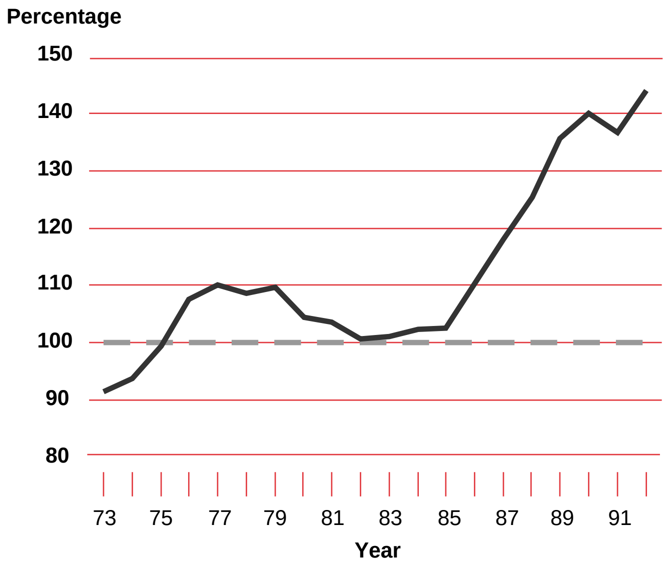


FIGURE 7–2

Distribution of Transportation Energy Use by Mode: 1991

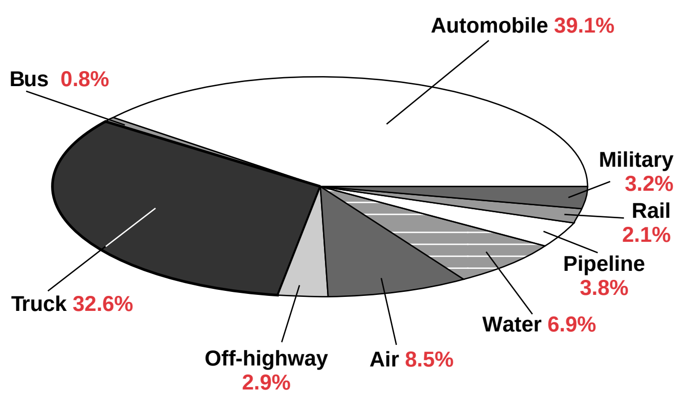


FIGURE 7–3

Automobiles

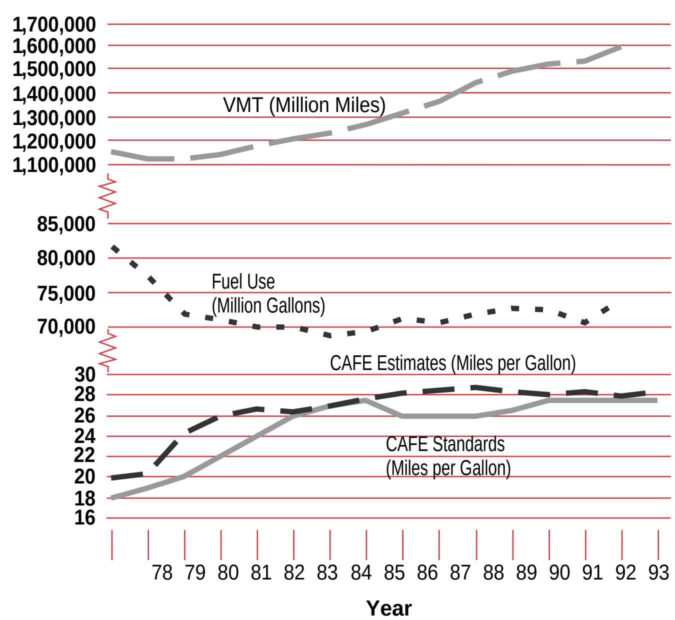


TABLE 7-4

Transportation Energy Consumption by Mode: 1970-1991
(Thousand Barrels per Day Crude Oil Equivalent)

Year	Autos	Motor-cycles	Buses	Light Trucks[1]	Other Trucks	Total Highway	Air	Water	Pipeline	Rail	Total Non-highway	Total Trans-portation[2]
1970	4,027	4	51	727	709	5,520	617	356	465	272	1,710	7,230
1975	4,540	7	56	1058	845	6,506	602	402	394	282	1,680	8,186
1980	4,269	12	66	1,394	1,145	6,886	722	792	420	305	2,239	9,125
1985	4,097	11	76	1,715	1,381	7,280	793	619	358	237	2,007	9,286
1990	4,282	11	77	1,963	1,600	7,934	973	702	438	239	2,353	10,287
1991	4,182	11	82	1,928	1,561	7,763	910	740	408	227	2,284	10,706
Average Annual Percentage Change												
1970-91	0.2%	5.2%	2.3%	4.8%	3.8%	1.6%	1.9%	3.6%	-0.6%	-0.9%	1.4%	1.9%
1982-91	0.0%	-0.9%	2.0%	3.6%	3.5%	1.5%	3.1%	2.2%	0.1%	-2.1%	1.6%	2.2%

[1] Light trucks include only 22-axle/4-tire trucks

[2] Total transportation figures do not include military and off-highway energy use and may not include all possible uses for fuel

years, with a 19 percent improvement for automobiles and a 8 percent improvement for intercity buses. (See figure 7-5.) However, an energy intensity increase of 28 percent on a per passenger-mile basis was observed in transit bus from 1981 to 1992. (See table 7-5.)

Highway Freight Modes. Ideally, an appropriate measure of energy intensity for freight modes would be on a per ton-mile basis. Due to data limitations, however, energy intensities for the light- and medium-truck categories are measured on a per vehicle-mile basis. (See figure 7-6.) On that basis, heavy single-unit trucks are twice as energy intensive as two-axle, four-tire trucks. Although the energy intensity for heavy single-unit trucks declined 4 percent from 1981 to 1991, it actually increased over the 1984-1989 period.

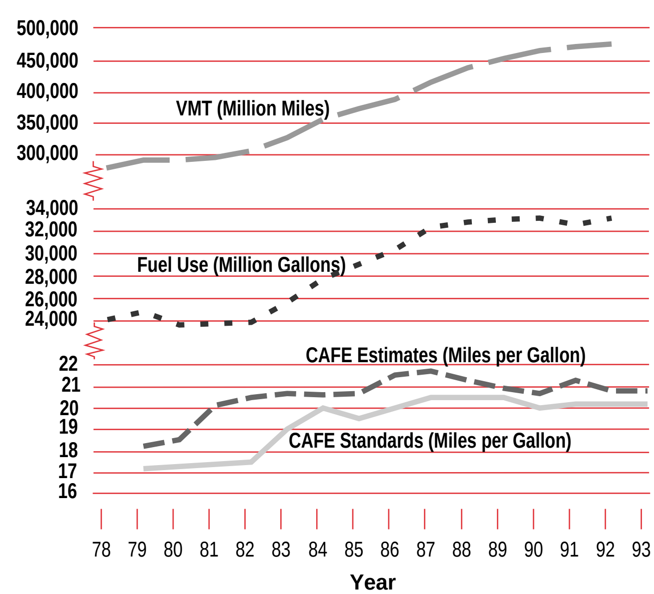
Energy intensity for combination trucks improved from 1981 to 1991, although it actually increased beyond the 1981 level between 1985 and 1987. On average, though, a combination truck required 3,100 Btu's to haul a one-ton cargo for one mile in 1991—8 percent less energy than required in 1981.

Nonhighway. Among nonhighway modes, air transport is the largest and fastest growing energy consumer, at 8 percent in 1991, followed by water (7 percent), pipelines (4 percent), and rail (2 percent).[8]

Nonhighway Passenger Modes. Certificated domestic air carriers reduced their energy intensity by 19 percent, from 5,733 Btu's per passenger-mile in 1981 to 4,647 in 1991. (See table 7-6.) The reduction in energy intensity was the result of increased load factors (from 50 percent in

FIGURE 7-4

Two-axle, Four-tire Trucks



1970 to 61 percent in 1991), and improvements in engine design, aerodynamics, and airline operating procedures.[2] Even more dramatic improvements in aviation energy efficiency can be achieved in the 21st century by advanced technologies; for instance, the current 55 to 70 seat miles per gallon (Smpg) could be improved to as much as 130 to 150 Smpg.[9]

On a per revenue passenger-mile (rpm) basis, intercity rail (Amtrak) energy intensity increased by 28 percent, from 1,716 Btu's per rpm in 1981 to 2,205 Btu's per rpm in 1992. Rail transit energy intensity

TABLE 7–5

Energy Intensity of Highway Modes

	Passenger Modes Btu's per Passenger-Mile			Freight Modes Btu's per Vehicle-Mile		
		Bus			Other	
Year	Passenger Car	Transit	Intercity	2-axle, 4-tire	Single Unit	Combination
1981	4,406	2,944	1,085	10,002	18,322.9	3,400.2
1982	4,267	3,164	1,062	9,741	18,290.6	3,361.7
1983	4,192	3,133	1,041	9,755	18,399.5	3,236.2
1984	4,077	3,243	1,082	9,777	18,189.4	3,301.3
1985	4,040	3,395	1,135	9,730	18,735.6	3,467.9
1986	4,072	3,546	1,083	9,729	18,779.5	3,443.4
1987	3,921	3,592	1,159	9,705	18,771.8	3,445.7
1988	3,836	3,696	1,181	9,350	18,657.7	3,388.6
1989	3,822	3,680	1,103	9,081	18,458.0	3,384.9
1990	3,671	3,722	994	8,904	18,019.2	3,292.4
1991	3,558	3,771	997	8,632	17,517.8	3,137.1

TABLE 7–6

Energy Intensity of Nonhighway Modes

	NonhighwayPassenger Modes Btu's per Passenger-Mile				Nonhighway Freight Mode Btu's per Ton-Mile		
			Rail				
Year	Domestic Air	General Aviation	Amtrak	Transit	Rail	Air	Water
1981	5,733	11,044	1,716	2,946	567	6,872.3	360
1982	5,333	13,252	2,350	3,069	544	6,933.9	310
1983	5,043	10,566	2,339	3,212	521	6,216.4	319
1984	5,183	11,946	2,312	3,732	505	6,276.9	346
1985	4,918	11,697	2,239	3,461	492	6,105.8	446
1986	4,883	11,934	1,900	3,531	481	5,959.1	463
1987	4,751	11,501	1,769	3,534	453	5,412.9	402
1988	4,813	11,789	2,002	3,585	440	5,173.6	361
1989	4,764	10,237	1,986	3,397	434	4,722.8	403
1990	5,049	10,148	2,071	3,453	418	5,071.0	396
1991	4,647	9,194	1,975	3,710	388	4,529.9	402

also increased by 26 percent, from 2,946 Btu's per passenger mile in 1981 to 3,710 in 1991.[10] (See figure 7-7.)

Nonhighway Freight Modes. Instead of being measured on a per passenger-mile basis, energy intensities for freight modes are typically expressed on a per ton-mile basis. The energy intensity of Class I freight railroads improved by 32 percent, from 567 Btu's per ton-mile in 1981 to 388 in 1991. (Table 7-6.) A railroad was designated as a Class I railroad in 1993 if its revenues were more than $251.4 million in 1992. Although this class of railroads only comprised 2 percent of the number of railroads, it accounted for 74 percent of the mileage operated, 89 percent of people employed by the railroad industry, and 91 percent of the railroad freight revenue in 1992.[11]

Energy intensity for domestic waterborne commerce increased, from 360 Btu's per ton-mile in 1981 to 402 in 1991. The 1991 estimate was derived based on the assumption that the 1991 total number of ton-miles equals the 1989 figure, because data on the ton-miles in 1990 and 1991 are yet to be made available. Year-to-year variations in water commerce energy intensity generally are associated with changes in average length of haul. (See figure 7-8.)

Pipelines. Due to data limitations on the total ton miles of natural gas products transported, energy intensity for pipelines cannot be calculated. Trends in total pipelines energy use, however, indicate that pipeline energy use was only slightly higher in 1990 than it was a decade earlier. (See figure 7-9.)

FIGURE 7–5

Energy Intensity of Highway Passenger Modes

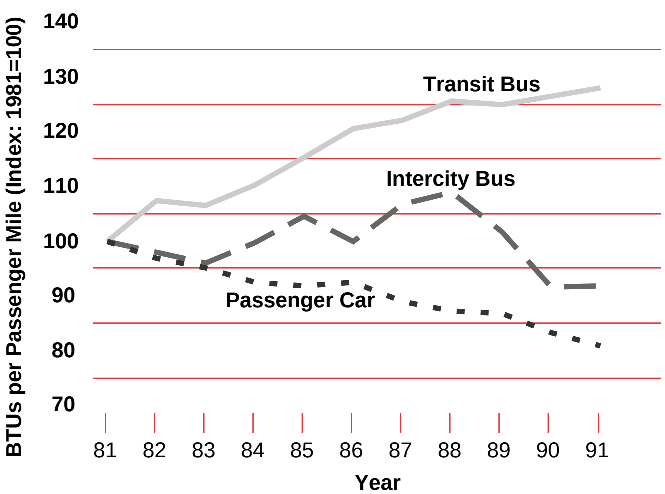
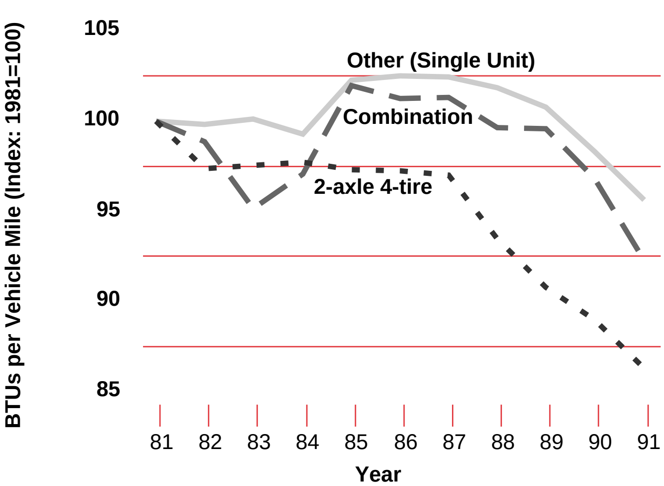


FIGURE 7–6

Energy Intensity of Truck Types

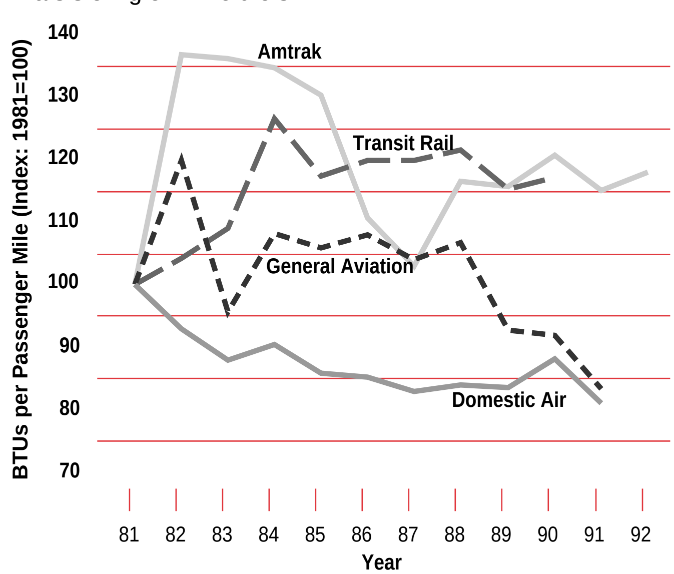


Alternative Transportation Fuels

Increased fuel efficiency for autos and other vehicles and the use of alternative, nonpetroleum fuels are among the major means for reducing the transportation sector's vulnerability to fuel supply interrup-

FIGURE 7–7

Energy Intensity of Nonhighway Passenger Modes



tions and price shocks. Alternative fuels are also expected to help address air quality and other environmental problems generated by tailpipe emissions. Policies are already in place to promote more widespread use of alternative transportation fuels.

The Alternative Motor Fuels Act of 1988 (AMFA) promotes the development and use of methanol, ethanol, and natural gas as transportation fuels. The Act also provides incentives for automobile manufacturers to produce alternative-fuel vehicles, and it authorizes studies of electric and solar-powered vehicles. Credits toward corporate average fuel economy standards will be given for producing and selling dual fuel, flexible fuel, or dedicated alternative fuel vehicles.

In 1992, there were four AMFA Federal Vehicle demonstration projects, consisting of 81 vehicles, and located in the District of Columbia; Detroit, Michigan; and Los Angeles and San Diego, California. Of these 81 vehicles, 16 are conventional gasoline vehicles (control vehicles) and 65 are alternative-fuel vehicles which are capable of operating on any mixture of gasoline and methanol, up to a mixture of 85 percent methanol. For a meaningful comparison, these vehicles are categorized into the following three groups:

(1) Group 1 operates predominantly on 85 percent methanol and 15 percent unleaded gasoline (M85).

(2) Group 2 operates predominantly on unleaded gasoline (labeled “Gasoline” in Table 7-7).

(3) Group 3 operates only on unleaded gasoline (labeled “Conventional Gasoline” in Table 7-7).

Because gasoline has almost twice the energy content per gallon as M85, a conventional miles-per-gallon measure is not correct for comparing the vehicle energy efficiency performance of different energy sources. Rather, Btu’s per mile driven

TABLE 7–7

On-Road Fuel/Energy Economy Summary for the AMFA Federal Vehicles: FY 1992*

Vehicle Site and Type	Number of Vehicles	Miles per Gallon	Mpg - Gasoline= Energy= Equivalent	Btu/Mile
Washington, DC				
M85 AFVs	21	11.7	20.7	5,580
Gasoline	2	14.3		8,060
Conventional gasoline vehicles	4	22.8		5,060
Detroit, MI				
M85 AFVs	18	15.9	28.1	4,110
Gasoline	2	19.4		5,940
Conventional gasoline vehicles	4	24.9		4,640
Los Angeles, CA				
M85 AFVs	9	13.9	24.5	4,710
Gasoline	2	22.1		5,230
Conventional gasoline vehicles	4	25.5		4,530
San Diego, CA				
M85 AFVs	9	15.8	27.9	4,140
Gasoline	2	20.2		6,710
Conventional gasoline vehicles	4	24.3		4,750

* Based on 115,400 BTU/gal for gasoline and 65,400 BTU/gal for M85.
** Gasoline energy equivalent miles per gallon is the M85 alternative fuel vehicle fuel economy for the difference in fuel energy content between gasoline and M85 (e.g., M85 has 56 percent of the energy of unleaded gasoline).

FIGURE 7–8

Energy Intensity of Nonhighway Freight Modes

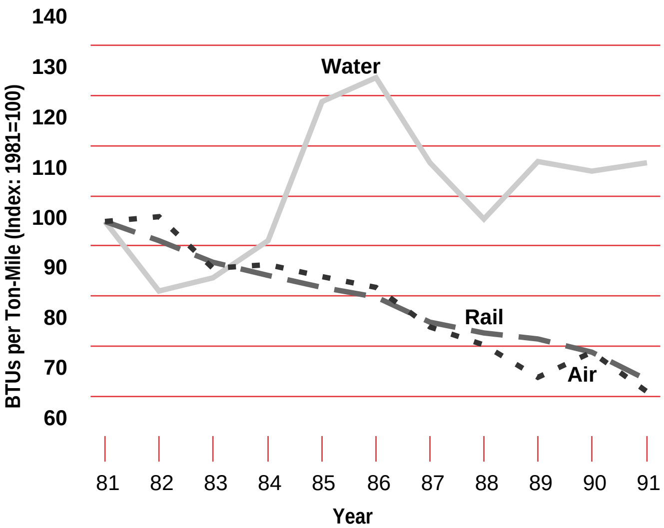
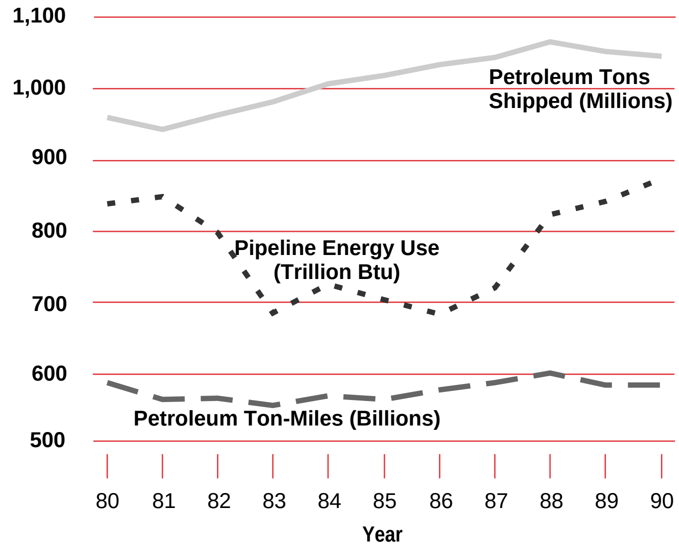


FIGURE 7–9

Pipeline



is used. In all four sites, vehicles that predominantly operate on unleaded gasoline have the poorest energy efficiency. (Table 7-7.)

Among the obstacles to promoting wider use of alternative transportation fuels is the refueling infrastructure. As of 1993, there were 3,851 alternative-fuel refueling sites in the United States, an increase of 160 sites from 1992. However, not all of these sites are available to the public. More than 86 percent of these sites are liquefied petroleum gas (LPG) refueling sites, and 1 percent are M85 sites. California, Florida, and Texas have the greatest number of alternative-fuel refueling sites while Hawaii has none, and the District of Columbia just three alternative-fuel refueling sites. (See table 7-8.) In some states, such as California, these refueling sites are clustered in certain areas, with few or no sites in other parts of the state. (See figure 7-10.)

As part of the effort to promote alternative-fuel vehicles, a number of the vehicles acquired annually by federal agencies are required to be alternative-fuel vehicles. A total of 5,707 federal procurement requests for alternative-fuel vehicles were in place for fiscal year 1993. A breakdown shows that 54 percent of the requested vehicles are fueled by natural gas, 42 percent by alcohol, and 4 percent by other fuels. (See figure 7-11.) Furthermore, the Energy Policy Act of 1992 (EPACT) includes a fleet requirement program in which a certain percentage of new light-duty motor vehicles acquired in each model year for a fleet (excluding federal, state fleet, or fleet owned or controlled by a covered person) shall be alternative-fueled vehicles. The proposed schedule is:

20 percent of the motor vehicles acquired in model years 1999 through 2001.
30 percent for model year 2002.
40 percent for model year 2003.
50 percent for model year 2004.
60 percent for model year 2005.
70 percent for model year 2006 and thereafter.

However, the Secretary of the U.S. Department of Energy (DOE) may establish a lesser percentage requirement for any model year based on a feasibility study.

Transportation Fuel Prices

Based on a sample of service stations in 85 urban areas, DOE has estimated the average retail fuel prices by motor fuel type.[12] After controlling for inflation, prices for every fuel type generally show a downward trend, with unleaded gasoline having the greatest price drop since 1982. Prices for special transportation fuels have also dropped significantly over recent years. (See table 7-9.)

TABLE 7–8

Number of Methanol, CNG, Ethanol and LPG Refueling Sites: 1993

State	M85 Sites	CNG Sites	E85 Sites	LPG Sites	Total Sites
Alabama	0	7	0	85	92
Alaska	0	0	0	8	8
Arizona	1	10	0	45	56
Arkansas	0	6	0	104	110
California	34	38	0	214	286
Colorado	1	41	0	47	89
Connecticut	0	4	0	19	23
Delaware	0	2	0	6	8
Washington, D.C.	1	1	1	0	3
Florida	1	27	0	222	250
Georgia	0	18	0	80	98
Hawaii	0	0	0	0	0
Idaho	0	1	0	20	21
Illinois	1	14	3	165	183
Indiana	0	24	0	124	148
Iowa	0	2	0	108	110
Kansas	0	6	0	38	44
Kentucky	0	6	0	35	41
Louisiana	0	5	0	44	49
Maine	0	0	0	12	12
Maryland	1	6	0	21	28
Massachusetts	0	7	0	41	48
Michigan	1	11	0	182	194
Minnesota	0	10	0	125	135
Mississippi	0	0	0	75	75
Missouri	0	2	0	83	85
Montana	0	4	0	48	52
Nebraska	0	9	1	47	57
Nevada	0	2	0	20	22
New Hampshire	0	0	0	31	31
New Jersey	0	7	0	36	43
New Mexico	0	3	0	46	49
New York	4	23	0	100	127
North Carolina	0	1	0	72	73
North Dakota	0	4	0	17	21
Ohio	2	34	0	98	134
Oklahoma	0	22	0	56	78
Oregon	0	4	0	21	25
Pennsylvania	0	28	0	132	160
Rhode Island	0	1	0	5	6
South Carolina	0	0	0	43	43
South Dakota	0	3	1	24	28
Tennessee	1	4	0	80	85
Texas	0	26	0	202	228
Utah	0	5	0	20	25
Vermont	0	1	0	33	34
Virginia	0	6	0	38	44
Washington	1	24	0	37	62
West Virginia	1	9	0	16	26
Wisconsin	0	27	1	139	167
Wyoming	0	2	0	33	35
United States	**50**	**497**	**7**	**3297**	**385**

TABLE 7–9

Prices for Selected Transportation Fuels: 1978-1992 (Cents per Gallon, Excluding Tax)

Year	Propane *1 Current	Propane *1 Constant 1990*4	Finished Aviation Gasoline Current	Finished Aviation Gasoline Constant 1990*4	Jet Fuel Kerosene-type Current	Jet Fuel Kerosene-type Constant 1990*4	Diesel Fuel Oil *2 Current	Diesel Fuel Oil *2 Constant 1990*4
1978	33.5	67.1	51.6	103.4	38.7	77.5	37.9	75.9
1979	35.7	64.3	68.9	124.0	54.7	98.5	57.6	103.7
1980	48.2	76.4	108.4	171.9	86.6	137.3	83.0	131.6
1981	56.5	81.2	130.3	187.2	102.4	147.1	100.2	144.0
1982	59.2	80.1	131.2	177.6	96.3	130.4	95.4	129.2
1983	70.9	93.0	125.5	164.6	87.8	115.2	83.1	109.0
1984	73.7	92.7	123.4	155.3	84.2	105.9	82.6	103.9
1985	71.7	87.1	120.1	145.9	79.6	96.7	78.3	95.1
1986	74.5	88.8	101.1	120.5	52.9	63.0	49.2	58.6
1987	70.1	80.6	90.7	104.3	54.3	62.4	53.8	61.9
1988	71.4	78.9	89.1	98.4	51.3	56.7	49.2	54.4
1989	61.5	64.8	99.5	104.9	59.2	62.4	56.3	59.3
1990	74.5	74.5	112.0	112.0	76.6	76.6	69.2	69.2
1991	73.0	70.0	104.7	100.4	65.2	62.6	67.2	64.4
1992	66.2	61.6	102.7	95.6	61	58.3	*3	*3
Average Annual Percentage Change								
1978-92	5.0%	-0.6%	5.0%	-0.6%	3.3%	-2.0%	4.5% *4	-1.3% *4
1982-92	1.1%	-2.6%	-2.4%	-6.0%	-4.5%	-7.7%	-3.8% *4	-7.4% *4

*1 Consumer grade.
*2 Wholesale cost.
*3 Data are not available.
*4 Average annual percentage change is for years 1978-91 and 1982-91.

Environmental Quality

Transportation has many undesirable impacts on the environment. The fuels that power vehicles produce emissions that damage our environment, affect human health, and contribute to global climate change. Transportation activities also generate noise, vibration and structural damage, and congestion. Recognizing the interdependence between transportation systems and the environment, transportation planners and environmentalists are increasing their efforts to maintain a proper balance between the two. The Clean Air Act Amendments of 1990 (CAAA) require that transportation plans and projects conform with state air quality implementation plans and contribute to attainment of the national ambient air quality standards. The Intermodal Surface Transportation Efficiency Act (ISTEA), signed in 1991, contains provisions to provide state and local transportation officials with adequate funding and flexibility to meet their CAAA requirements. Together, CAAA and ISTEA may provide the means to achieve both mobility and clean air.

Over the past twenty years, dramatic reductions have been achieved in new

FIGURE 7–10

Methanol and Ethanol Refueling Sites (California)

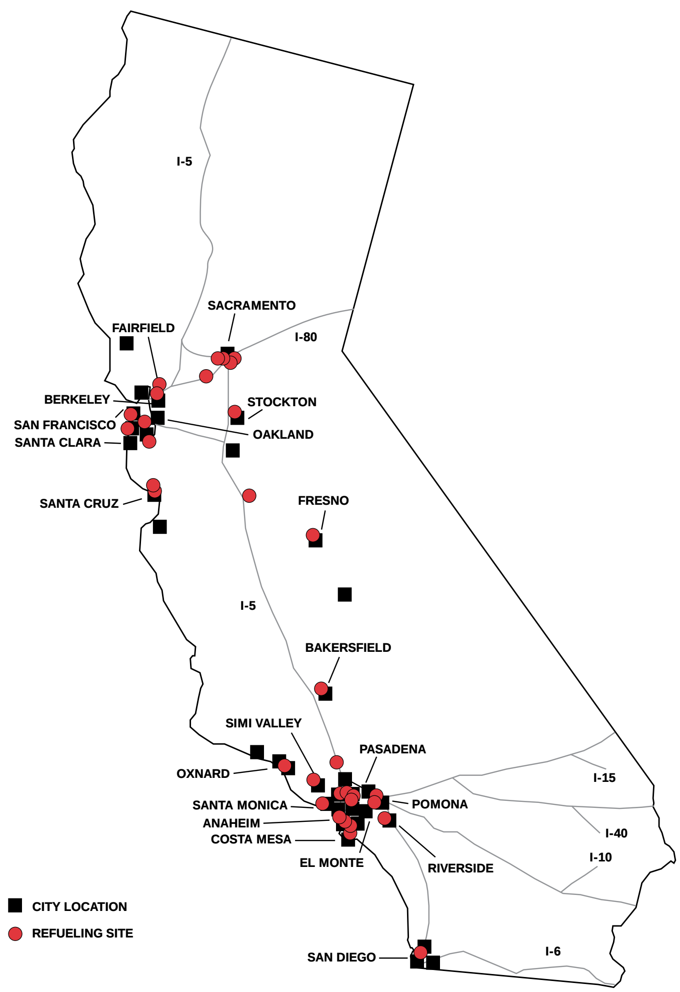
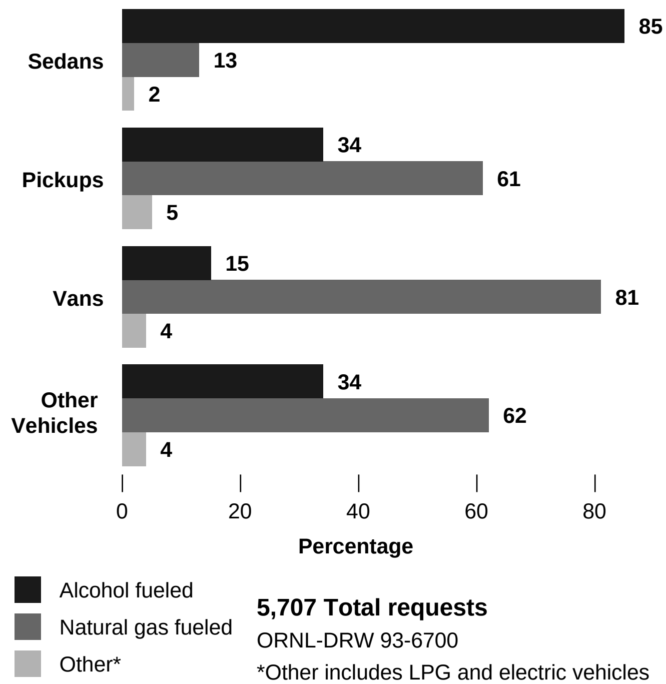


FIGURE 7–11

Federal Agencies' Procurements for Alternative Fuel Vehicles FY93



vehicle emissions by means of the control technology applied to achieve mobile source standards. The typical new, properly operating, 1993 car emits 80 percent less pollution than a typical 1970 model. Estimates of total vehicular emissions have been steadily declining for most pollutants, and lead has been virtually eliminated from vehicle exhaust. But in many areas National Ambient Air Quality Standards have still not been met. In 1992, there were 22 serious ozone nonattainment areas and 42 carbon monoxide nonattainment areas. The 1990 Clean Air Act Amendments call for even greater reductions to vehicular emissions using more advanced control technologies and cleaner fuels, and bringing some previously unregulated transportation modes within the scope of emissions regulation. In nonattainment areas the need to show that transportation improvements will not negatively affect air quality is creating a growing conflict between the goals for efficient, economical transportation and compliance with air quality standards.

Other important environmental concerns include spills and leaks of oil and other hazardous materials, noise, land use impacts, and emissions of Chlorinated Fluorocarbons.

Air Quality. Air pollutants are emitted into the atmosphere by both mobile and stationary sources. Mobile sources of air pollution are basically transportation-related. One of the major environmental concerns about developing and operating transportation systems is the contribution of vehicles to air quality, acid rain, and global climate change. In 1991, transportation accounted for 70 percent of carbon monoxide (CO) emissions, 39 percent of nitrogen oxides (NO_x), 30 percent of nonmethane volatile organic compounds (VOC), 21 percent of particulate matter and 22 percent of carbon dioxide (CO_2). (See table 7-10.) The U.S. Environmental Protection Agency (EPA) has put specific emission standards in place to control these emissions, including standards for light-duty trucks and automobiles, and gasoline- and diesel-powered heavy trucks. (See table 7-11.) The 1994 and 1995 standards are based on CAAA, which requires a 39 percent reduction in automobiles' nonmethane VOC emission, and 60 percent reduction in both NO_X and particulate matter.

Carbon Monoxide (CO). Transportation continues to be the major contributor of CO emissions. (Figure 7-12.) Highway vehicles are the largest single source of CO emissions. However, national CO emissions have declined 50 percent over the past 20 years, with the greatest decrease of 55 percent being achieved by the transportation sector, from 106.76 million short tons in 1970 to 47.94 million short tons in 1991. Forest fires, the second largest contributor of CO emissions, emitted 10 percent of the total CO emissions in 1991.

Three transportation modes emitted less CO in 1991 than in 1970—highway vehicles, railroads, and off-highway vehicles and machinery. Despite a 96 percent increase in vehicle travel, highway vehicles reduced their CO emissions by 59 percent during the 1970-1991 period. Significant improvements in motor-vehicle emission control systems have contributed to this substantial reduction. Based on EPA's analysis, CO emissions from highway vehicles would have increased more than threefold from 1970 to 1991 if it had not been for the implementation of vehicle emission controls.[13] EPA also projects that

TABLE 7–10

Total National Emissions by Sector: 1991 (Millions of Short Tons)

Sector	CO	NOx	TP	SOx	VOC	Lead*
Highway Vehicles	39.81	5.93	1.45	0.67	4.21	1.58
	58.2%	28.7%	17.8%	2.9%	22.6%	28.8%
Aircraft	1.16	0.14	0.08	0.02	0.20	n/a
	1.7%	0.7%	1.0%	0.1%	1.1%	n/a
Railroads	0.18	0.51	0.03	0.08	0.12	n/a
	0.3%	2.5%	0.4%	0.3%	0.6%	n/a
Vessels	1.89	0.26	0.04	0.22	0.56	n/a
	2.8%	1.3%	0.5%	1.0%	3.0%	n/a
Other Off-Highway	4.90	1.17	0.12	0.09	0.51	0.21**
	7.2%	5.7%	1.5%	0.4%	2.7%	3.8%**
Transportation Total	47.94	8.00	1.73	1.09	5.60	1.79
	70.0%	38.7%	21.2%	4.8%	30.1%	32.7%
Stationary Source Fuel Combustion	5.16	11.67	2.14	18.24	0.74	0.50
	7.5%	56.4%	26.2%	79.8%	0.4%	9.1%
Industrial Processes	5.17	0.66	2.81	3.49	2.28	2.43
	7.6%	3.2%	34.4%	15.3%	12.3%	44.3%
Solid Waste Disposal	2.27	0.11	0.37	0.03	8.66	0.76
	3.3%	0.5%	4.5%	0.1%	46.5%	13.9%
Miscellaneous	7.91	0.24	1.12	0.01	0.76	0.00
	11.6%	1.2%	13.7%	0.0%	4.1%	0.0%
TOTAL OF ALL SOURCES	68.45	20.68	8.16	22.86	18.61	5.48
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Thousands of short tons.
** Includes all off-highway and nonhighway vehicles.

advances in emission control technology and continued elimination of older vehicles from the vehicle fleet will allow the CO emission rate to decrease to 10 grams per mile by the year 2000, down from 25 grams per mile in 1988.

The reduction in CO emissions from highway vehicles was primarily attributable to the reduction by gasoline-powered passenger cars. During this period, CO emissions from diesel-powered heavy-duty trucks increased more than one and one-half times. Aircraft and water vessels also emitted more CO in 1991 than in 1970.[14]

Stationary sources of transportation-related air pollutants include petroleum refining and storage, petroleum transfer, and refueling.[15] An 80 percent reduction in CO emissions from petroleum refining was achieved from 1970 to 1991 by installing more emission controls.

Nitrogen Oxides (NO_X). NO_X emissions are emitted mostly by stationary fuel-combustion sources and by motor vehicles. (Figure 7-13.) Although transportation NO_X emissions decreased by 42 percent during the 1980-1991 period, NO_X emissions from stationary fuel combustion sources increased by 5 percent.[16]

For mobile sources, EPA has attributed reduction in NO_X emissions to the Federal Motor Vehicle Control Program (FMVCP).[17]

FIGURE 7–12

National Emission Estimates of Carbon Monoxide

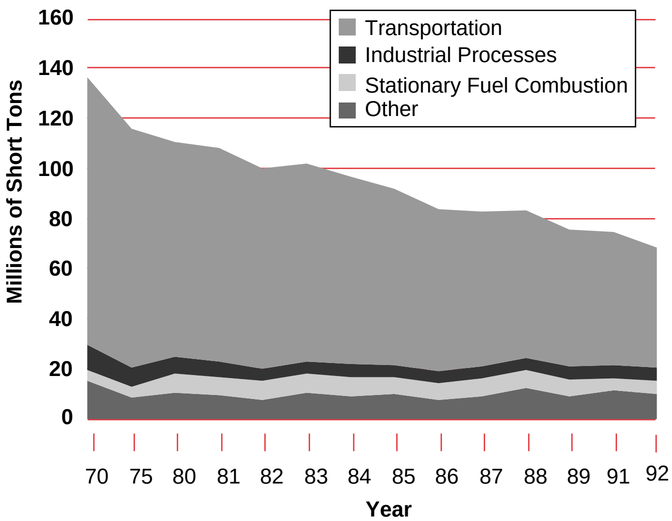


FIGURE 7–13

National Emission Estimates of Nitrogen Oxides

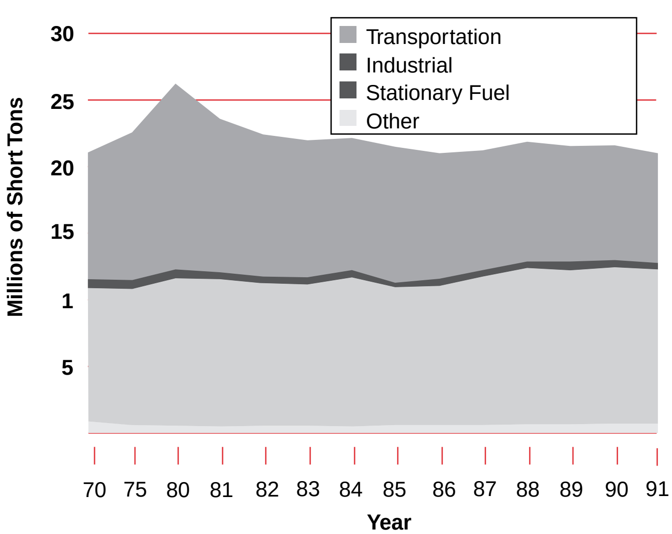


TABLE 7–11

Motor Vehicle Emission Standards: 1993-1995

	1993	1994	1995
Automobiles (grams per mile)			
Nonmethane Volatile Organic Compounds	0.41	0.25	0.25
Carbon Monoxide	3.40	3.40	3.40
Nitrogen Oxides	1.00	0.40	0.40
Particulates	0.20	0.08	0.08
Light Trucks (grams per mile)			
Nonmethane Volatile Organic Compounds	0.80	0.25	0.25
Carbon Monoxide	10.00	3.40	3.40
Nitrogen Oxides	1.20[1]	1.20[1]	0.40[1,2]
Particulates	0.26	0.26	0.08
Heavy-Duty Trucks (grams per brake horsepower-hour)			
Gasoline-Powered			
Nonmethane Volatile Organic Compounds	1.90	1.90	1.90
Carbon Monoxide	37.10	37.10	37.10
Nitrogen Oxides	5.00	5.00	5.00
Diesel-Powered			
Nonmethane Volatile Organic Compounds	1.30	1.30	1.30
Carbon Monoxide	15.50	15.50	15.50
Nitrogen Oxides	5.00	5.00	5.00
Particulates	0.25	0.10	0.10

1 Applies to light trucks 3,750 pounds or less loaded vehicle weight.
2 Does not apply to diesel light trucks.

EPA projected that without this program, NO_X emissions from highway vehicles could have more than doubled. This program has resulted in the widespread use of catalytic converters on automobiles to help reduce NO_X, VOC, and CO emissions, and the use of unleaded gasoline for vehicles with these converters. An NO_X emission control device for post-1973 model-year vehicles is the exhaust gas recirculation device.

From 1980 through 1991, NO_X emissions from highway vehicles decreased from 11.6 million short tons to 5.9 million short tons, a 49 percent decrease.[18] Among all types of highway vehicles, the reduction in NO_X emissions from diesel-powered passenger cars was the greatest (98 percent). This great decrease was due to the decreased popularity of diesel cars. NO_X emissions from gasoline-powered passenger cars decreased by 50 percent during the period. All non-highway modes, except railroads, increased their CO emissions during the past 20 years.[19]

Total Particulate Matter (TP). Despite lower fuel consumption and decreased industrial production in the years prior to 1970, TP emissions for the period 1940-1970 were significantly greater than in the post-1970 period.[20] Since 1970, overall TP emissions have decreased by 61 percent largely due to air pollution control efforts. Industrial processes continue to contribute most of the TP emissions followed by stationary fuel combustion sources. (Figure 7-14.)

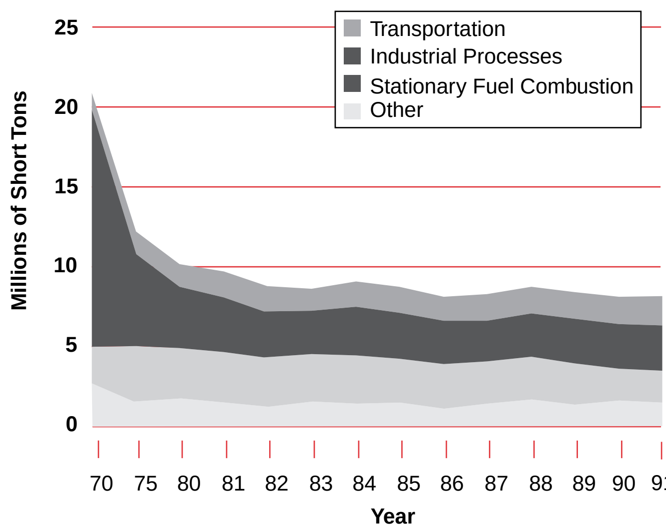
Although total national TP emissions declined substantially during the 1970-1991 period, transportation's contribution to TP emissions increased, from 1.3 million short tons in 1970 to 1.73 in 1991, a 33 percent increase. TP and sulfur oxide emissions were the only two air pollutants emitted by the transportation sector that have had an upward trend in the past 20 years.

Among transportation modes, highway vehicles are the major contributor to transportation TP emissions, accounting for 84 percent, followed by off-highway. (See table 7-12.)

In 1985, EPA established a particulate emission standard for heavy-duty diesel engines. The standard required that 1988 model-year heavy-duty diesel engines reduce their TP emissions to 0.10 grams per brake horsepower-hour. For 1994 model-year vehicles, emissions are to be further reduced to 0.10, from 0.60 grams per brake horsepower-hour for 1988 and later model-year vehicles. This emission standard became effective in October 1993.

FIGURE 7–14

National Emission Estimates of Total Particulate Matter



Sulfur Oxides (SO_X). SO_X emissions result from fossil fuel combustion. The use of cleaner fuels with lower sulfur content, increases in nonferrous smelters, and increased use of emission control devices have contributed to a 27 percent decline in SO_X emissions during the 1970-1991 period.[22] Examination of the current and historical SO_X emissions from different sectors shows that fuel combustion accounts for most of the SO_X emissions. (Figure 7-15.)

Transportation's contribution to total SO_X emissions has always been relatively modest, less than 5 percent in the past 30 years. However, there has been an upward trend since 1970.[23] The 1991 highway vehicle SO_X emissions are more than double those in 1970. The increase was primarily the result of increased travel. Sulfur content in gasoline and in No. 2 diesel fuel has basically remained unchanged. (Figure 7-16.)

Because sulfur content in No. 2 diesel fuel is more than three times that in gasoline, more than half of the SO_X emissions from highway vehicles can be attributed to diesel-powered heavy-duty trucks.[24] To effectively lower the total TP emitted from heavy-duty diesel trucks to meet the par-

TABLE 7–12

Emissions of Total Particulate Matter from Highway Vehicles (Million Short Tons)

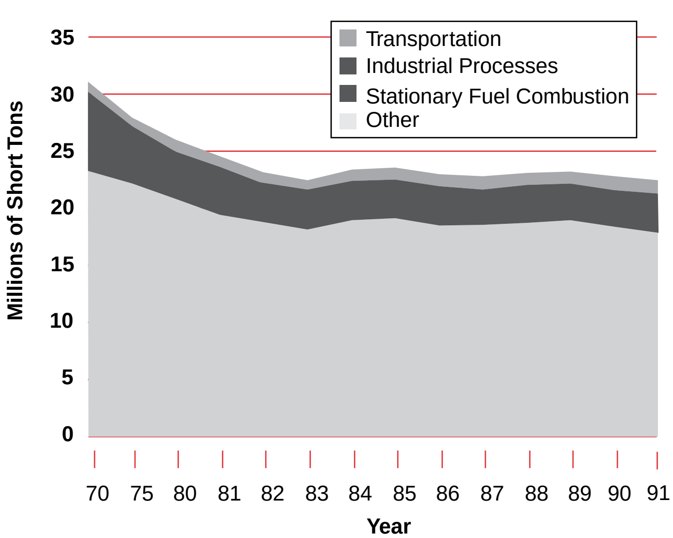
Highway Vehicles	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Gasoline Powered														
Passenger Cars	0.67	0.75	0.63	0.60	0.61	0.61	0.61	0.59	0.59	0.62	0.65	0.68	0.69	0.72
Light Trucks-1	0.09	0.11	0.10	0.10	0.09	0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.15	0.16
Light Trucks-2	0.02	0.04	0.07	0.08	0.07	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.09	0.08
Heavy Duty Vehicles	0.07	0.06	0.06	0.06	0.05	0.06	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.04
Motorcycles	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total-Gasoline	0.85	0.96	0.87	0.85	0.84	0.85	0.85	0.83	0.84	0.88	0.93	0.97	0.98	1.01
Diesel Powered														
Passenger Cars	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Light Trucks	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heavy Duty Vehicles	0.14	0.20	0.28	0.31	0.30	0.28	0.29	0.37	0.34	0.36	0.39	0.40	0.41	0.43
Total Diesel	0.14	0.20	0.29	0.33	0.32	0.30	0.32	0.40	0.37	0.38	0.41	0.42	0.43	0.44
Highway Vehicle Total	1.00	1.16	1.16	1.18	1.16	1.15	1.17	1.23	1.21	1.25	1.34	1.39	1.41	1.45

Note: 1990 emission estimates are preliminary. The sums of subcategories may not equal total due to rounding.

ticulate emission standards, EPA reduced the allowable sulfur levels in diesel fuel. As a result, the sulfur content of highway diesel fuels is required to be lowered from 0.27 weight percent to 0.05 weight percent, as of October 1993. The sulfur content in gasoline may be reduced as a byproduct of meeting the lower NO_X emission standards in severe ozone nonattainment areas.

FIGURE 7–15

National Emission Estimates of Sulfur Oxides



Nonmethane Volatile Organic Compounds (VOC). Industrial processes and transportation continue to contribute most of the national VOC emissions. (Figure 7-17.) VOC emissions increased about 77 percent from 1940 to 1970, largely due to increases in vehicle travel and industrial production. From 1970 to 1991, VOC emissions decreased by 11.6 million short tons, a 38 percent reduction.[25] This reduction in VOC emissions resulted from motor vehicle emission controls and less open burning of solid waste.[26]

Transportation VOC emissions decreased at a faster rate than overall VOC emissions did during this period. Consequently, transportation's share of VOC emissions continued to decline, from 47 percent of the total VOC emissions in 1970 to 30 percent in 1991. This reduction occurred in spite of a 96 percent increase in travel. Highway vehicle VOC emissions decreased 67 percent during this period, again primarily due to the FMVCP.

Although two of the nonhighway modes (aviation and railroads) both decreased their VOC emissions from 1970 to 1991, the 56 percent increase in vessel VOC emissions offset these decreases and resulted in a 7 percent increase in non-highway VOC emissions.[27] Petroleum refining emitted relatively modest amounts of VOC—4.1 percent of the total emissions in 1991.

Lead. Total lead emissions—transportation in particular—have improved remarkably since 1970. (Figure 7-18.) As a result of FMVCP, the use of unleaded gasoline prevails and national lead emissions have decreased dramatically, from 219,400 short tons in 1970 to 5,500 short tons in 1991. Between 1975 and 1991, the percentage of unleaded gasoline sales increased from 13 percent to 96.5 percent, and lead emissions from highway vehicles decreased by 99 percent.

Another significant decrease (76 percent) occurred in transportation lead emissions between 1985 and 1986. This reduction is attributed to an EPA requirement that petroleum refiners lower the lead content of leaded gasoline from at least 1.1 grams per gallon to 0.1 grams in 1986.

Transportation—highway vehicles in particular—was the major contributor to lead emissions until 1988. Since then, industrial processes have become the major source. They account for more than 44 percent of the national lead emissions in 1991, while highway vehicles account for 29 percent of the total. These percentage contributions are extraordinarily different from the percentage contributions in 1970, when highway vehicles accounted for 78 percent of the total lead emissions.

Acid Rain and Global Climate Change

Acid rain results from discharges of SO_X, NO_X, and VOC into the atmosphere

FIGURE 7–16

Sulfur Content of Fuels: 1970 - 1986

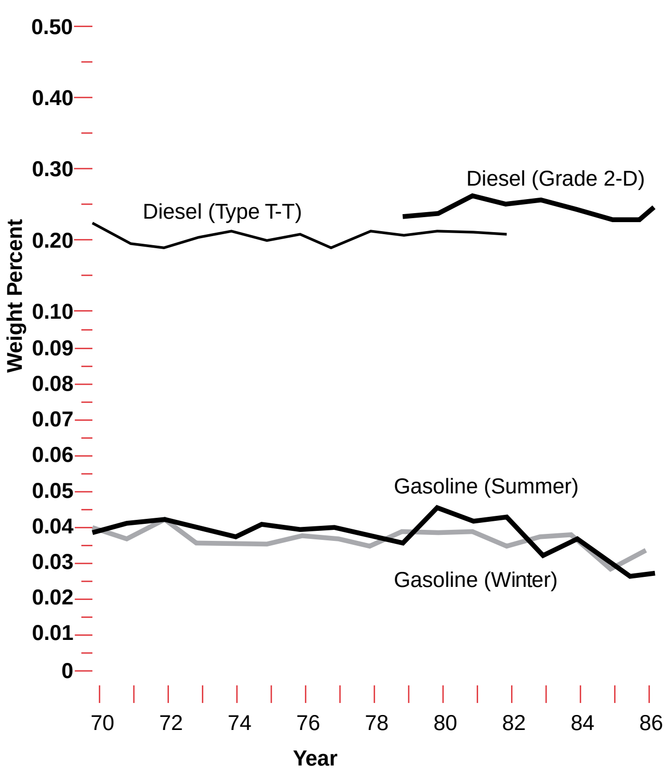


FIGURE 7–17

National Emission Estimates of Nonmethane Volatile Organic Compounds

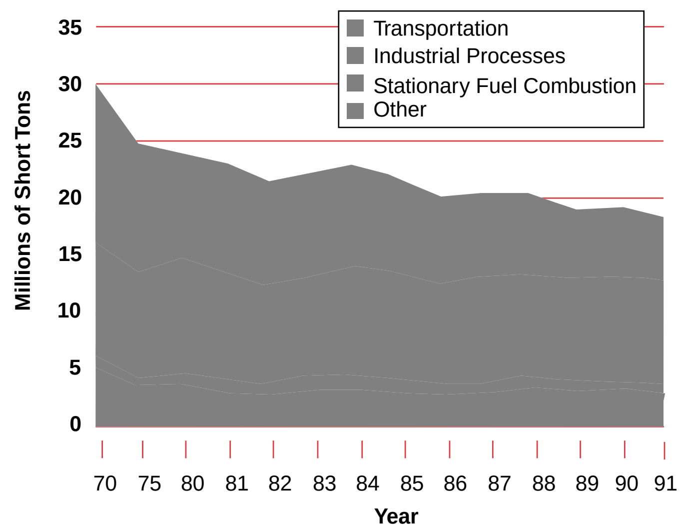
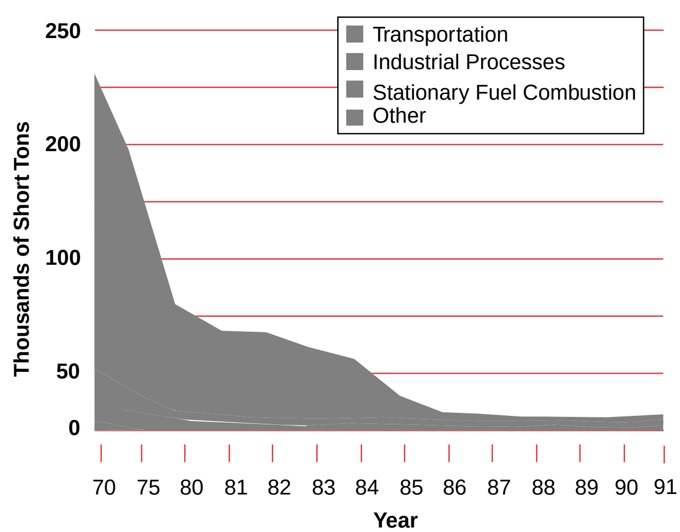


FIGURE 7–18

National Emission Estimates of Lead



by mobile sources, combustion, and industrial processes. In 1991, the transportation sector was responsible for 39 percent of NO_x emissions, and 30 percent of the VOC emissions. However, the role of the transportation sector in acid deposition is not yet completely understood.[28]

Another major impact of transportation on our environment is the greenhouse effect. Many scientists now believe that the increase in anthropogenic emissions of greenhouse gases will probably change the climate of the earth.[29] These greenhouse gases are primarily carbon dioxide (CO_2), nitrous oxide (N_2O), ozone (O_3), methane (CH_4), and chlorofluorocarbons (CFCs). In its 1990 report to Congress, EPA estimated that transportation energy use contributed 18 percent to global warming and CFC-12 contributed another 10 percent. (See figure 7-19.) Almost 36 percent of all CFC-12 is used as the refrigerant in vehicle air conditioning systems.

Carbon Dioxide (CO_2). CO_2 is expected to be responsible for about half of the climate change theoretically induced by humans. CO_2 concentration increased from 315 parts per million (ppm) in 1958 to 350 ppm in 1988, an increase of 11 percent.[30] This increase is believed to be associated with increased use of fossil fuels. Transportation is estimated to be responsible for almost 22 percent of U.S. CO_2 emissions. However, after taking into account the full energy cycle,[31] transportation accounts for almost 30 percent of the U.S. CO_2 emissions.

Because CO_2 is a byproduct of the fossil-fuel combustion process, one way to reduce CO_2 emissions from transportation sources is to reduce the use of fossil fuels, through improved vehicle fuel efficiency and increased use of alternative fuels. Another source of CO_2 emissions is congestion. According to the U.S. Department of Transportation estimates, congestion caused the waste of 3 billion gallons of gasoline in 1984. This waste resulted in the release of an extra 30 million tons of carbon dioxide. By 2005, more than 70 million tons of CO_2 emissions are estimated to result from growing highway congestion. Reducing congestion is another strategy for reducing CO_2 emissions.

A study conducted by the Argonne National Laboratory estimated the CO_2 emitted from the full energy cycle of different alternative transportation fuels. It calculated that, on average, a standard gasoline-powered light-duty vehicle will emit 486.3 grams of CO_2 per mile driven.[32] On a per-mile-driven basis, this type of vehicle emits more CO_2 than vehicles powered by either diesel, compressed natural gas (CNG), liquefied natural gas (LNG), or liquefied petroleum gas (LPG) from a mixture of natural gas liquids and petroleum. When comparing CO_2 emissions of battery-powered light-duty electric vehicles (EVs), this study noted that there is no CO_2 emitted from EVs themselves, and found that the full energy cycle with light-duty EVs using electric power from solar power plants emit the least amount of CO_2 (67.3 grams per mile), closely followed by EVs using electricity from nuclear power plants (90 grams per mile).

Chlorofluorocarbon (CFC). Only one ozone-depleting substance, CFC-12, is a major factor in transportation. (See figure 7-20.) CFC-12 depletes the stratospheric ozone layer which serves as a shield against harmful ultraviolet radiation. Almost 36 percent of all CFC-12 is used as the refrigerant in vehicle air conditioning systems. Vehicle air conditioning across the world accounts for more than half of global consumption of CFC-12. Today, more than 90 million cars and trucks on U.S. roads have factory-installed air conditioning.

FIGURE 7–19

Contribution to Global Warming: 1985

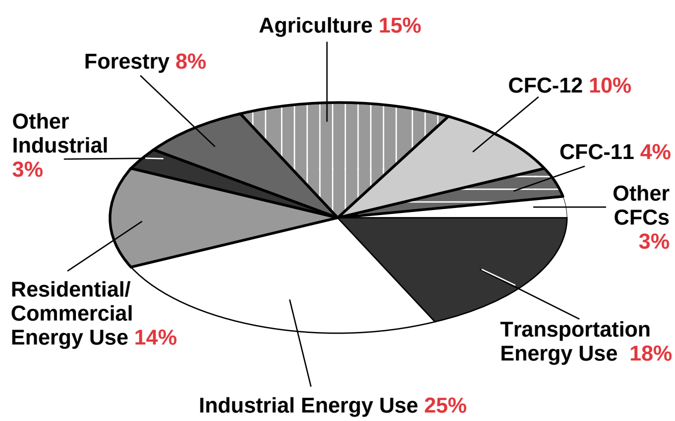
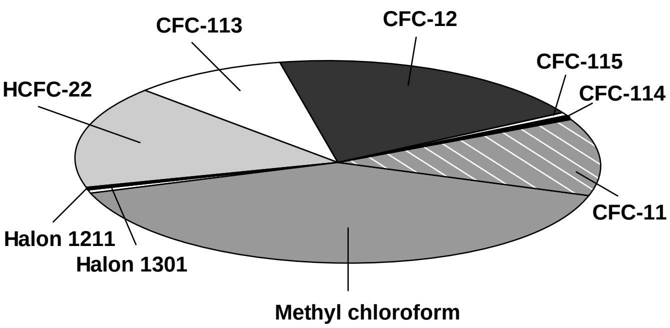


FIGURE 7–20

U.S. Production of Ozone-Depleting Substances: 1986 (1633 Million lb)



To protect the ozone layer, 35 nations, including the United States, signed the *Protocol on Substances that Deplete the Ozone* in 1987 in Montreal. This protocol called for a 50 percent reduction in the production of CFCs by the year 1998. The protocol was superseded in 1989 by a United Nations agreement to end CFC production by the year 2000 in 81 countries, including the U.S., and accelerated to 1995 by members of the North Atlantic Treaty Organization (NATO).

The near-term solution to reduce CFC-12 consumption is to substitute other substances for CFC-12. Although far less damaging to the ozone layer than CFC-12, these substitutes are, in fact, greenhouse gases that might potentially contribute to global warming. The long-term goal is to develop CFC-12 replacements or alternative air conditioning technologies that are energy efficient, safe to use, environmentally "friendly," low cost, and high comfort and performance.

International Comparison. Compared to other countries, the U.S. transportation sector emitted by far the greatest amount of CO_2, CO, and NO_x. (See table 7-13.) On a per capita basis, U.S. transportation CO_2 and CO emissions were also the greatest. All countries in this comparison increased their transportation CO_2 emissions during the 1970-1990 period; all reduced their transportation CO emissions, except the United Kingdom, which doubled its CO emissions. Transportation's contribution to NO_x emissions is the smallest in the United States.

Noise

Over the years, legislation and government efforts have helped to mitigate transportation noise problems. The U.S. Department of Transportation (DOT) has developed guidance on land-use compatibility with transportation noise. The Federal Aviation Administration funds noise compatibility planning programs. The Noise Control Act of 1972 authorized EPA to regulate noise emissions from vari-

TABLE 7–13

Atmospheric Emissions of Selected Pollutants from the Transportation Sector (Million Short Tons)

	Total Emissions						% Total Emissions		
	CO_2		CO		NO_x		CO_2	CO	NO_x
	1971	1991	1971	1991	1971	1991	1991	1990	1990
Canada	97	130	8.71	n/a	0.90	.24	27.1	n/a	58.3
United States	**1,190**	**1,641**	**106.73**	**53.25**	**9.32**	**8.63**	**29.6**	**76.6**	**40.4**
Japan	65	272	n/a	n/a	n/a	n/a	22.9	n/a	n/a
France	87	147	n/a	7.27	0.59	1.17	32.7	87.1	71.3
West Germany	112	175	9.83	6.73	1.17	2.10	n/a	74.7	73.3
Netherlands	53	74	1.64	0.79	0.23	0.37	34.7	68.8	61.1
Switzerland	12	20	0.55	0.30	0.10	0.14	40.5	62.9	67.9
United Kingdom	109	156	3.28	6.68	0.91	1.72	23.3	90.5	56.1

*Based on Anthropogenic Emissions from Energy Use ous equipment, including setting operational standards for trucks and rail equipment. Effective January 1988, a new truck weighing more than 10,000 pounds is limited to generating a noise level of no more than 80 decibels (dBA), a noise level that is roughly equivalent to that of an alarm clock or a sewing machine. (See figure 7-21.) The Federal-Aid Highway Act of 1970 required the Federal Highway Administration (FHWA) to develop noise standards for mitigating traffic noise, including noise level criteria for different types of land-use activities. The Federal Railroad Administration (FRA) issued regulations for compliance with noise emission regulations set forth by EPA. Considerable progress has been made in the past two decades in controlling transportation noise at its source, as well as in the reduction of noise impacts on various communities.

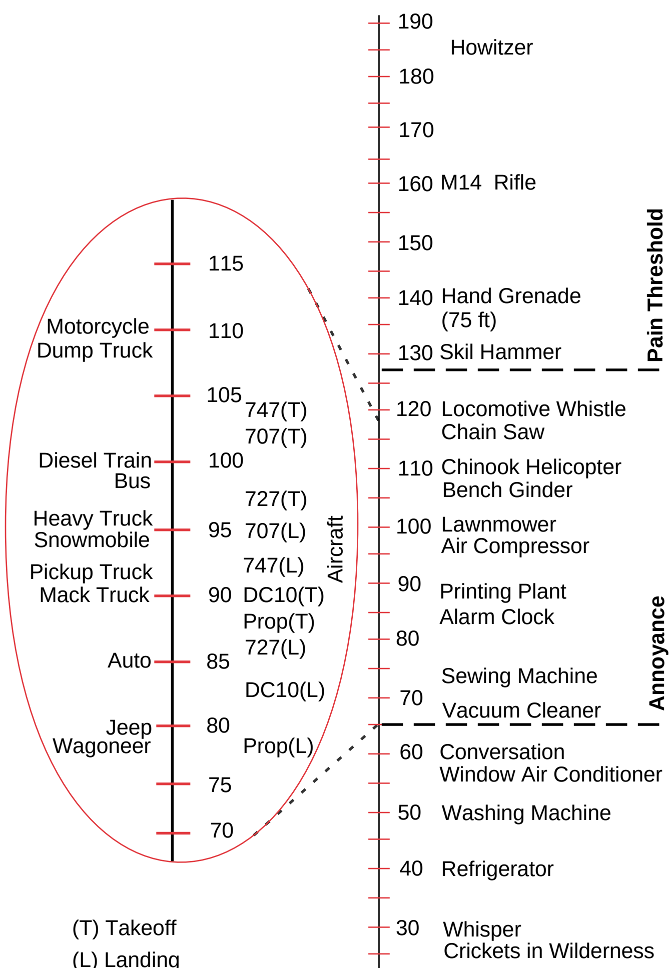
Noise barriers are one mitigation measure that is most often associated with noise abatement. An FHWA survey has estimated that more than 720 miles of noise barriers had been constructed as of 1989. The total cost for these constructions was estimated to be more than $635 million (in 1989 dollars).

Normally, a noise level of 55 to 60 dBA is acceptable in residential areas, and 125 dBA is considered the pain threshold. A potential health effect from exposure to noise levels more than 75 dBA includes changes in motor coordination. Based on a report published by the Organization for Economic Cooperation and Development, 0.4 percent of the U.S. population is exposed to noise levels more than 75 dBA from highway vehicles, and 0.1 percent is exposed to similar noise levels from aircraft. (See table 7-14.)

In addition to its effects on health, noise can also diminish property values. By one estimate, traffic noise reduced home property values from $6 to $182 per decibel, even after some steps were taken to mitigate noise problems. Based on total travel in urban areas in 1989, noise damage from cars and trucks to property in urban areas is estimated at about $9 billion (1989 dollars) per year. Trucks are responsible for about 85 percent of this damage.

FIGURE 7–21

Transportation Noise Levels, dBA



Transport and Spill of Waste Materials

Each year, our economy generates millions of tons of waste and hazardous materials that must be moved, creating a difficult and growing problem for the transportation system. Data on the tons of hazardous materials transported suggest that transport across state lines increased by 7 percent from 1987 to 1989.[33] Because the data do not include transportation of hazardous materials within state boundaries, the actual tons of hazardous materials transported are expected to be higher. The more hazardous the materials transported, the higher the risk of accident and damage to the environment.

The potential for oil discharge during transport presents another environmental hazard. Although there are several sources of oil discharges (vessels, land

TABLE 7–14

Percentage of U.S. Population Exposed to Transportation Noise and the Corresponding Health Effects

	>55dBA	>60dBA	>65 dBA	>70 dBA	>75dBA
Noise Source	Annoyance	Normal Speech Level	Communication Interference	Smooth Muscles/ GlandsReact	Changed Motor Coordination
Road Transportation	37.0%	18.0%	7.0%	2.0%	0.4%
Aircraft	9.0%	4.0%	2.0%	0.4%	0.1%
Railroad	2.4%	1.4%	1.0%	0.2%	n/a

TABLE 7–15

Annual Oil Spills into U.S. Navigable Waters by Source: 1982-1992

	Tank Ships		Tank Barges		Other Vessels		Total Vessels		Non-Vessel		Total	
Year	Incidents	Volume (Thousand Gallons)	Incidents	Volume (Thousand Gallons)	Incidents	Volume (Thousand Gallons)	Incidents	Volume (Thousand Gallons)	Incidents	Volume (Thousand Gallons)	Incidents	Volume (Thousand Gallons)
1982	289	1,221	566	1,810	1,443	409	2,298	3,440	6,314	5,748	8,612	9,189
1983	263	143	545	1,803	1,526	368	2,334	2,315	6,874	5,956	9,208	8,270
1984	244	1,907	529	2,488	1,652	1,873	2,425	6,258	6,820	9,987	9,245	16,255
1985	173	10,732	417	3,689	1,479	707	2,069	15,128	4,953	3,547	6,993	18,667
1986	225	1,165	575	1,644	2,284	330	3,084	3,139	3,246	1,288	6,330	4,428
1987	195	1,543	451	574	2,472	1,009	3,118	3,127	2,965	633	6,083	3,760
1988	260	852	555	3,181	2,540	407	3,355	4,440	2,800	2,177	6,155	6,617
1989	255	11,272	578	752	2,957	712	3,790	12,737	4,133	770	7,923	13,507
1990	312	4,978	530	1,002	3,493	484	4,335	6,463	5,265	4,912	9,600	11,376
1991	254	92	498	246	3,664	502	4,416	840	5,434	612	9,850	1,452
1992	198	118	328	74	4,893	400	5,419	592	3,371	912	8,790	1,504

vehicles, nontransportation-related facilities (e.g., refinery, bulk storage, and marine and land facilities), in 1992, vessels caused more than 60 percent of all oil-spill incidents. The number of incidents that resulted in oil discharges into U.S. navigable waters rose from 6,330 in 1986 to 8,790 in 1992, an increase of 39 percent. However, the volume of oil spilled decreased by two-thirds during the 1986-1992 period. (See table 7-15.)

From 1982 to 1986, a period for which detailed spill data are available, most of the liquid hazardous waste spills occurred in non-transportation related facilities.[34]

Municipal Solid Waste: An Environmental Problem Becomes a Transportation Business

The growth in municipal solid waste and the closure of nearby sanitary landfills has turned a local environmental problem into a new line of business for railroads and long-haul truckers. Although municipal solid waste is not an environmental consequence of transportation, concerns with the environmental impacts of municipal solid waste will affect the ability of transportation to assist in its disposal.

In 1988, the U.S. generated nearly 180 million tons of municipal solid waste, representing an increase of 107 percent since 1960. The average amount of solid waste per person per day increased from 2.1 pounds to

6.7 from 1960 to 1988. By 1990, the amount of municipal solid waste to be disposed of was almost equal in weight to the total amount of corn—and more than three times the tonnage of wheat—grown in the U.S. Although recycling and the conversion of waste to energy may reduce this quantity in the future, substantial tonnage of solid waste will still require disposal. (See table 7-16.)

Sanitary landfills, which receive almost 80 percent of municipal solid waste, are closing as they reach capacity or fail to meet the more stringent environmental requirements specified in the reauthorization of the Resource Conservation and Recovery Act (RCRA). Roughly one-half the landfills operating in 1986 are closed today. Approval of new landfills takes five to eight years, if environmentally and politically viable sites can be found at all.

With the exhaustion of many landfills and the increasing amounts of municipal solid waste generated, the market for interstate transportation of municipal solid waste has grown substantially. Although 92 percent of municipal solid waste was disposed of within the generating state, approximately 15 million tons moved in interstate commerce in 1989. During 1989 and 1990, there were 132 different and regular interactions through which municipal solid waste moved between two states. Of these, 109 (or 83 percent) were between contiguous or nearby states. The remaining 17 percent were between distant, noncontiguous states.

TABLE 7–16

Composition of Municipal Solid Waste

	1960	1970	1980	1990
Gross Waste Generated				
In million tons	67.5	121.9	151.5	195.7
In pounds per person per day	2.6	3.3	3.7	4.3
Materials Recovered or Combusted				
In million tons	n/a	33.7	28.2	65.3
In pounds per person per day	n/a	0.8	0.7	1.9
Landfill or Other Disposal				
In million tons	54.9	88.2	123.3	130.4
In pounds per person per day	1.7	2.4	3.0	2.9

Nearly all interstate municipal solid waste was moved between contiguous or nearby states. The major exceptions are exports from New York and New Jersey, which reach beyond the Mississippi River. (See figure 7-22.) Additional data on the 48 contiguous states show that: 38 states import and export municipal solid waste: Five states export only, four states import only, and one state (Montana) has no known interstate activity. All states outside the Northeast except Texas export less than 100,000 tons per year. (See figure 7-23.)

From 1987 to 1990, interstate transportation of municipal solid waste has quadrupled due to New York exports alone. This has given impetus for heated debates and proposed bans or exclusionary fees on interstate transportation and disposal of municipal solid waste. New York and New Jersey were responsible for exporting nearly eight million tons, more than half of all interstate municipal solid waste during 1989 and 1990. Each state accounts for 195,000 truckloads of waste.

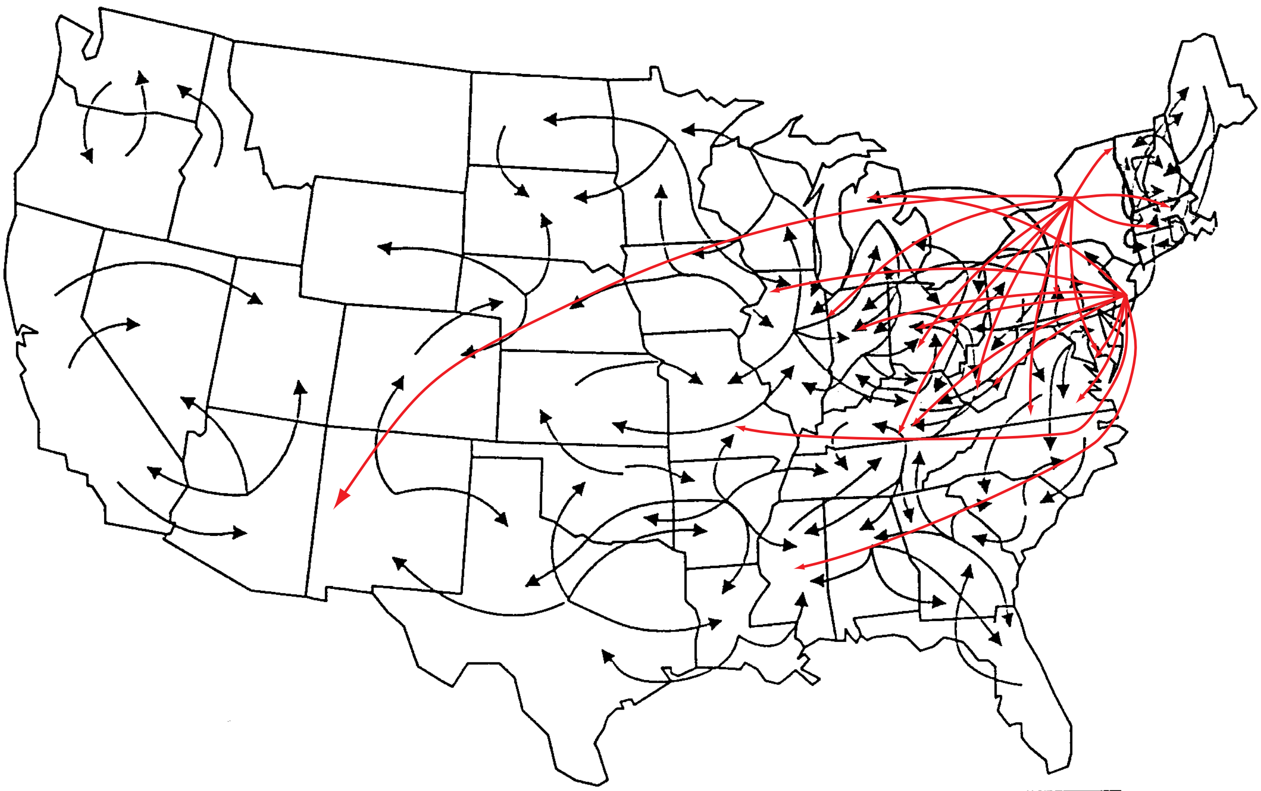
Historically, the overwhelmingly dominant mode for transporting the bulk of municipal solid waste has been by truck. Trucks continue to dominate the market for transporting municipal solid waste, hauling approximately 95 percent of the traffic from the Northeast. The U.S. Census Bureau reported that 127,600 trucks of more than 10,000 pounds gross vehicle operating weight carried scrap, refuse, and garbage as their principal commodity in 1987.[35] This number does not include government-owned vehicles, which account for a major share of local pickup of municipal waste.

With the closing of more than half of the sanitary landfills and the resulting increase in longer distance transportation of municipal solid waste, the market for rail service is growing. Many railroads have already seen an opportunity to gain a significant increase in this market. The characteristics of municipal solid waste fit the description of a perfect rail-bound commodity. It is one that is low in value, high in bulk, and heavy when compacted. Other concerns such as increased highway congestion and a corresponding increase in highway accidents create additional initiatives for rail haulers.

The amount of municipal solid waste-

FIGURE 7-22

Movement of Municipal Solid Waste (New Jersey and New York in Red)



movements on railroads is difficult to determine because the Standard Transportation Commodity Classification (STCC) system also includes scrap materials such as iron, steel, and metal in the category "waste and scrap."[36] The total quantity moved in that category was 3.5 million tons in 487 carloads in 1992. This is a 12.5 percent increase in carloads from 1991 to 1992, which compares to a 1.6 percent increase in total carloads for the same year.

Pollution Abatement and Control Expenditures

In constant 1982 dollars, expenditures on pollution abatement and control rose from $53.5 billion in 1975 to $74.4 billion in 1989, an increase of 39 percent. (See table 7-17.) The vehicle's share of total expenditures increased from 17.6 percent to 20.0 percent during the period 1975-1989, reaching its peak in 1985.

Transportation, Energy, and the Environment: What More We Need to Know

Transportation and Energy

A fundamentally important indicator of the performance of the transportation system is the energy efficiency of transportation in actual operation. With a few exceptions, data on realized fuel economy are poor or nonexistent. Comprehensive in-use fuel economy data have not been collected by the Energy Information Administration since 1985.[37] Even then, only household vehicles were covered; light duty vehicles in fleets and all heavy duty vehicles were excluded. The best available data on heavy duty trucks comes from the Census of Transportation, Truck Inventory and Use Survey. These estimates are numbers reported by owners, rather than actual in-use estimates. Highway vehicle efficiency estimates presented in Table VM-1 of *Highway Statistics* are inferred based on estimates from other sources and a process of reconciliation of fuel use and vehicle travel estimates. None are directly measured. Data on other modes are sometimes adequate; in other instances they are virtually nonexistent. For commercial air carriers, the second largest energy user, reliable fuel use and fuel efficiency statistics are available to estimate in-use aircraft miles per gallon, seat miles per gallon, and passenger-miles per gallon. What we are missing are estimates of the circuity of travel (miles actually traveled divided by great circle distance from origin to destination), a key factor in evaluating systems efficiency. Good aggregate energy efficiency data are also available for most public transit modes, but data on school bus fuel economy, for example, are all but totally absent. If we are to monitor and analyze trends and changes, and to project future energy use, we must have better information on real-world energy efficiency.

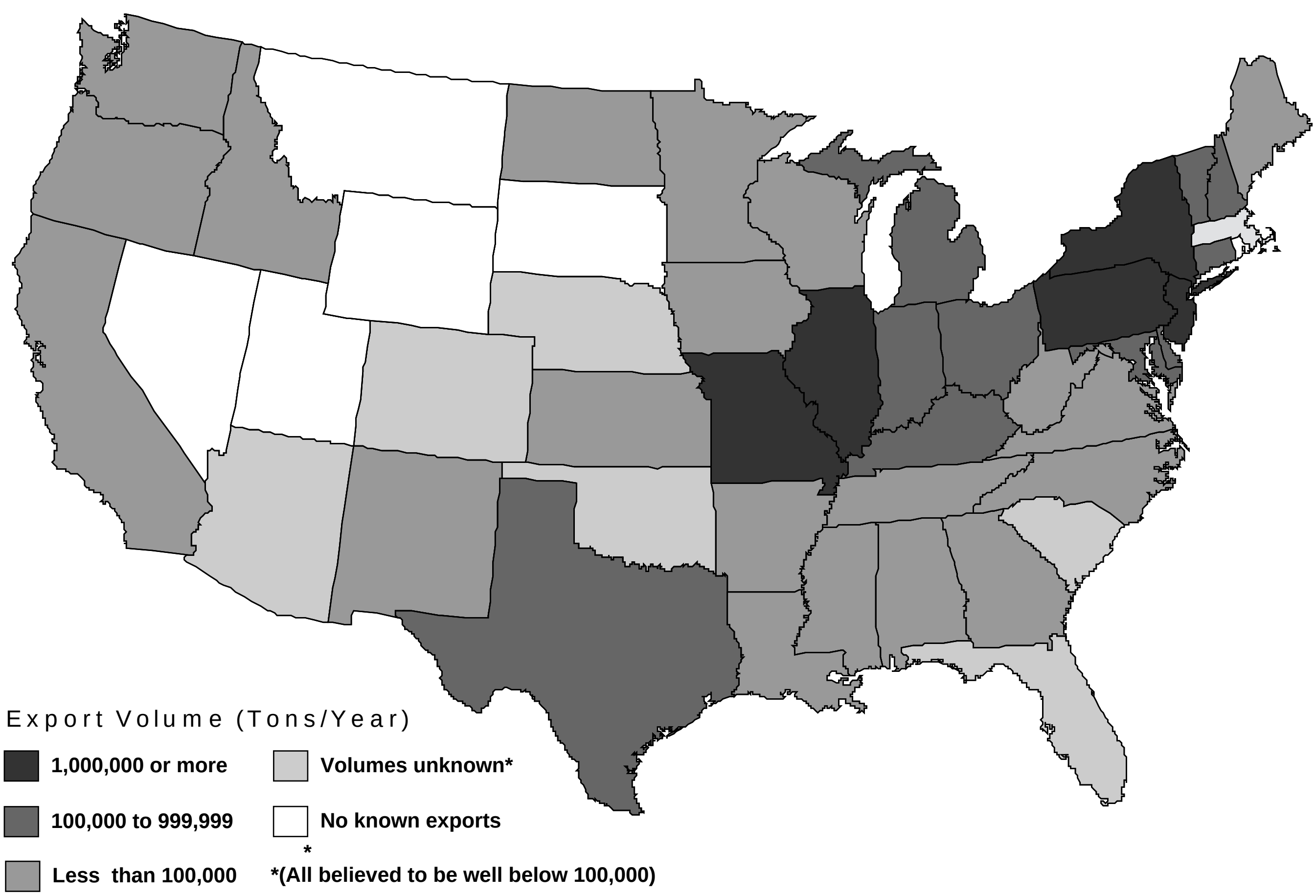
As alternative fuel vehicles begin to penetrate the vehicle fleet in large numbers, we will also need information on their usage and performance. Although existing surveys, such as DOE's Residential Transportation Energy Consumption Survey, and the Department of Transportation's Nationwide Personal Travel Survey, will provide information on household vehicles, business and government fleet vehicles, the main target of most programs, are outside the scope of these surveys. In the coming years, attention must be paid to developing adequate information systems to monitor and evaluate the impacts of alternative fuel vehicles on transportation energy use.

Transportation and the Environment

Although there are numerous individual areas in which transportation environ-

FIGURE 7–23

Exports of Municipal Solid Waste (1989–1990)



mental data are deficient, the one area that stands out above the rest is the real-world emissions performance of transportation vehicles. Unlike in-use energy efficiency, where data are adequate for some modes and circumstances, in-use emissions information is generally deficient. In 1990, the National Research Council reported that current data probably underestimates emissions of hydrocarbons (volatile organic compounds), a major precursor of ozone pollution, by a factor of two to four.[38] The emissions inventory models used for planning to achieve ambient air quality standards may be off by a factor or two or more. Evidence accumulating from studies around the country points to the fact that vehicles perform very differently in the real world than in laboratory tests. The task of gathering and analyzing data on real-world emissions is complex, costly, and time consuming. Efforts have been piecemeal and largely uncoordinated. As more data are collected and analyzed, we must build a comprehensive data resource on the real-world emissions performance of transportation vehicles.

Sources

Figures

Figures 7-1 through 7-4: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 7-5: *1992 National Transportation Statistics*.

Figure 7-6: *Transportation in America*, Eno Transportation Foundation. National Trans-

TABLE 7–17

Pollution and Control Expenditures: 1975-1989 (In Billions of 1982 Dollars)

Type of Expenditure	1975	1980	1984	1985	1986	1987	1988	1989
Personal Consumption	5.9	7.2	10.6	11.3	12.2	10.3	11.0	9.2
Motor Vehicle Emission Abatement Devices	2.1	3.9	6.9	7.5	8.2	7.4	8.4	7.8
Operation of Motor Vehicle Emission Abatement Devices	3.8	3.2	3.7	3.8	4.0	3.0	2.7	1.3
Business Consumption	32.8	39.2	40.6	40.8	42.7	43.8	45.2	47.1
Capital	14.8	15.0	14.6	14.9	14.5	14.6	15.0	15.5
Motor Vehicle Emission Abatement Devices	1.2	2.2	4.3	4.6	4.5	4.3	5.1	4.7
Plant and Equipment	1.6	10.6	7.9	7.9	7.7	8.2	8.0	9.1
Other	2.0	2.2	2.3	2.4	2.3	2.1	1.9	1.8
Current Account	17.8	24.2	26.0	25.9	28.2	29.2	30.2	31.5
Operation of Motor Vehicle Emission Abatement Devices	2.3	2.4	2.6	2.7	2.8	2.1	2.0	1.1
Operation of Plant and Equipment	10.5	15.5	15.9	16.3	17.9	19.5	19.9	21.5
Operation of Public Sewer Systems	3.4	4.7	5.8	5.9	6.7	7.1	7.6	7.8
Other	1.6	1.6	1.7	0.8	0.8	0.5	0.7	1.1
Government Consumption	15.0	15.7	13.1	12.3	13.3	13.7	13.8	14.4
Regulation and Monitoring	*	*	1.2	1.1	1.3	1.2	1.3	1.3
Research and Development	*	*	2.2	2.2	2.3	2.3	2.3	2.4
Total Expenditures	53.5	62.0	64.7	67.7	71.8	71.4	73.6	74.4
Total Motor Vehicle Expenditures	9.4	11.8	17.5	18.6	19.5	16.8	18.2	14.9
Motor Vehicle Percent	17.6%	19.0%	27.1%	27.5%	27.2%	23.5%	24.7%	20.0%

*Included in "Government" expenditures

portation Statistics. *Transportation Energy Data Book*. Oak Ridge National Laboratory. *Highway Statistics, VM-1*.

Figure 7-7: *1992 National Transportation Statistics. Transportation Energy Data Book*. Oak Ridge National Laboratory.

Figure 7-8: *National Transportation Statistics. Transportation in America*, Eno Transportation Foundation. *Air Carrier Traffic's Statistic Monthly*. Transportation Energy Data Book.

Figure 7-9: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 7-10: Alternative Fuels Data Center, Golden, CO. "*Refueling Site Maps*" August 25, 1992.

Figure 7-11: Oak Ridge National Laboratory, Oak Ridge, TN.

Figure 7-12 through 7-15: *National Air Polution Emission Estimates, 1900-91*, Environmental Protection Agency.

Figure 7-16: *Trends of Petroleum Fuels, 1987*, National Institute for Petroleum and Energy Research.

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THE STATE *of the* STATISTICS

Substantial data exist about the transportation system, but fall short of providing the information needed to inform policymakers about the strategic issues facing the U.S. Department of Transportation."[1] To address this problem, the Bureau of Transportation Statistics (BTS) is required by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to provide "documentation of methods used to obtain and ensure the quality of the statistics presented in the [annual] report." BTS interprets this requirement as a mandate to evaluate the state of transportation statistics used to assess the state of the transportation system, and to identify needed priorities among improvements to the data and methods underlying those statistics.**

Methods for Assessing the State of Transportation Statistics

Comprehensive assessments of transportation statistics have been published at least since 1969.[2] The most recent effort, documented in *Data for Decisions: Requirements for National Transportation Policy Making*,[3] is a classic example of the comprehensive approach. Information needs and resources are catalogued in a comprehensive review of data users and providers, gaps are identified, and priorities are established through the budget process.

The comprehensive approach starts with a listing of fundamental questions about transportation and its consequences—what we need to know about freight transportation, what we need to know about passenger transportation, and why we need to know those things for public policy. (See table 8-1). The list is updated from a similar table in *Data for Decisions*. For each item in Table 8-1, we must ask three questions to evaluate our state of knowledge:

- Do we know how to measure the

item in question? (Do we know how to define the concept in a way that can be quantified and unambiguously interpreted? Do we have the analytical or data collection skills to turn the definition into a useful statistic?)

- Do we have quality data to measure the item in question? (Have we applied the data collection skills to feed the desired statistic?)
- How well can we describe and understand the trends involving the item in question?

The answers to these questions will vary by item in question, by mode of transportation, and by level of geography. (See figure 8-1.)

BTS also uses a market-response approach to assessing data needs, recognizing that the broad sweep of comprehensive assessments tend to be retrospective. Although many transportation issues and information needs have a long history, new topics do emerge and new technology creates opportunities for innovative data products that do not fit traditional molds. Comprehensive assessments also provide little guidance on setting priorities among proposed data programs. For these reasons, BTS emulates the private sector by developing some prototype data products independent of its strategic plan, and by carefully assessing user reaction to both new and established products to determine whether BTS is meeting the needs of the transportation community.

BTS has not been in existence long enough to gain extensive insights on data needs from the market-response approach. Customer reactions can take several months to evolve after release of a product, and BTS has been in operation only since December 16, 1992. The Bureau's one product developed early enough (in January, 1993) to stimulate detailed customer reactions is the *Transportation Data Sampler* CD-ROM.

The *Transportation Data Sampler* CD-ROM was an introduction to the variety of information resources within DOT and allied agencies, and serves as a test of compact disk-read only memory (CD-ROM) technology for the dissemination of data products. This *Sampler* contains data bases and reports in a variety of spreadsheet, data base, and word processing formats, and includes a user response form that asks for comments on the content, formats, and other aspects of the product. Resulting comments by telephone, fax, and letter have provided insights on the utility of the included data sets, their ease of use, and desires for additional data items, and have increased BTS awareness of the need for search and retrieval software on CD-ROM products.

Selected Contents of the
Transportation Data Sampler
CD-ROM

- Summary statistics from publications such as Highway Statistics, the FAA Statistical Handbook of Aviation, the 1990 Nationwide Personal Transportation Survey, and selected publications on water transportation by the Maritime Administration and the Corps of Engineers
- Individual records from the 1990 Nationwide Truck Activity and Commodity Survey, a year's worth of the Fatal Accident Reporting System and the General Estimates System of police-reported traffic crashes, and the Federal Aviation Administration's inventories of air carrier aircraft, general aviation aircraft, and aircraft engines.
- The complete 1990 Rail Waybill public use file of the Interstate Commerce Commission.
- Geographic data bases on the highway and railroad networks and on airports for analytical studies, routing analyses, and mapping.
- Text files such as an overview of the Hazardous Materials Information System, an annotated bibliography of recent publications on the environmental effects of transportation systems, and the Intermodal Surface Transportation Efficiency Act of 1991.

Perspectives on the Current State of Transportation Statistics

Although BTS has not had the opportunity in its brief existence to develop its own comprehensive assessment or assess

TABLE 8–1

What We Need to Know About Transportation

What We Need to Know About Freight Transportation	**What We Need to Know About Passenger Transportation**	**Why Do We Care?** (for public policy, infrastructure planning and market analysis)
What moves? How much moves?	Who travels? How much Travel?	Source of transport demand, basic input to following questions; most direct beneficiaries of transportation investments.
How valuable is the material being moved?	Why do they travel?	Importance of demand to the economy and to carriers, linkages of transportation to social condition and economic structure.
How far is the move?	How far is their travel?	Aggregate measure of transport to be consumed.
From where to where?	From where to where?	Location of transport facilities and services to be consumed; geographic regions and corridors to be affected by trade and social interaction.
What main mode was used?	What main mode was used?	Basic input to debates over intermodal competition and promotion activities.
What other modes were used?	What other modes were used?	Demand for intermodal connections and local access.
Do the links, nodes, and service providers cover current and anticipated origins and destinations?	Do the links, nodes, and service providers cover current and anticipated origins and destinations?	Most basic system performance measure: can you get there from here?
How much of the system capacity (links, nodes, vehicles, services) are consumed by current and anticipated movements?	How much of the system capacity (links, nodes, vehicles, services) are consumed by current and anticipated travel?	Market consequence of demand for transportation; basic input to estimates of adequate system capacity and consequences of transportation.
Do the links, nodes, and service providers have enough capacity for current and anticipated movements?	Do the links, nodes, and service providers have enough capacity for current and anticipated travel?	Physical capacity of the system to service basic demand for transportation.
How costly to the service and infrastructure providers are the movements between origins and destinations?	How costly to the service and infrastructure providers are the movements between origins and destinations?	Efficiency and effectiveness of the transportation system to the service or infrastructure provider.
How much of the costs to serve and infrastructure providers is public versus private?	How much of the costs to serve and infrastructure providers is public versus private?	Investment requirements; cost allocation; privatization issues.
How costly to the shipper are the movements between origins and destinations? (Prices)	How costly to the traveler are the movements between origins and destinations? (Prices)	Efficiency of the transportation system to the user, source of the system's consequences for economic productivity and internatjional competitiveness; market analysis.
How timely are the movements between origins and destinations? (Traveltime, system speed)	How timely are the movements between origins and destinations? (Traveltime, system speed)	Effectiveness of the transportation system to the user; source of user satisfaction and the system's consequences for economic productivity and international competitiveness; market analysis.
How reliable are the movements between origins and destinations?	How reliable are the trips between origins and destinations?	Quality of the transportation system to the user; source of user satisfaction and the system's consequences for economic productivity and international competitiveness; market analysis.
How likely is the shipment to be damaged, lost, or stolen?	How likely is the traveler to be hurt or luggage damaged?	Safety and security.
Who is the service provider?	Who is the service provider?	Direct beneficiaries of transportation investments; accountability for operation of the transportation system.
What is the financial condition of the service provider?	What is the financial condition of the service provider?	Ability of service providers to maintain and improve performance and safety; susceptibility to foreign ownership and legal complications.
Who is the shipper? Who is receiving the shipment?	If the travel is for business, what industry is being served?	Economic sectors receiving direct benefits from transportation investments.
Who else is dependent on the shiment?	Who else is dependent on the travel?	Others receiving direct benefits from transportation investments.
How much damage is done to the physical infrastructure?	How much damage is done to the physical infrastructure?	Establishment of investment needs; allocation of costs among users and others.

continued

TABLE 8–1

What We Need to Know About Transportation (Continued)

What We Need to Know About Freight Transportation	What We Need to Know About Passenger Transportation	Why Do We Care? (for public policy, infrastructure planning and market analysis)
What is the risk of health-threatening mishaps?	What is the risk of health-threatening mishaps to bystanders?	Safety; hazardous materials.
How much damage is done to air quality?	How much damage is done to air quality?	Clear Air Act requirements.
How much damage is done to water quality?	How much damage is done to water quality?	Wetlands preservation and related environmental protection requirements.
How much noise and other pollution is created?	How much noise and other pollution is created?	One of the politically sensitive conflicts between environmental concerns and interstate commerce.
How much energy is consumed?	How much energy is consumed?	Energy conservation; national security.
Who is affected by these externalities?	Who is affected by these externalities?	Societal consequences of transportation.
What is affected by these externalities?	What is affected by these externalities?	Consequences of transportation for endangered species and environmental concerns.

market responses in a thorough, rigorous manner, the Bureau has a clear sense of major problems with transportation statistics based on a quarter century of studies, a year of meetings, and the legislation that created the Bureau. The major problems are consistent across perspectives of Congress, DOT, and the transportation community as portrayed by the National Academy of Sciences.

Perspectives of Congress

Congressional concerns with transportation statistics have been expressed in ISTEA. ISTEA organizes those concerns in the six functional areas for BTS, and expands on those concerns in the specific subjects and projects within those areas:

- Compile and analyze statistics, particularly related to 11 major topics to be covered in the *Transportation Statistics Annual Report.*
- Collect data on subjects that transcend or fall between existing DOT's existing statistical programs, specifically including an Intermodal Transportation Data Base to be created by BTS for the Office of Intermodalism.
- Establish guidelines to improve comparability and quality of DOT statistics, and convene an Advisory Council on Transportation Statistics to assure quality and relevance of BTS products.
- Represent transportation in the statistical community.
- Make statistics accessible and understandable.
- Identify data needs through ongoing BTS activities and through a one-time study by the National Academy of Sciences.

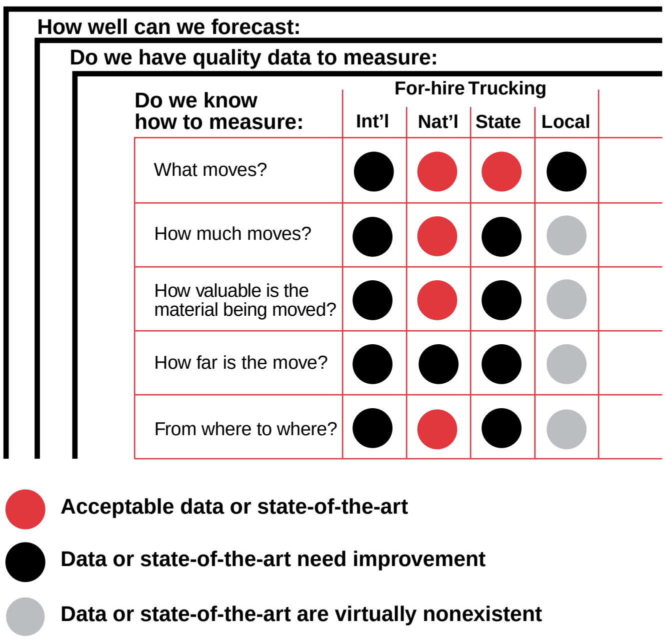
DOT Perspectives

Additional concerns by DOT with the state of transportation statistics have been expressed through discussions of the Intermodal Transportation Advisory Board (ITAB), which consists of DOT modal administrators and secretarial officers. In response to departmentwide needs, modal administrations have suggested that BTS:

- identify data and tools to define and analyze the proposed National Transportation System;
- take the lead in defining and implementing better measures of economic productivity of the transportation industry;
- improve information on international transportation by resurrecting the Survey of Domestic Transportation of U.S. Foreign Trade and helping the modal administrations negotiate for better data from the Customs Service and other agencies;
- provide a forum in which the modes can share forecasts of transportation,

FIGURE 8–1

Tracking the State of Knowledge



economic, and demographic variables to improve the quality and consistency of those forecasts;

- coordinate purchases of data from private vendors to avoid duplicative purchases, to achieve economies of scale, and to assure that all parts of DOT have access to common data sources;
- supplement the Nationwide Personal Transportation Survey and similar data collections to improve coverage accuracy, especially for modes such as transit and intercity rail passenger service that are not ubiquitous;
- identify and capture opportunities to piggyback transportation questions on the Censuses of Manufacturing, Agriculture, Wholesale and Retail Trade, and Governments;
- undertake studies of multimodal-modal and intermodal trends, such as the effects of *edge cities* on transportation demand and the impacts of flooding on freight transportation; and
- help the modes develop better information on transportation costs.

BTS has also been asked to assist individual modal administrations in projects such as:

- the Federal Highway Administration's Overweight Container Enforcement Study;
- the Federal Aviation Administration's survey of general aviation;
- travel behavior surveys in high-density corridors for the Federal Transit Administration;
- expansion of the Economic Census to short-line railroads for Federal Railroad Administration;
- a CD-ROM on hazardous materials transportation for the Research and Special Programs Administration and the Coast Guard;
- analyses of freight transshipments through the U.S. (without stopping) and cargo diversion to Canada for the Maritime Administration; and
- the integration of health care statistics related to highway accidents for the National Highway Traffic Safety Administration.

Perspectives of the National Academy of Sciences

The specific ISTEA mandate for BTS reflects a larger concern with the information base upon which decisions can be made, and with the visibility of transportation needs in public debates over resource allocation. Major information gaps and analytical needs are identified in *Data for Decisions*. This report, authored by a panel of experts from throughout the transportation community with extensive input from DOT's modal administrations, defines major topics for BTS beyond the specifics of ISTEA:

- BTS should provide departmental leadership in advancing geographic information systems (GIS) technology, methods of data acquisition (particularly with respect to Electronic Data Interchange and Global Positioning Systems), and protection of confidentiality of data on individuals, households, and businesses.
- BTS should develop and publish better measures of systemwide performance, providing a more accurate picture of how well the transportation system works from the user perspective.
- BTS should analyze transportation's role in the economy, its environmental and energy consequences, and its ability to support national security and emergency preparedness.

TABLE 8–2

Illustrations of Key Data Deficiencies

Data Category	Data Deficiency	Agencies Involved in Data Compilation	National Policies Served
Supply and demand	Passenger and commodity flow data	DOT; Bureau of the Census	Congestion alleviation; investment decisions; system capacity for civilian and defense needs
Performance Safety and personnel security	Exposure data Reporting of injuries and nonfatal accidents Measures of system security	DOT	Identification and monitoring of major system safety and security problems; evaluation of alternative safety regulations
Access	Measures of availability, use and cost of transport services in rural and small urban areas and for handicapped, elderly, and low-income populations	DOT; DOA; DHHS	Investment decisions and development strategies; evaluation of costs and benefits of alternative service delivery mechanisms
Service delivery	Measures of service quality Measures of intermodal performance	DOT DOT; Bureau of the Census; U.S. Customs Service	Investment decisions; identification of impediments to transportation performance affecting economic growth and international trade
Impacts on other national objectives			
Economic growth	Measures of transportation impacts on industrial profitability Expanded data on specific transportation service sectors and their relative contribution to productivity of the sector as a whole	DOT; BLS; BEA; Bureau of the Census	Articulation of value of transportation to economic growth; investment policies to support U.S. competitiveness
National Security	Location, condition, and use of transportation facilities	DOT; DOD	Investment strategies for improved military deployment; economic impacts of alternative levels of demand
Environmental quality/land use	VMT, speed data, and other measures of transportation impacts on air quality Measures of transportation impacts on global warming, wetlands degradation, water and noise pollution, and other environmental concerns	DOT; EPA; DOE; states; other agencies with environmental missions	Evaluation of environmental impacts of alternative transportation investments Identification of magnitude and effects of transportation impacts on the environment; development of policies to mitigate adverse impacts
Energy use	Improved measures of vehicle fuel efficiency	DOT; DOE	Evaluation of energy performance of alternative transportation modes; monitoring energy performance of the transportation sector

Note: VMT=vehicle miles traveled; DOT=Department of Transportation; EPA=Environmental Protection Agency; DOE=Department of Energy; DOD=Department of Defense; DOA=Department of Agriculture; DHHS=Department of Health and Human Services; BLS=Bureau of Labor Statistics; BEA=Bureau of Economic Analysis

Perspectives of Other Federal Agencies: The Case of the Department of Defense

The Department of Defense is a major user of civilian transportation facilities and services at home and abroad, as illustrated by the significant demands for *just-in-time* delivery of the military force and supporting civilian activity during the Persian Gulf War. As discussed in *Data for Decisions,* the transportation system was able to cope with the stress because the recessionary economic environment of the time created considerable slack in the system.

Data for Decisions states that the DOT Secretary "should be able to assess what impact different levels of demand, military and civilian, would have on economic performance; identify where added investment in facilities would provide the greatest benefits in improved military deployment capability; and evaluate how the special requirements of military equipment (e.g., ammunition shipped in containers) would affect commercial activity."

The report further notes that:

> *Collecting the data to address these questions is complex, time-consuming, and costly, because of the special characteristics of defense transportation data requirements. First, the data must be precise regarding the location, physical characteristics, and performance capabilities of transportation facilities. For example, it is not enough to know that there are three bridges rated structurally deficient on primary highways in the metropolitan Miami area. Data on condition and use must be linked directly to specific facilities at specific locations on strategic defense highways. Second, the data must be comprehensive. Defense transportation data needs are concerned with all transportation modes and how they interact; it is frequently at the links between the modes—rail or highway connections to ports, for example—where delays and breakdowns in transporting equipment occur.*[4]

Transportation data concerns of the Department of Defense cut across the

Findings and Recommendations in *Data For Decisions*

Transportation data are plentiful, but inadequate for national policymaking. The biggest gap in DOT's multimodal data programs is in passenger and freight flow data. These data provide basic system information on who or what is moving, by what mode, and from where to where; they are also basic input for other desired system indicators. Flow data provide an exposure measure for calculating accident rates per passenger-mile or ton-mile. They are a critical input to forecasts of vehicle activity, which affect projections of congestion, estimates of emissions levels in urban areas with unacceptably high levels of ozone and carbon monoxide, and monitoring of energy use by the transportation sector. A departmental priority should be the collection of national passenger and freight flow data, which have not been gathered since 1977. Although national surveys will not provide the data for detailed analyses of local congestion or air quality problems, additional sampling in major transportation corridors and urban areas should provide adequate detail for national monitoring and analysis purposes.

Development of [a national transportation performance monitoring system] will also require improving the comparability of data collected on individual transportation modes to enhance inter modal comparisons and provide an assessment of overall system performance. Existing data must also be integrated and supplemented to enhance the capability of the department to determine the contribution of the transportation system to such other national objectives as economic growth, national security, environmental quality, and energy use. DOT must work cooperatively with the operating administrations, other federal agencies, and the states to develop these data.

Opportunities for using data that are gathered by the private sector or collaborating with the private sector in data collection efforts should be explored as an alternative to new data collection efforts. Advances in data gathering and information processing technologies have the potential to reduce costs and reporting burdens while improving the speed and reliability of data collection and analysis. The areas of greatest opportunity for application to developing [a national transportation performance monitoring system], such as automated surveying methods, electronic linking of records through [electronic data interchange], automated vehicle and traffic monitoring through [intelligent vehicle highway systems] technologies, and integration of data into [geographic information systems] for analysis, should be carefully investigated.

TABLE 8–3

Definitions and Criteria Currently Used to Measure Fatalities by Mode of Transporation

Mode	Terminology	Definition	Criteria/Exclusions
Air Carrier	Fatal Injury	Any injury which results in death	Within seven days of the accident
Hazardous Materials	Fatality	The information received indicated that the death was due to the hazardous material involved	Not specified
Highway	Motor Vehicle Traffic Fatality	A death or injury resulting from motor vehicle accident injuries occurring on a trafficway	Within 30 days of the accident
Pipelines	Fatality	A death resulting from the failure or escape of gas, or the escape of liquid	Not specified
Rail Rapid and Transit	Casualty	1) Employees who are on duty and who are killed; 2) Casualties involving passengers or other personnel (off-duty employees, contractors, etc.) which occur at or in exclusive approached to or from faregates, or equivalent, or with the normal "paid" area, and which results in fatalities	Assaults, attempted suicides, and suicides are excluded
Railroad	Fatality	1) The death of any person from an injury;	Within 365 days of the accident/incident
		2) The death of any railroad employee from occupation illness	Within 365 days after the occupational illness was diagnosed by a physician
Recreational Boating	Fatality	All deaths and missing persons resulting from an occurrence that involves a vessel or its equipment	Other than deaths by natural causes
Waterborne	Fatality	All deaths and missing persons resulting from a vessel casualty, such as a collision, fire, or explosion	Excludes nonvessel casualty-related deaths

entire range of BTS interests. The Department of Defense has provided BTS with the following assessment of data needs as a starting point for discussion.

HIGHWAYS

Critical

- An accurate and complete national bridge database for the Interstate and primary systems containing information on:
- Structural capacity to support heavy loads through identification of a national military load classification (MLC)
- Structure location (with accuracy of 1,000 to 1,500 meters)
- Vertical clearance capability (at least the width of one lane)
- Vehicle bypass capability around restrictive structures (less than 16 ft)
- A linear reference (mileposts) database compatible with state mileposts programs for Interstate and primary highway systems
- An accurate traffic volume (ADT) database for links of the Interstate and primary systems
- A congestion delay (time-windowed traffic density based on ADT) database for links/nodes of the Interstate and primary systems

Desirable

- An Interstate interchange configuration database

- A speed information (post limits) database for the Interstate and primary systems
- A route (link and node) population density database for the Interstate and primary systems

Reason for Need

- To provide enhanced analytical examination of military unit movements to determine ability to deploy in required time frames. Will allow DOD planners and strategists ability to make decisions based on available operational information regarding best/quickest/safest routing to seaports and airfields.

RAILROADS

Critical

- An accurate and complete rail line characteristics database for civil rail lines important to national defense (CRLIND) containing information on:
  - Carrier posted safety-maintenance speed classification
  - FRA safety-maintenance classification status
  - Vertical and lateral clearances
  - Freight (without passenger) traffic density
  - A national linear reference (mileposts) database for CRLIND

Desirable

- A database of abandonment status for CRLIND rail lines in the ICC process
- A route (link and node) population density database along CRLIND

Reason for Need

To monitor and confirm the defense readiness conditions of CRLIND for mobilization and deployment. This data will be used to conduct detailed examination of military equipment movements in required time frames.

INTERMODAL SYSTEMS

Critical

- An accurate and complete intermodal transfer point characteristics database containing information on:
  - Facility location (using a reference system compatible with DOT highway and rail line digitized networks)
  - Highway/rail line access (i.e., number of lanes/rail lines, double-stack capability, container reception/staging capacity, etc.
  - Container transfer capacity (TEUs per hour)

Desirable

- Intermodal transfer point information on:
  - Container handling equipment availability
  - Hours of operation
  - Ownership, servicing carriers, point-of-contact

Reason for Need

This information will be used by the Strategic Transportation Analysis system to model transfer of intermodal containers between the highway and rail networks in mobilization and deployment situations. It will also be used to identify key intermodal facilities that link defense important highways and rail lines.

BTS Perspectives from the *Transportation Statistics Annual Report*

BTS has established its own perspectives on information needs through the development of the *Transportation Statistics Annual Report*. Each preceding chapter concludes with a section on what we don't know as well as we should.

Major subjects requiring *basic information*:

- the location, condition, and physical performance of transportation services and facilities provided by the private sector;
- the location, condition, and physical performance of intermodal connections;
- the quantity and geographic distribution of commodity and passenger movements;
- the direct costs of transportation services to carry commodity and passenger flows;
- business travel;
- expenditures and revenues of for-hire carriers in passenger transportation, arrangers of transportation services, short-line railroads, and water transportation;
- the inventory and use of transporta-

tion resources controlled by establishments that are not primarily in the business of for-hire transportation; and
- fuel consumption and fuel economy based on real-world experience rather than laboratory conditions.

Major subjects requiring more reliable, comparable, or *detailed information*:
- the location, condition, and physical performance of transportation services and facilities provided by the public sector;
- the balance of trade related to transportation services and international travel;
- the characteristics and travel behavior of foreign visitors in the U.S. and of U.S. travelers abroad;
- motor vehicle miles of travel by vehicle type;
- safety (particularly with respect to definitions of terms); and
- environmental conditions affected by transportation.

Major subjects requiring better measures or analytical methods for improved understanding:
- congestion;
- relationships between transportation spending and economic activity, particularly with respect to international trade, employment, regional development, and the Gross Domestic Product;
- relationships between economic activity and the use of craft and vehicles.
- relationships between environmental quality and the use of craft and vehicles.
- the transportation needs of disadvantaged groups.

BTS was established in part because basic information on commodity movements, passenger movements, and intermodal connections was absent or out of date. Many additional topics requiring have been identified, some requiring new data collection and others requiring innovative measures or analytical methods to turn raw data into information. The topics related to the effects of transportation on our pocketbooks and the larger role of transportation in the economy require that the basic taxonomy of transportation industries and the accounting of transportation within the structure of the economy must also be more adequately defined.

Data collection needs are driven by quality problems as well as by gaps in existing data bases. The most common quality concern involves vehicle activity. Estimates of current vehicle activity are central to informed discussions of safety issues, tax policy, energy consumption, and environmental pollution. Although estimates of total vehicle activity are generally accepted, disaggregations by vehicle type or locality are often questioned. Existing data collections must be expanded and improved to provide the needed detail.

Data gaps and quality problems can often be ameliorated by combining existing data sets through record matching or statistical means; however, such data integration requires comparability of data collection methods, analytical procedures, and basic definitions. Comparability is also essential to understanding the differences among modes and to identifying opportunities for efficient intermodal activity. Comparability is difficult to achieve in transportation when definitions of even the most basic concepts vary among the modes. DOT's varied definitions for *fatality* illustrate the problem. (See table 8-3.)

Comparability is only one aspect of the larger problems of relevance and understandability of measures used to describe transportation. Productivity is a prime example, as recently documented in the Federal Highway Administration report, *An Examination of Transportation Industry Productivity Measures.*[5] Even if the daunting problems of inadequate data and classification systems to support existing measures are resolved, those measures may be so esoteric that no one except a professional economist can understand them. Even if the mechanics of the measures are understood, the philosophical basis of the measures are not always obvious. A quantitative measure of change in productivity typically interpreted as more efficient output and a benefit to society can also be interpreted as exploitation of labor that violates equity and other values to the detriment of society's members. We know neither whether things are getting better or worse, nor what we mean by better or worse.

The state of transportation statistics is not all negative; there are also enormous opportunities and challenges related to emerging information technology. Electronic data interchange (EDI), global positioning systems (GPS), automated vehicle identification (AVI), weigh-in-motion (WIM), and portable computer technologies have the potential for acquiring greater amounts of information with higher precision at less cost and respondent burden than traditional forms of data collection based on paper, telephones, or personal interviews. Geographic information systems (GIS) promise significant improvements in the management, analysis, and visualization of data, although the promise has been made and broken several times over the past quarter century. The promise may be achieved this time because of the democratization of computers. Inexpensive microcomputers, spreadsheets, and CD-ROM technology are placing computational and data management power in the hands of small organizations and individuals, removing the hardware barriers that formerly restricted large data manipulation to organizations that could afford mainframe computers and computer programmers.

These opportunities also bring many challenges to BTS and to the transportation community. Emerging data acquisition technology will change the type of data that can be collected, as illustrated by WIM. Truck weight data was once collected by stopping vehicles at portable, roadside scales. The number of observations was limited by the cost to the data collector and the annoyance to the trucker, and data quality suffered from scale avoidance. Unobtrusive WIM technology allowed dramatic increases in observations at reduced costs, respondent burden, and bias from selective avoidance by truckers in a hurry. However, the technology has reduced the attribute detail for each observation. Information on the contents of the truck, the truck's owner, and the driver could be collected while the truck was being weighed on a static scale. WIM technology obtains only the weight of each axle and the spacing between axles. The resulting information is important and much improved in accuracy, but it lacks the richness of data obtained by the old methods. Supplemental data collections such as the Nationwide Truck Activity and Commodity Survey are needed to replace essential attributes that have been lost to the new technology. Unobtrusive data acquisition and administrative record matching technologies also raise societal issues such as privacy and confidentiality that must be respected.

The democratization of data and analysis through microcomputers, spreadsheets, and CD-ROM technology also creates challenges. These technologies expand dramatically the customer base to be served by BTS and others, creating a whole new class of data-hungry organizations and individuals. These technologies can also provide easy access to data that are difficult to use properly. Technology and cost no longer restrict data use to experienced *power* users. This places a greater burden on BTS and others to provide effective training in the proper use of the data. For example, five different weights are reported for each vehicle in the Census Bureau's Truck Inventory and Use Survey. The proper vehicle weight to use depends on the analysis being performed, and the appropriate choice is not always obvious. Training material for this data base is needed to explain the subtleties involved, in effect matching the power and flexibility of the data base with clarity and completeness in the instructions. BTS must increase its emphasis on user support as it increases the amount and sophistication of available data. BTS must also increase the sophistication of the training media to reach a growing customer base with available staff resources and to avoid overwhelming those customers with mammoth manuals.

The Future State of Transportation Statistics: A Potential Crisis with the Year 2000 Census

The future state of transportation statistics could be significantly changed by near-term decisions involving the Year 2000 Census of Population and Housing. The Census Bureau is considering a radical change in the way it will conduct the 2000 census that would not provide the benchmark travel-to-work data traditionally provided by the decennial census for transportation planning. All other BTS activities to resolve data problems and capture opportunities for better information could be dwarfed by this potential crisis in transportation statistics, if appropriate census data cease to be collected.

Data from the decennial census are the backbone of the statistical system that supports the transportation planning process of our nation. DOT, as well as state and local transportation planning organizations, have relied on the consistent data collection provided by the decennial census since 1960 when transportation questions were first added to the census questionnaire. Today, these organizations are increasingly reliant on census data to implement the requirements of ISTEA and the Clean Air Act Amendments of 1990 (CAAA).

Special tabulations of 1990 census data for states and metropolitan regions, tailored to the needs of transportation planners and policy makers, are currently being released. At the same time, although the next census is six years in the future, planning for the 2000 census is well underway. The decisions will determine the transportation data and data products from the decennial census to meet the nation's data needs at the turn of the twenty-first century.

In its role of coordinating the collection of transportation data with information-gathering activities of other federal departments, BTS is working closely with the Bureau of the Census, the Office of Management and Budget, and other federal agencies to represent the interests of the transportation community in the 2000 census planning process. Furthermore, in response to its statutory responsibility for making transportation statistics readily accessible, BTS is playing an integral part in providing the 1990 census results to state and local transportation planners.

The History of Transportation Data from the Decennial Census

In the Beginning: The 1960 Census. DOT and the Bureau of the Census have a long tradition of working together to meet the nation's needs for transportation data. Transportation data were first collected in the 1960 census, when questions on city and county of work, means of transportation to work, and the number of automobiles available to each household were added to the census questionnaire. The pioneering regional transportation studies undertaken in many large cities in the latter half of the 1950s, and provisions of the Federal-Aid Highway Act of 1956 to provide alternative interstate service into, through, and around urban areas, gave impetus to the demand for comprehensive statistics on the amount and character of commuting within metropolitan communities.

The Federal-Aid Highway Act of 1962 required that approval of any federal-aid highway project in an urbanized area of 50,000 or more population be based on a continuing, comprehensive urban transportation planning process. By 1965, all then existing urbanized areas had an urban transportation planning process underway. This planning process created the need for more geographically detailed commuting data for urban areas to monitor local travel patterns.

The 1970 Census: the First Data for Traffic Analysis Zones. The development by the Census Bureau of computerized Address Coding Guides made it operationally feasible for the Bureau to collect the actual street address of work places in the 1970 census and code them to the city block level. Local transportation planning agencies, supported by state highway planning and research funds, assisted the Census Bureau in the development of these coding tools.

After the 1970 census, DOT contracted with the Bureau of the Census to produce compilations of block-level socioeconomic and travel-to-work data aggregated to traffic analysis zones. The standardized tabulations contained in this *Transportation Planning Package* were designed to provide a common data base for transportation studies and reduce processing costs. Metropolitan planning organizations submitted census block-to-traffic analysis zone equivalency files for their metropolitan areas, and the Census Bureau produced the traffic zone data packages on a cost-reimbursable basis.

In 1973, the Transportation Research Board of the National Academy of Sciences held the first national conference on "Census Data and Urban Transportation Planning" in Albuquerque, New Mexico. The conference was attended by

DOT and Census Bureau officials, as well as professionals from throughout the nation who were working in census and transportation planning activities, who reviewed their experiences in using the data from the 1970 census in the transportation planning process and formulated recommendations for improvements in the transportation data from the 1980 census.

The 1980 Census: A Fully-Developed Journey-to-Work Statistics Program. The energy crisis of the early 1970s heightened the need for transportation statistics to assess the transportation implications of energy shortages and costs. To meet this need for data, DOT sponsored a travel-to-work supplement to the Annual Housing Survey, conducted by the Bureau of the Census for the Department of Housing and Urban Development. The travel-to-work statistics collected in the American Housing Survey between 1975 and 1977 became the model for the transportation items collected in the 1980 census. The increasing importance with which the Bureau of the Census viewed transportation statistics also was demonstrated in 1978 when it established a Journey-to-Work Statistics Staff.

The 1980 census marked the first census for which the Census Bureau had a fully developed journey-to-work statistics program. The number of transportation questions asked in the census increased significantly in 1980. In addition to the inquiries on place of work, means of transportation to work, and the number of automobiles available to each household that had been included in the census in 1960 and 1970, the 1980 census asked new questions on carpooling arrangements, the number of persons in the carpool, travel time from home to work, the number of persons with disabilities that limited or prevented them from using public transportation, and the number of trucks and vans available.

The geographic reference materials used to code responses to the place-of-work question for the 1980 census were improved, resulting in an improvement in the accuracy and completeness of the coded data. Major employer files and reference lists of buildings, colleges and universities, military installations, shopping centers, and other employment sites were developed to code work place responses.

The development of computerized Geographic Base File/Dual Independent Map Encoding (GBF/DIME) Files by the Census Bureau to code addresses for the 1980 census also contributed greatly to the improved accuracy of block-level place-of-work data. Regional transportation planning organizations in the nation's metropolitan areas assisted the Census Bureau in the development of GBF/DIME Files by creating and updating the files based on local maps and expertise. DOT provided funding to support this cooperative effort.

Once again for the 1980 census DOT contracted with the Census Bureau to create a series of special tabulations in a Transportation Planning Package. Metropolitan planning organizations obtained the data tabulated for their traffic analysis zones on a cost-reimbursable basis.

After the 1980 census, the Transportation Research Board conducted the second "National Conference on Decennial Census Data for Transportation Planning." Held in Orlando, Florida in 1984, the conference was structured to provide a review of data user experience with the 1980 census and make recommendations for improvements in the program for the 1990 census. Officials from DOT and the Bureau of the Census participated in the conference along with state and metropolitan transportation planners.

The 1990 Census: A Refinement. The 1990 census transportation statistics program marked the continued refinement of transportation data available from the census, technical improvement in the geographic coding of place-of-work responses to small areas within metropolitan regions, and the creation and dissemination of innovative transportation data products. The 1990 census again included questions on place of work, means of transportation to work, carpooling, carpool occupancy, and travel time to work. An important new question on time of departure from home to work was added to the census questionnaire to allow tabulation of commuting patterns and characteristics by peak hours of travel. The questions on automobiles available and trucks or vans available were combined into one question on number of vehicles available. The question on public transportation disability was replaced with a more general question that identified persons whose disabilities limited their ability to get around outside the home alone.

Two innovative technical advancements in place-of-work coding were made for 1990. The first innovation was the joint development by the Census Bureau and DOT of the Census/Metropolitan Planning Organization Cooperative Assistance Program. This program gave local metropolitan planning organizations the opportunity to assist the Census Bureau in improving the accuracy of place-of-work data for their region. Planning organizations were given the opportunity to take part in three activities: providing files of employers and their locations to the Census Bureau, working with major employers to ensure that their employees reported accurate work place addresses, and assisting the Census Bureau in coding place-of-work responses that census clerks could not code. More than 300 metropolitan planning organizations took part in these cooperative activities. The Federal Highway Administration made the costs incurred by the metropolitan planning organizations for this work an eligible activity for use of Federal-Aid Highway Planning Funds.

The second advancement in place-of-work coding was the implementation by the Census Bureau of an automated place-of-work coding system. Place-of-work addresses were keyed to create machine-readable files that were then matched to address coding and major employer files to assign a geographic codes to the place-of-work responses. Cases that could not be coded on the computer were sorted and clustered and referred to clerks for research and computer-assisted clerical coding. The automation of place-of-work coding allowed the Census Bureau to accomplish the coding operation efficiently and cost effectively.

Significant innovations in the dissemination of the journey-to-work data also have been achieved for the 1990 census. Two Transportation Planning Packages are being produced: statewide packages for each state and the District of Columbia, and urban packages for the transportation study area defined by each metropolitan planning organization. Production of the Transportation Planning Packages by the Bureau of the Census is sponsored by the state departments of transportation under a pooled funding arrangement with the American Association of State Highway and Transportation Officials. This pooled funding arrangement supports the production of data for the entire country instead of only those areas that decided to purchase the data as in previous censuses. Funding to develop the 1990 Census Transportation Planning Package Program was provided by the Federal Highway Administration and the Federal Transit Administration.

To make the data contained on the data tapes easily accessible and widely available, the Bureau of Transportation Statistics is releasing the 1990 Census Transportation Planning Packages on CD-ROM and providing software to display and retrieve the data. This revolutionary advancement in disseminating the census data in a format that is compatible with widely available microcomputers has democratized data that have been accessible only on mainframe computers in previous censuses.

In April, 1994, the Transportation Research Board will sponsor the third National Conference on Decennial Census Data for Transportation Planning. DOT officials, Census Bureau officials, and state and local transportation planners will meet in Irvine, California to review their experiences with using the 1990 census data for transportation planning and make recommendations for the 2000 census.

Uses of Decennial Census Data for Transportation Planning

Transportation data from the decennial census are used by DOT as a comprehensive database supporting development of new policies and programs, and as benchmark data with which to evaluate the impacts and overall effectiveness of previously implemented programs.

DOT works in partnership with states and local governments to assess project and corridor-level impacts of implemented plans, programs, and specific projects. In supporting ISTEA and CAAA, as well as other federal legislation such as the National Environmental Protection Act, Title VI of the Civil Rights Act of 1964, the Uniform Relocation Assistance Act, and the

Highway Safety Act, decennial census data facilitate a consistent level of responsible federal oversight and review of state and local plans and programs. For example, census data are an important tool in the environmental review process required under the National Environmental Protection Act to assess the potential impacts of yet-to-be implemented projects. In consideration of CAAA, journey-to-work data from the 2000 census will provide important feedback on the overall effectiveness of today's national air quality agenda. To respond to the requirements of the Americans With Disabilities Act for fully accessible transportation to all segments of the population, the data on persons with mobility limitations that are traditionally provided by the census provide an opportunity for the Department to conduct a nationwide assessment of service needs.

Decennial census data for small areas such as census tracts and traffic analysis zones are used by states and metropolitan planning organizations to meet the provisions of ISTEA, CAAA, and the Americans With Disabilities Act. ISTEA requirements for comprehensive planning, project selection, congestion management, and corridor preservation are not new concepts, but place greater emphasis on local decision-making which in turn creates greater demand for extensive, locality-specific information.

Regions cited for being in non-attainment of federal air quality standards must comply with Environmental Protection Agency and DOT requirements under CAAA. The transportation/air quality planning requirements of CAAA require state and local public agencies to prepare comprehensive vehicular travel and pollutant emissions profiles. To prepare these profiles requires analysis of detailed household and worker characteristics, means of travel, commuting patterns, and journey-to-work trip lengths obtained from the decennial census.

CAAA also requires severely polluted areas to compute regional average rates of vehicle occupancy in the commute to work. The census provides these data in a consistent manner nationwide.

Under CAAA, preparation of the State Implementation Plan and the comprehensive urban transportation planning process must be coordinated. Transportation facilities and projects proposed as part of the long-range transportation plan must be evaluated for their impact on air quality. Thus, forecasted travel volumes along specific routes are translated into forecasted traffic speeds and emissions. The results are used in determining conformity with the State Implementation Plan. Data from the decennial census are the basis of these forecasts.

DOT has initiated a Travel Model Improvement Program (TMIP) to help states and localities address their transportation and environmental needs and meet the requirements of ISTEA and CAAA. The General Accounting Office places significant importance on TMIP in its October, 1993 report, Transportation Infrastructure: Better Tools Needed for Making Decisions on Using ISTEA Funds Flexibility. Continued availability of census data are essential to the success of the TMIP.

Understanding regional travel patterns assists transit agencies in developing new services and revising existing services. These services may include vanpools and carpools, in addition to fixed rail and fixed route bus services. Small area census data for traffic analysis zones on journey-to-work characteristics are used for route planning, market analysis, publicity, and advertising.

The Americans With Disabilities Act requires states and local transit operators, with oversight and policy review by DOT, to provide service levels that are fully accessible to all segments of the population. Data from the census which describe the geographic distribution of persons with disabilities that limit their ability to get around outside the home are used to develop and improve transportation services for this specific population.

ISTEA Requirements for Census Data

Comprehensive Planning. ISTEA contains specific provisions requiring comprehensive transportation planning processes on a statewide basis, as well as at the metropolitan area level. States, local governments, and regional agencies must analyze the impacts of transportation plans, policies, and programs. The procedures involved are very data intensive, and small-area data from the decennial census provide much of the required information. Principal among these procedures is travel forecasting.

The function of transportation models is to replicate how people travel, to model their travel to and from different locations, by time of day, purpose, and mode. Models are used to forecast how people will travel in the future, with assumptions made about transportation infrastructure development and changes, land use changes, parking cost and availability, and changes in individual travel behavior. By building these models, planners can evaluate different alternatives. For example, will adding carpool lanes along a particular highway reduce or increase congestion in the future, and how do these results compare with building general purpose lanes or increasing transit service. For most travel models, the forecasting horizon is twenty to thirty years. Thus, data from the 1990 census are used to test the reliability of current models to predict 1990 travel behavior, and to then forecast travel in 2000, 2010, and 2020.

The decennial census provides the baseline of household and person characteristics, origins and destinations of work trips, and travel characteristics for small areas such as traffic analysis zones used in regional and local travel demand modeling efforts. These forecasts are used by state, regional, and local agencies to develop, test, and refine methods for projecting future travel needs at the regional, subarea, and corridor levels. Using these models for travel forecasting allows analysis of alternative highway, transit, and multimodal-modal developments with various policy scenarios.

In addition to supplying data for travel forecasting, the decennial census provides important information for transportation planners to monitor trends in travel behavior. Census data permit the tracking of travel times and peak hours of travel by mode of travel and by residence and work location. The census also provides estimates and data for trend analyses of rates of carpooling and public transit use in the journey-to-work.

Transportation Improvement Program: Project Selection. ISTEA specifically requires that statewide and metropolitan transportation plans address broad issues such as land development and demographic growth, impacts of transportation facilities on population segments, and regional mobility and congestion levels. These plans must give consideration to the social, economic, and environmental effects, including air quality effects, of transportation plans and programs. Projects contained in Transportation Improvement Programs must be found to conform to the emissions reduction schedules in a state Implementation Plan. Census data on commuter travel flows and travel behavior patterns provide important baseline values against which Transportation Improvement Program projects can be evaluated and selected.

Traffic Congestion Management. ISTEA requires states, in cooperation with metropolitan planning organizations, to develop traffic congestion management systems. Transportation Control Measures and Travel Demand Management programs often use census data on the journey to work as baseline values from which to establish goals for increasing average vehicle occupancy and for decreasing single occupant vehicles. Census data also are used for preparing a comprehensive profile of peak period commuter flows.

Corridor Preservation. ISTEA provides a planning framework for early identification of transportation corridors needing some form of capacity expansion. Small area data from the census provide a basis for defining these corridors and the number and characteristics of residents and jobs affected.

Current Status of Planning for the 2000 Census

General Testing and Content Determination. The Census Bureau is currently planning the first full scale test of alternative census methods. This test will be conducted in the spring of 1995. The Bureau also plans to conduct a test of new and improved methods and procedures in 1996 and a dress rehearsal of the 2000 census design and methodology in 1998.

The content determination process is being conducted in parallel with the operational planning. Through mid-1995, the Census Bureau will work with federal agencies to identify their data needs with respect to uses of the data, legislative or other justifications for collecting the data in the decennial census, and the geographic levels for which the data are required. The Bureau also will consult during this same period with data users outside the federal government to determine their needs as well.

In 1996, the Census Bureau plans to conduct a major test of content—new questions and question wording—for the 2000 census. By April 1, 1997, the Bureau must report to Congress the subjects it proposes to include in the 2000 census. By April 1, 1998, the Bureau must report to the Congress the actual questions it proposes to ask in the 2000 census.

The Continuous Measurement Alternative to the Decennial Census. The Census Bureau is seriously considering a radical change in the way it conducts the decennial census. The Bureau is studying the operational feasibility and cost of implementing what it calls a *continuous measurement* alternative for the 2000 census.

Under the continuous measurement design, the decennial census conducted in 2000 would collect on a 100-percent basis only the population and housing unit counts and minimal short-form population and housing data. The transportation characteristics traditionally obtained from a sample of households using the long-form questionnaire, as well as the whole range of social, economic, and housing data collected on the long form, would not be collected. Instead, the long form would be replaced with an Intercensal Long-Form Survey.

The Intercensal Long-Form Survey would comprise a monthly 350,000 household sample that would be cumulated to produce rolling averages over various periods of time. The survey would produce five-year moving averages of commuter travel between small areas such as census tracts or traffic analysis zones. For example, if the Intercensal Long-Form Survey begins in 1998 (as called for in the Census Bureau prototype), commuting data for traffic analysis zones could be released in 2003 based on the cumulated average of survey data collected in 1998-2002, in 2004 based on the cumulated average of survey data collected in 1999-2003, in 2005 based on the cumulated average of survey data collected in 2000-2004, and so on.

The five-year averages of commuting patterns between traffic analysis zones that continuous measurement cannot be used as point estimates of journey-to-work and related characteristics of small areas. Without the point estimates provided by previous censuses, state and local transportation planning organizations will have no benchmarks with which to validate their travel forecasting models.

DOT Participation in Planning for the 2000 Census. As in past censuses, DOT is working closely with the Census Bureau to ensure that the 2000 census will provide the data that are needed by transportation policy makers and planners at all levels of government. BTS represents the Department on the Policy Committee for the 2000 Census. This committee, comprised of representatives from federal agencies that depend on decennial census data for program implementation and evaluation, advises the Census Bureau on issues regarding census content and operations, and monitors the 2000 planning process on behalf of its constituent data users.

In response to the Office of Management and Budget's request for federal agency needs for data from the 2000 census, BTS submitted on behalf of the DOT documentation describing the transportation data needed from the 2000 census, the uses of the data for federal, state, and local transportation planning, and the legislation that requires the planning activities which depend so heavily on the decennial census data. BTS is supporting a study to determine the implications of Continuous Measurement data for the traditional uses of decennial census data in transportation planning, such as calibrating travel forecasting models. The results of this study will be provided to the Census Bureau to assist the Bureau in its decision on the method of conducting the 2000 census.

BTS is working closely with the Committee on National Statistics Panel on Census Requirements in the Year 2000 in its congressionally mandated study to assess the needs for data collected in the decennial census. BTS is preparing a case study of the uses of small-area data from the decennial census in transportation planning. This case study will describe the legislative requirements for transportation data from the census, the uses of the data to fulfill those legislative requirements by federal, state, and local transportation planners, major limitations of data currently available from the census, and alternative sources of the information traditionally collected in the census. The transportation case study will be included in the Panel's final report to Congress, which is scheduled to be completed in late 1994.

To keep the transportation planning profession informed about the status of 2000 census planning, BTS will participate with representatives from the Federal Highway Administration and the Federal Transit Administration, as well as state and local transportation officials, in two sessions on the decennial census at the 1994 Annual Meeting of the Transportation Research Board (TRB). The first session will focus on the uses and applications of the 1990 census data for transportation planning. The second session will deal with future state and local needs for data from the 2000 census and the Census Bureau's plans for meeting those needs. These TRB sessions will be the precursor for the third decennial National Conference on Decennial Census Data for Transportation Planning, to be held in March, 1994. The proceedings of that conference will be submitted to the Bureau of the Census, the Office of Management and Budget, and Congress to help guide the planning for the 2000 census.

Recent Congressional Action in 2000 Census Planning. Congress has reaffirmed its commitment to providing the decennial census data needed to administer federal programs. In guidance included in the House-Senate conference report on the Census Bureau's fiscal year 1994 budget request, the Congress stated its expectation that the Secretary of Commerce and the Office of Management and Budget will ensure that the data requirements of federal departments and agencies, as well as state and local government data needs, are considered in the planning for the 2000 census.

The conference report on the Census Bureau's fiscal year 1994 budget also stated that the conferees expect that other federal departments and agencies with significant data requirements, for which the decennial census is determined to be the most effective means of collection, will reimburse the Census Bureau for a portion of the costs of planning for and conducting the Year 2000 Census. The Census Bureau is currently seeking clarification of congressional intent on this statement.

A cost-reimbursable census would be unprecedented in the history of the decennial census. However, the inclusion by Congress of funding for collection of decennial census data within the budgets of data-user agencies may have significant advantages. For example, it would serve to focus federal agency data needs and allow for collection of additional data if agencies choose to provide the necessary funds. As paying customers, a cost-reimbursable census would give agencies more control over census content, processing requirements, and the timing of data availability. Under this scenario, cost-reimbursable special tabulations such as the 1990 Census Transportation Planning Package could be produced in a more timely manner as a standard decennial census product.

BTS Action in 2000 Census Planning

BTS understands the vital importance of the census to the transportation community, and has already committed significant staff resources to work with Census and others on several committees and conferences for 2000 census planning. BTS has initiated research on the impacts of continuous measurement on transportation planning models. BTS recognizes that its future activities with states and metropolitan planning organizations would have to expand dramatically if the Year 2000 Census fails to deliver data upon which states and metropolitan planning organizations have come to depend.

The Future of Transportation Statistics: Transportation and Economic Classification

As stated throughout this volume, transportation is inadequately represented in most analyses of the national economy. The reason stems largely from the way in which economic activity is classified under federal statistical standards. The problem is exacerbated by the lack of a federal statistical standard for the products carried by the transportation system. Fortunately, OMB has created an opportunity to rectify these problems through the charter of the Economic Classification Policy Committee (ECPC);

ECPC has been established to consider changes to the Standard Industrial Classification (SIC) system and related federal statistical standards. These standards relate to the classification of establishments, products, employment, and economic geography, and affect both data collected by other agencies and the accounting of transportation's role in the national economy. BTS is particularly concerned with economic classification related to commodities, which will be a major design issue for the next Commodity Flow Survey. BTS therefore approaches issues of economic classification as a data user, data provider, and statistical policy agent for the transportation community.

BTS is continuing DOT's involvement in economic classification that started when the Department became an active participant on OMB's Technical Committee on Industrial Classification (TCIC) for the 1987 revisions to the SIC system. DOT interest in this area has increased significantly by the growing number of policy questions related to the interdependence of transportation, commerce, and the economy.

General Problems with the 1987 SIC System

Deliberations of the Technical Committee on Industrial Classification (TCIC) for the most recent revisions to the SIC system in 1987 revealed that traditional concepts are being eroded by the growing number and importance of multi-activity establishments, particularly between industries that are converging in the development of new products and services. This is illustrated by explosive growth of intermodal transportation services, such as the growing number establishments that transcend the traditional boundaries between motor carriers and airlines for express letter and parcel delivery service. The emergence of multi-function establishments creates or exacerbates four issues that were not addressed in the 1987 SIC Manual. These issues include: definition of the establishment concept in an increasingly integrated economy; better identification of auxiliary establishments; inconsistencies between the 4-digit Industry Group, 3-digit Industry Group, and 2-digit Major Group levels of the SIC hierarchy; and overlap across boundaries of Divisions.

The Need for a Broader Definition of Establishment. The concept of establishments is easy to implement when individual facilities have distinct and stable locations. Increasingly integrated manufacturing processes, the nearly ubiquitous availability of freeways and air transportation, and a revolution in the economics and technology of computers and communications are bringing establishments closer together functionally while allowing them to become geographically dispersed and footloose. Establishments are becoming mobile nodes on a dynamic network.

The SIC Manual recognizes that many establishments in transportation, communications, and public utilities in Division E include geographically dispersed but functionally integrated activities. Similar recognition is needed in other Divisions, thanks to electronic networks and new organizational structures.

The concept of establishments as geographically dispersed systems rather than single locations is used in the SIC Manual primarily to delineate the employees and revenues to be counted with a specific establishment. The concept is generally not used to determine the establishment's Industry. The occasional exception is in Division E. Local pick up and delivery service that is part of an intercity carrier is classified in the Industry for intercity or long-distance service by that mode of transportation; local service that is not an integral part of the intercity service is classified in the local Industry for that mode.

Consistent recognition that the function of the network defines the function of the establishment on that network is needed across Divisions, but is difficult under current classification concepts based on the activity of the establishment rather than the enterprise (company or network) that it serves. Until a broader definition of establishment is adopted, the basis of classifying establishments will vary between what goes on in the establishment without regard to other units and what the establishment does as part of a network of other units.

Identification of Auxiliaries: The Need for More Detail. The SIC Manual recognizes two kinds of establishments: operating and auxiliary. An operating establishment sells most of its goods or services to establishments owned by other enterprises, and is classified by what it makes or does. An auxiliary establishment sells most of its goods and services to other establishments of the enterprise that also owns it, and is classified by the activities of the establishments that it serves. For example, a local motor carrier that serves a grocery chain is classified as an operating establishment with local trucking in Industry Group 421. A local motor carrier subsidiary of the grocery chain is classified as an auxiliary establishment in Industry 5411 (Grocery Stores).

Under the 1987 SIC Manual, a fifth digit has been added to indicate what the auxiliary establishment does for the Industry that it serves. The trucking example would be classified as a warehousing auxiliary if the trucking arm of the grocery store was based with the warehouse, or as an auxiliary not elsewhere classified. Most auxiliary establishments are central administrative offices, and a large percentage are in-house research and development laboratories.

The new fifth digit does not provide enough detail for policy analysis. The need for more detailed identification of auxiliary activities is particularly acute in the trucking example. Less than half of all trucking activity in the United States is performed by for-hire motor carriers. The majority is performed by private trucking, such as the trucking auxiliary of the grocery chain already mentioned. Many government policies involve establishments that are engaged in trucking, whether private or for hire, and statistics are needed on both segments of the industry. Data on operating establishments engaged in trucking are easily found in Industry Group 421, but trucking auxiliaries are not identified even with the newly ordained fifth digit. Data on the auxiliary establishments are also needed to evaluate shifts in revenues, employment, and other characteristics of the trucking industry, since the shift may reflect a change in ownership rather than true change in economic activity. In some states, a grocery chain that spins off its trucking auxiliary to become a motor carrier can cause significant changes in the Industry statistics even though the trucks may be providing the same service to the same stores.

These problems are conceptually easy to resolve by expanding the auxiliary function code to four digits. Rather than use the four categories of auxiliary activity in the new fifth digit, the auxiliary activity could be identified by the code of the Industry into which the establishment would have been classified if it had been an operating establishment. The trucking auxiliary of the grocery chain would thus be classified by the number 5411.4214. The TCIC selected the single digit code over this option for the 1987 revision on the grounds that implementation would be too difficult at that time.

Expansion of detail would allow much more accurate accounting of economic activity, and would resolve much of the current debate over how much of the growth in services is real or a statistical artifact. The costs and benefits of such expansion of detail require further exploration.

Inconsistent Hierarchical Structure. The continued growth of multi-function and intermodal establishments highlights fundamental weaknesses of the SIC system's hierarchy of Industries, Industry Groups, and Major Groups: the lack of a rigorously defined, consistent hierarchy across the four-, three-, and two-digit levels; the inherent constraints of a base 10 numbering system; and, the lack of places to classify inter-industry activities.

A rigorously defined, consistent hierarchy above the Industry level is important in the SIC system because:

- substantial data are collected or published only at the two- and three-digit level;
- the hierarchy specifies relationships among Industries, providing direction to coding and to aggregation of statistics; and
- the TCIC was very reluctant to move activities across Industry Group and Major Group boundaries.

The importance of this hierarchy is in contrast to the lack of rigor in its definition. Only Industries are defined by rigorous, detailed, explicit rules. Most TCIC recommendations for reorganizing Industry Groups and Major Groups were based on intuitive reasonableness or on the limits of a base 10 numbering system. (Industries were reallocated among Industry Groups when more than nine were together, and the not-elsewhere-classified category occasionally became a dumping ground for industries that could both be accommodated rather than the location of Industries that are too small or hard to classify.) This lack of rigor has resulted in inconsistencies and caprice, such as the grouping of public warehousing with trucking in Major Group 42 even though the warehousing industries are more logically placed with transportation services (Major Group 47).

Even if the hierarchy were rigorously defined, there are few places for inter-industry activities to be classified. Activities which are the outgrowth of an interaction between Industries, such as piggyback service between trucks in Major Group 42 and railroads in Major Group 40, are typically buried in one of the affected Industries or under "Not Elsewhere Classified." Proposals for new Industries are useful but only piecemeal patches to the problem, especially when the affected Industries reside in different Industry Groups.

The inconsistent hierarchy and other problems cannot be resolved completely without a draconian overhaul of the SIC system. The SIC system might have to be restructured from a top-down approach that starts with Divisions, rather than from the TCIC's bottom-up approach that starts with Industries. The requisite magnitude of change may never be possible given the substantial costs of changing data collection programs and converting long-term series of data to a new SIC system.

Boundaries. The problems with the hierarchical structure of the SIC system extend to the Division level, although the issue is primarily one of boundaries rather than of how many and what type of categories should be defined. The boundary problems are most notable between the Divisions for manufacturing and services, and between Public Administration and the other Divisions. Boundary problems also exist between the Divisions for manufacturing, wholesale trade, and retail trade.

Problems with the boundary between Manufacturing (Division D) and Services (Division I) involve a growing number of borderline industries that are packaging services into goods and turning goods into services. Indeed, the entire concept of *services* is a problematic one. The government does not have a rigorous definition of what constitutes a service rather than a good. The shift from services to goods is illustrated by the new Industry 7372 (Prepackaged Software), the location of which was extensively debated because computer programs were traditionally produced as a service until microcomputers created a mass market for software. When is a computer program a good or service? Is it a question of whether the program is sold in shrink-wrap plastic?

The shift goods to services is illustrated by Publishing (Major Group 27), where many printed goods are becoming more popular in electronic form and potentially causing establishments to move from their manufacturing roots in Division D to less readily apparent categories in Division I (such as Industry 7375 for Information Retrieval Services). The publishers of the Official Airline Guide would move from manufacturing to services if revenues from the electronic version exceed sales of the book.

The borderline Industries are particularly important given the pervasive references to the manufacturing and service sectors of the economy using a plethora of explicit and implied definitions of those sectors. The often-reported shift of the Nation's economy from manufacturing to services is due in part to the changing character of goods and services just noted and to the increasing tendency of manufacturers to contract with other firms for transportation and other services that were previously performed the manufacturer's own employees.

Commodity Classification

BTS particularly appreciates ECPC's desire to include product classification in the discussion of economic classification. BTS believes that much of the pressure for change in the SIC would be reduced by the development of a standard product classification system that includes both physical commodities and services rendered. For example, a product classification system could provide an effective solution to several of the problems described for auxiliaries and borderline industries.

BTS concern with product classification has been intensified by experience with the Commodity Flow Survey (CFS). CFS was conducted throughout calendar year 1993 by the Bureau of the Census with substantial DOT support to obtain the quantity and value of shipments by manufacturers, merchant wholesalers, and selected other industries by type of commodity, mode of transportation, state and region of origin, and state and region of destination. The railroad industry's Standard Transportation Commodity Classification (STCC) system is used in the CFS to provide comparability with the predecessors to the CFS in 1963 through 1977. STCC codes are also used because no other domestic classification system has similar detail and hierarchical structure based on characteristics of concern to DOT.

STCC codes have not been a panacea. Shippers have difficulties reporting by STCC codes if they do not use railroads. The Bureau of the Census has spent considerable effort bridging between STCC codes and their own industry-based product codes. Bridges between STCC codes and international systems are an additional challenge.

BTS would replace STCC codes with a governmentwide statistical standard if a system that meets the Bureau's commodity classification needs is established. BTS would also embrace a product classification system that reduced the magnitude of needed change in the SIC system. Major changes to the SIC are disruptive to historical series, costly for others to implement, and potentially disruptive to the establishment-based CFS sample frame.

BTS Recommendations

BTS has recommended that the ECPC commit to establishing a complete product classification system in time for the 1997 Economic Census, including the CFS, and in time for use in baseline studies related to the North American Free Trade Agreement.[6] BTS believes that the discussion of product classification should focus initially on whether the system should be based on the characteristics of the producer, the transportability of the product, or both. Once that issue is resolved, the effort should shift to consideration of whether to adopt or modify an existing international system such as the Standard International Transportation Classification and the Central Product Classification.

BTS believes that it is possible to implement a product classification system in time for the 1997 CFS and other Census activities and minimize the need for disruptive changes to the SIC system. The requisite effort will be significant, but necessary if effective change is to be accomplished before 2002. BTS has offered significant support for the many activities needed to research and implement a product classification system and to evaluate changes to the very large number of transportation-related industries in the SIC.

What We Need to Know the Most: Priority Areas Requiring BTS Attention

BTS concurs with *Data for Decisions* in placing inadequate information on commodity and passenger movements at the center of most problems with current transportation statistics. The needs for this basic information and BTS plans to meet those needs as its highest priority effort are explained fully in the BTS report, *Purpose and Status of the Multimodal Commodity and Passenger Flow Surveys*.[7]

BTS believes that other issues requir ing immediate attention include: inventory of the geographic locations and characteristics of transportation facilities and services, particularly those involving intermodal transfers; the decennial census and economic classification as described in this chapter; the establishment of common definitions throughout transportation statistics, particularly in the areas of safety; and the rethinking of basic measures of transportation and its consequences, such as congestion and economic productivity. In all of these pursuits, BTS places a premium on identifying the temporal and geographic variation of transportation and its consequences in addition to determining systemwide averages.

Sources

Figure

Figure 8-1: Bureau of Transportation Statistics.

Tables

Table 8-1: Bureau of Transportation Statistics.

Table 8-2: Transportation Research Board, *Data for Decisions Special Report 234*, p. 50-57.

Table 8-3: Volpe National Transportation Center.

Endnotes

1. *Data for Decisions*, page 45.
2. U.S. Department of Transportation, *Transportation Information* (Report to the Committee on Appropriations, U.S. house of Representatives, from the Secretary of Transportation), May, 1969.
3. Transportation Research Board Special Report 234
4. *Data for Decisions*, p. 59.
5. Searching for Solutions No. 8, July, 1993.
6. Bureau of Transportation Statistics correspondence of May 28, 1993, to Jack E. Triplett, ECPC Chairman, Bureau of Economic Analysis, in response to the ECPC *Federal Register* notice of March 31, 1993.
7. Report of Bureau of Transportation Statistics to the Committees on Appropriations of the United States Senate and U.S. House of Representatives, May 20, 1993.

TRANSPORTATION *and the* FUTURE

"The Secretary of Transportation shall . . . promote and undertake the development, collection, and dissemination of technological, statistical, economic, and other information relevant to domestic and international transportation" (149 USC 301). Congress mandated in Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) that the *Transportation Statistics Annual Report* include "recommendations for improving transportation statistical information." These recommendations are embodied in the working agenda for the Bureau of Transportation Statistics (BTS), which is drawn from the perspectives of Congress, The Department of Transportation (DOT), the National Academy of Sciences, and the Bureau's internal deliberations as expressed in the preceding chapter. The BTS working agenda is organized around its missions, as defined in DOT management order that implemented Section 6006 of ISTEA:

> ***The missions of BTS are to compile, analyze, and make accessible information on the Nation's transportation systems; to collect information on intermodal transportation and other areas as needed; and to enhance the quality and effectiveness of the statistical programs of the DOT through research, the development of guidelines, and the promotion of improvements in data acquisition and use.***

Compiling and Analyzing Statistics

The *Transportation Statistics Annual Report* embodies the initial BTS response to the congressional requirement for data compilation and analyses of 11 major topics. Many areas have been identified for investigation, such as the measurement of productivity, and will be pursued further in subsequent annual reports.

An important driving force in BTS data compilation and analysis activities will be support for the Secretary's proposed effort to identify a National Transportation System, extending the ISTEA-required designation of a National Highway System. The Secretary's initiative will require extensive geographic data on transportation facilities and networks, the activities they serve, and the surroundings they affect. The initiative will also require the refinement and application of analytical methods based on geographic information systems (GIS) technology.

The data compilation and analysis requirements of the Secretary's National Transportation System correspond with proposals in the Vice President's National Performance Review to establish the National Spatial Data Infrastructure (NSDI). NSDI is the creation and maintenance of demographic, environmental, economic, and other information by geographic location in an electronic form that can be easily accessed, updated, and analyzed. Transportation networks are a key element of NSDI, both as features that help define areas (such as streets around a Census Tract) and as facilities upon which human activity takes place.

BTS recognizes that the history of GIS technology and comprehensive geographic data bases spans a quarter century, and is littered with broken promises. GIS technology is not a panacea to data integration and analysis, and problems of data comparability are not universally solved by adding latitudes and longitudes. While significant strides have been made in the development of effective hardware and software, many of the basic problems remain concerning data acquisition, data element definition, quality assurance, and institutional arrangements.

BTS expects to lead by example rather than directive whenever possible as it pursues GIS technology and geographic data initiatives. Rather than dictating appropriate GIS practice to others, BTS will focus on meeting its internal data and analysis needs with BTS-sponsored enhancements to existing data resources. BTS will create entirely new data resources to meet its internal needs only as a last resort. Since BTS needs for geographic data and analysis parallel the needs of other modal administrations, this focus should serve DOT.

To support both the National Transportation System and NSDI initiatives, BTS plans to resurrect and update in an electronic form the *National Transportation Atlas* published by DOT in 1977. BTS will work with DOT's modal administrations to establish network and facility data bases that tentatively will include major highways, all railroads except yards and industrial spurs, fixed guideway transit, interregional pipelines, all navigable waterways, towered airports, harbors, truck-rail and major truck-only terminals, intercity bus terminals and rail passenger stations, and all scheduled ferry services. This national transportation data base will not include local streets and roads, collection and distribution pipelines, landing strips, or aqueducts unless BTS resources are expanded by an order of magnitude or more to maintain at an adequate level of quality.

The national transportation data base will include attributes and intermodal connections that are essential for transportation analyses. Transportation services will be identified where possible, such as intercity bus routes for passengers and double-stack train service for intermodal cargo. Geographic accuracy will meet or exceed national standards for maps of 1:100,000 scale, and topolog-

Planimetric and Topological Accuracy

BTS will emphasize the importance of both planimetric and topological accuracy in geographic data. Planimetric accuracy is the traditional concern of cartographers, and topological accuracy is the concern of analysts. Planimetric accuracy means that the bridge, intersection, or other facility is in the right place. Topological accuracy means that bridges are distinguished from intersections, and that connections in the real world are reflected in the computer representation. Planimetric accuracy is important for visual credibility, and for linking data on transportation facilities with environmental, economic, and social information about the surrounding area. Topological accuracy is essential for most forms of transportation analysis, in which the computer must determine whether you can really get there from here.

ical accuracy will be established. Methods will be developed to preserve statistical links between the national transportation data base and other spatial data, such as those tied to the Census Bureau's TIGER system. The national transportation data base will be structured and documented in accordance with the Spatial Data Transfer Standard, and will be disseminated at little or no cost to the public to maximize its use. BTS will foster public feedback to assist in updating and quality control.

In recognition of NAFTA and the globalization of transportation and other economic activity, BTS plans to extend coverage of its GIS initiatives and the analyses required to support the *Transportation Statistics Annual Report* beyond U.S. territorial borders. As time and resources permit, BTS will compare the state of the U.S. transportation system with other countries, and will study international transportation linkages particularly with Canada and Mexico.

BTS hopes to undertake a number of additional projects as time and staff resources permit. Examples include:

- Development of more accurate and understandable measures of productivity, congestion, mobility, and geographic accessibility, and environmental consequences of transportation for domestic applications and international comparisons.
- Development of consistent measures across modes to permit evaluation of benefits and costs of transportation investments, and to identify data requirements.
- Transport cost and energy consumption studies as follow-ons to the Commodity Flow Survey.
- Baseline studies for analyzing impacts of reduced barriers with Canada and Mexico on trade and transportation.
- Studies of intermodal transportation activity and trends, with particular emphasis on patterns of container inventory and use.

BTS has also begun to assist other modal administrations in the purchase of private data and forecasting services to improve procurement efficiency and assure useful access to private services by DOT analysts.

BTS Activities Related to Data Collection

The major data collection initiatives of BTS are described in *Purpose and Status of the Multimodal Commodity and Passenger Flow Surveys* (Report of BTS to the Committees on Appropriations of the United States Senate and U.S. House of Representatives, May 20, 1993). The Commodity Flow Survey (CFS) was conducted throughout calendar year 1993 by the Bureau of the Census to measure tons and value of commodities moved by type, mode, geography, and other characteristics, based on quarterly mail-out-mail-back questionnaires to 200,000 establishments. Data products will be released in 1995 after extensive quality assurance. A similar survey is planned for 1995 to measure passenger flows among regions.

BTS is also participating in a number of other data development activities, including:

- identification of transborder surface freight movements by rail, truck, and pipeline modes;
- a special tabulation of foreign trade data to identify the diversion of U.S. imports and exports to Canadian ports;
- a redesign of the Nationwide Truck Activity Survey to improve efficiency and data quality;
- enhanced coverage and content of the Nationwide Personal Transportation Survey, which measures daily travel patterns of households; and
- a transportation supplement to a survey of the disabled by the Department of Health and Human Services.

BTS is also commissioning state-of-the-art papers on opportunities to apply new data acquisition technology to transportation.

BTS Activities Related to Guidelines for Quality and Comparability

BTS recognizes the need to pursue improvements in the quality and comparability of transportation statistics, but also recognizes that the requisite effort is labor intensive and will entail a long-term investment before significant accomplishments can be measured. BTS has started the effort by assuming responsibility for reviewing new DOT survey plans prior to submission to OMB to ensure adequate sample design and statistical methods. The next and larger step will be to develop a DOT-wide data element dictionary. This dictionary will identify all variables used in DOT data collections and analyses, and will highlight differences in definitions of the same variables. Whether or not the identified differences are warranted, at least their existence will be recognized so that statistical bridges among data sets can be built.

In its new passenger flow survey, BTS will take into account established statistical standards of the United Nations regarding domestic and international travel. These standards cover definitions of travelers, trip purposes, mode, and trip duration.

ISTEA requires establishment of an Advisory Council on Transportation Statistics to review the quality and effectiveness of BTS products. Prospective candidates for the Council will be identified by the BTS Director after the Director's confirmation.

BTS Activities Related to Representation of Transportation among the Statistical Community

BTS provides a bridge between the transportation and statistical communities. These communities have many overlapping interests, but often speak different languages and respond to different needs. Languages differ because the transportation perspective is often based on the disciplines of economics, engineering, and operations research, while the statistical community comes from the disciplines of demography and market research. Even methods of expanding samples to a universe can differ dramatically among these disciplines. Needs differ because the data users in the transportation community thirst for greater detail while the data providers in the statistical community struggle with respondent burden.

BTS is starting to build the needed bridges by participating in the monthly meetings of statistical agency heads convened by OMB, the quarterly meetings of the Committee on National Statistics of the National Research Council, and the semiannual U.S.-Canadian Transportation Statistics Interchange with the Bureau of the Census, Statistics Canada, Transport Canada, and other agencies. BTS goes beyond bridge-building to be an active advocate of the interests of the transportation community in the Federal Geographic Data Committee, the Economic Policy Classification Committee, and other interagency units that establish statistical standards. BTS is actively involved in Year 2000 Census planning in response to a significant potential for loss of data critical to the programs of DOT, EPA, state transportation agencies, and metropolitan planning organizations.

BTS Activities Related to Making Statistics Accessible and Understandable

BTS is committed to disseminating DOT's extensive information to the public through as many channels as appropriate. The BTS experiment with CD-ROM technology, the *Transportation Data Sampler*, was well received and is being continued as the *Transportation Statistics Annual Report* CD-ROM. BTS is exploring the use of Internet, electronic bulletin boards, fax-on-demand services, and other avenues of data dissemination. BTS has established a toll-free statistical information number, developed an inventory of DOT data sources and experts, and updated its annual *National Transportation Statistics* to encourage public access to DOT knowledge base.

The biggest BTS product to date is the Census Transportation Planning Package (CTPP) CD-ROMs. CTPP is an extensive tabulation of journey-to-work and other information from the 1990 Census, produced on 9-track tape by the Bureau of the Census for the American Association of State Highway and Transportation

Officials. CTPP includes statewide tabulations at the place level and metropolitan tabulations at the Census tract or traffic analysis zone level. To make the tabulations widely available and more easily used, BTS is distributing CTPP on CD-ROM with TransVU-CTPP, a software package developed by Caliper Corporation to query, display, and extract spatial data.

BTS attempts to be customer-driven. Customers are more than existing data users and clients. To serve only existing data users ignores the broader audience for improved information. To serve *clients* implies that BTS responds with advice when asked. To serve *customers* is to seek markets, determine specific needs through experimental products and other means, and to evolve products to meet the customers' needs.

The Future

BTS faces many immediate challenges. The Bureau must stretch its staff and contractor resources to the limit to meet Congressional deadlines for the *Transportation Statistics Annual Report* and to begin the flow of useful, timely information products to the transportation community. BTS must become an effective and credible force for change to improve DOT statistical programs without undermining the responsiveness of those programs to DOT's other operating administrations. The organization must fulfill growing expectations for extensive and high-quality statistical products, while capturing the opportunity to rethink statistical methods, data acquisition strategies, and basic transportation measures.

BTS must rise to these challenges, both to meet the information needs of the transportation community and to serve as an organizational model for DOT. As DOT's newest operating administration, BTS has a unique opportunity to test concepts for improving organizational responsiveness and the quality of the working environment. BTS is committed to be customer-driven and entrepreneurial from its inception, and experiment with new ways to serve the public as the Bureau matures. The Bureau's staff looks forward to customer response to this report and other BTS products to help guide future efforts and make BTS an effective access ramp—rather than a speed bump—on the nation's information highway.

TRANSPORTATION STATISTICS PROGRAMS

The Bureau of Transportation Statistics (BTS) is responsible for only a portion of major federal statistical programs. Other programs are described by agency, starting with the constituent parts of the U.S. Department of Transportation (DOT).

Office of the Secretary, Office of Commercial Space Transportation

Agency Mission

The Office of Commercial Space Transportation (OCST) was established in 1984 within OST. The provisions of the Commercial Space Launch Act, which gave DOT the authority to regulate U.S. commercial space launch activities are carried out through OCST. Its mission is to facilitate development of a safe and competitive U.S. commercial space transportation industry. OCST carries out these responsibilities by (a) licensing and regulating all U.S. commercial launch activities to ensure that they are conducted safely and responsibly, and (b) promoting and encouraging commercial space transportation.

Current Data Programs

OCST is developing two databases to support its responsibilities in the rapidly evolving commercial space transportation sector.

Space Transportation Analysis and Research. This database provides information on international space transportation infrastructure and markets. Specifically, it provides information on launch vehicles, payloads (e.g., physical and operating characteristics), future and historical launch events, characteristics and facilities of launch sites, and characteristics of commercial launch service companies (e.g., facilities, products, and services).

Space Accident Data Base. OCST has developed the framework for this database and entered some data on space-related accidents and incidents for commercial space launches in the United States. The database encompasses ground, launch, orbital, and reentry accidents and incidents; it provides information on the parties involved and the payload, the date, a description and the sequence of the accident or incident, and the consequences (e.g., casualties, damage, and delays).

Research and Special Programs Administration

Agency Mission

The mission of the Research and Special Programs Administration (RSPA) is to serve as a research, analytical, and technical development arm of DOT for long-range and multimodal research and development and to conduct special programs. Particular emphasis is given to pipeline safety, transportation of hazardous cargo by all modes of transportation, safety, security, facilitation of domestic and international commerce, and intermodal research and development activities, including university programs.

Current Data Programs

Aviation Statistics. RSPA's Office of Airline Statistics manages the following data programs related to aviation economics and operating statistics:

- Form 41: Schedule T-100(f): Foreign Air Carrier Traffic Data by Nonstop Segment and On-Flight Market is filed by foreign air carriers that provide service to and from the United States. Schedule T-100 contains traffic (e.g., passengers enplaned) and operating (e.g., aircraft departures) statistics by nonstop segments and on-flight markets for scheduled, nonscheduled, and chartered operations. Data are for operations between the carrier's home country and the United States.
- Form 41: Report of Financial and Operating Statistics for Large Certificated Air Carriers (Financial Schedules Only) is filed by large certificated U.S. air carriers. It comprises 15 financial schedules.
- Carrier's Audit Report must be submitted by each large certificated U.S. air carrier whose records are audited by an independent certified public accountant.
- Form 291-A: Statement of Operations and Summary Statistics for Section 418 Operations contains profit and loss data and traffic and capacity statistics. The form is filed by U.S. air carriers operating under Section 418 domestic all-cargo certificates.
- Form 41: Schedule T-100: U.S. Air Carrier Traffic and Capacity Data by Nonstop Segment and On-Flight Market and Supplemental Schedules, T-1: U.S. Air Carrier Traffic and Capacity Summary by Service Class, T-2: U.S. Air Carrier Traffic and Capacity Statistics by Aircraft Type, and T-3: U.S. Air Carrier Airport Activity Statistics are filed by all large certificated U.S. air carriers. Schedule T-100 contains traffic (e.g., passengers enplaned) and capacity (e.g., available seat miles) statistics by nonstop segments and on-flight markets for domestic and international scheduled, nonscheduled, and chartered operations. The supplemental schedules contain summary traffic and capacity statistics without segment or market detail for domestic all-cargo operations, domestic charter operations, and international military charter operations.
- Form 251: Report of Passengers Denied Confirmed Space must be filed quarterly for scheduled passenger service performed with large aircraft (i.e., more than 60 seats), by all large U.S. certificated air carriers and foreign air carriers that provide service from the United States, disclosing the number of passengers who were denied confirmed space and how those passengers were accommodated.
- Form 298-C: Report of Financial and Operating Statistics for Small Aircraft Operators contains five schedules. U.S. scheduled passenger

commuter air carriers file three of the five; small U.S. certificated air carriers file all five.

- Form 2787: Passenger Origination and Destination Survey must be filed by certificated U.S. air carriers providing scheduled passenger service. The report includes a 10 percent survey of all tickets except for the largest domestic markets (approximately 1,000 markets), in which a 1 percent sample may be used. All carriers have elected to file a 10 percent sample. The survey provides information on the origin and destination of the passenger, routings by carrier, fare paid, and fare class.
- U.S. International Air Travel Sttistics is a program that was recently transferred to RSPA from OST. The compilation of international air travel statistics began in the 1970s under a joint project with DOT, the Immigration and Naturalization Service (INS), and the Travel and Tourism Administration. The project consisted of coding INS Form I-92, completed by international air carriers arriving in and departing from the United States. The information coded from the form included the international airports of embarkation and debarkation, flight number, date, and number of U.S. citizens and noncitizens aboard the flight. The origin and destination information is now being obtained from another form submitted to RSPA by the air carriers, but citizenship data is still being coded.
- Electronic Tariff Information System (Airlines) is another program that was recently transferred to RSPA from OST. International air carriers are regulated by DOT, so tariffs for changes in passenger fares, rules, and cargo rates must be filed with RSPA's Office of Automated Tariffs. Until fiscal year 1990, tariffs had been filed manually. In January 1989, DOT published a regulation that allows the international airline industry to file electronically with DOT and withdrew the requirement for manual posting at pricing locations. After an experimental program, the automation of international aviation tariffs began in phases. In July 1990, the fares portion of the system was completed and is operational. Future enhancements will include automating passenger rules and cargo rate tariffs.
- Air Carrier On-Time Performance Report. The 12 largest air carriers are required to submit monthly reports to DOT on domestic flights that are delayed 15 minutes or more from the scheduled departure or arrival time at an airport. The regulation requires this information to be reported for only the 31 largest U.S. airports, but the participating air carriers have voluntarily submitted reports for all airports on their domestic systems. A summary report that covers each airline's overall performance and the performance of individual airports by time of day is published each month. Detailed tabulations and a data tape that shows specific flight information can be purchased from the department's Volpe National Transportation Systems Center in Cambridge, Massachusetts.

Hazardous Materials Information System. RSPA's Office of Hazardous Materials Transportation collects the following data on the movement of hazardous materials. A summary of ongoing programs and policies for promoting hazardous materials transportation safety is provided in an Annual Report on Hazardous Materials Transportation. A national overview of safety and enforcement initiatives, and incident and accident data is provided; regulations and exemptions to regulations issued during the year are described; the status of the national safety program is summarized; and areas of future concentration are identified. Statistical summaries of incident and accident data indicate the condition of the hazardous materials transportation industry, and in conjunction with enforcement data, indicate the performance of that industry.

Pipeline Safety. RSPA's Office of Pipeline Safety collects the following data on liquids and natural gas pipelines for the Hazardous Materials Information System. Operators of natural gas transmission and gathering, and distribution pipeline systems, as well as liquids petroleum pipeline systems, are required to file incident and accident reports for any pipeline leak or failure that results in death, injuries that require hospitalization, or property and product loss in excess of specified amounts. These reports provide data about the nature of the incident, apparent cause, and impacts. Annual reports covering inventory data (e.g., miles of pipe by type) and leak repairs are also required of natural gas pipeline operators.

Multimodal Statistical Reports. RSPA's Volpe National Transportation Systems Center, under BTS sponsorship, is responsible for producing: *National Transportation Statistics* which provides summaries of modal operating and financial data, information on modal performance and safety trends, and supplementary data on transportation's impact on the economy and energy use.

Federal Aviation Administration

Agency Mission

The primary function of the Federal Aviation Administration (FAA) is to foster the development and safety of American aviation. More specifically, FAA is responsible for developing the major policies necessary to guide the long-range growth of civil aviation; modernizing the air traffic control system; establishing in a single authority the essential management functions necessary to support the common needs of civil and military operations; and providing for the most effective and efficient use of the airspace over the United States. The agency is also responsible for rulemaking relative to these functions.

FAA constructs, operates, and maintains the National Airspace System and the facilities that are part of the system; allocates and regulates the use of airspace; ensures adequate separation among aircraft operating in controlled airspace; and, through research and development programs, provides new systems and equipment for improving use of the nation's airspace.

The Airport Improvements Program authorizes FAA to make grants of federal funds to sponsors for airport development and for advanced planning and engineering. FAA also prescribes and administers rules and regulations concerning the competency of pilots, mechanics, and other FAA-licensed aviation technicians; aircraft airworthiness; and air traffic control. It promotes safety through certification of pilots and other technicians, aircraft, and flight and aircraft maintenance schools. Finally, it reviews the design, structure, and performance of new aircraft to ensure passenger safety.

Current Data Programs

FAA maintains a diverse set of data that supports critical activities in safety regulation; airspace and air traffic management; management of air navigation facilities; research, engineering, and development; testing and evaluation of aviation systems; airport programs; registration of aircraft; and others.

Because of the large amount of FAA data, many of which are used for administrative purposes, an attempt was made here to limit the list to those major statistical publications and databases from which summary statistics and trend data can readily be derived for policy purposes.

Major Statistical Publications

- *Airport Activity Statistics of Certificated Route Air Carriers* is a joint annual publication of FAA and RSPA that contains data on passenger enplanements and tons of enplaned freight (express and mail) by airport, carrier and type of operation, and type of aircraft.
- *Census of U.S. Civil Aircraft* is an annual publication that includes statistical data on the registered civil fleet, air carrier aircraft, and general aviation aircraft, both registered and active, including detailed reports for general aviation aircraft by owner's state and county, and registered aircraft by make and model.
- *FAA Air Traffic Activity* is an annual publication with data on terminal and en route air traffic activity (e.g., takeoffs and landings, aircraft handled, and flight plans filed). The data is collected and compiled from FAA-operated airport traffic control towers, air route traffic control centers, flight service stations, approach control facilities, and FAA contract-towered airports.
- *FAA Statistical Handbook of Aviation* is an annual publication that presents historical statistical informa-

tion pertaining to FAA; the National Airspace System (NAS); airports; airport activity; U.S. civil air carrier fleet; U.S. civil air carrier operating data; pilots, mechanics, and other FAA-licensed aviation technicians; general aviation aircraft; aircraft accidents; aeronautical production; and imports and exports.

- *FAA Forecast* is an annual publication of forecasts for key aviation activity and FAA workload measures.
- *General Aviation Activity and Avionics Surveys* is an annual report that presents the results of the General Aviation Activity and Avionics Survey conducted to obtain information on the activity and avionics of the U.S. registered general aviation aircraft fleet. The report contains estimated flying time, landings, fuel consumption, lifetime airframe hours, avionics, and engine hours of the active general aviation aircraft by manufacturer and model group, aircraft type, state and region of based aircraft, and primary use.
- *General Aviation Pilot and Aircraft Activity Survey* is a triennial report that includes data on the type and source of weather information services, trip length in time and distance, pilot age and certification, estimates of total 1990 general aviation operations, fuel consumption, and aircraft miles flown.
- *Rotorcraft Activity Survey* is a special one-time report containing breakdowns of active rotorcraft, annual flight hours, average flight hours, and other statistics by rotorcraft type, manufacturer and model group, region and state of based aircraft, and primary use. Also included are law enforcement and public use rotorcraft, lifetime airframe hours, engine hours, estimated miles flown, and estimated number of landings.
- *U.S. Civil Airmen Statistics* is a detailed annual report containing statistics on pilots, mechanics, and other FAA-licensed aviation technicians and the number of certificates issued.

Data Bases and Data Systems. The following list of major databases comprises, for the most part, real-time operational data systems; however, summary statistics can be and are regularly derived from them.

- Civil Aviation Security Information System provides information about security checks of airports, air carriers, and security stations; tracks security alerts, bulletins, and summaries; and records reports of arrests made at screening stations, bomb threats, explosion reports, screening device findings, hijackings, and use of K-9 teams.
- Comprehensive Airmen Information System includes information on personal, medical, and certification status of individuals associated with civil aviation operations including pilots, mechanics, flight crews, and others.
- Enforcement Information System contains data about violations of the Federal Aviation Regulations (FARs); violator's identification; the FAR violated; description of the aircraft, engine, or component involved; demographics; and recommended sanctions.
- Service Difficulty Reports System contains reports about abnormal, potentially unsafe conditions in aircraft, aircraft components, and aircraft equipment.
- Simulator Inventory and Evaluation Schedule System contains results of checklist inspection and certification activities, identification and correction of discrepancies, and vital statistics for operators and manufacturers.
- Manufacturing Inspection Man-agement Information System includes parts manufacturer approval supplements, technical standard order authorizations, information on production and quality control activities, type certification conformity inspections, results of applications for airworthiness certification of individual aircraft, reports of production flight tests, export certifications, and information about the private-sector designees authorized by FAA to perform manufacturing and airworthiness inspections.
- National Airspace Information Monitoring System (NAIMS) is an automated database management system used for tracking and analyzing reported safety-related incidents and rules violations occurring in the

NAS. NAIMS subsystems include the following:

  - Operational Errors System contains reports on occurrences attributable to elements of the air traffic control system that result in less than the applicable minimum separation distance among: (a) two or more aircraft, or (b) an aircraft and terrain or obstacles, which include vehicles, equipment, or personnel on runways.
  - Operational Deviations System contains reports on controlled occurrences in which applicable minimum separation distances as just defined were maintained, but one of the following situations occurred: (a) less than the applicable minimum separation distance existed between an aircraft and protected airspace without prior approval; (b) an aircraft penetrated airspace that was delegated to another position of operation or another facility without prior coordination and approval; (c) an aircraft penetrated airspace that was delegated to another position of operation or another facility at an altitude or route contrary to the altitude or route requested and approved in direct coordination or as specified in a letter of agreement, precoordination, or internal procedure; or (d) an aircraft, vehicle, equipment, or person encroached upon a landing area that was delegated to another position of operation without prior coordination and approval.
  - Pilot Deviations System contains reports on actions of pilots that result in alleged violations of airspace or ground air traffic control clearances.
  - Near Midair Collisions (NMACs) are reports received from pilots or flight crew members (who were in the cockpit of one of the aircraft involved) stating that a collision hazard existed between two or more airborne aircraft, regardless of aircraft separation distance. The usual criterion for declaring an NMAC is an unintentional proximity of less than 500 ft.
  - Pedestrian/Vehicle Deviations System includes reports on any entry or movement on an airport movement area by a vehicle or pedestrian that was not authorized by an air traffic controller.
  - Runway Incursions are reports on occurrences at airports that involve an aircraft, vehicle, person, or object on the ground that result in loss of separation with an aircraft taking off, intending to take off, landing, or attempting to land.
- Aviation Safety Reporting System (ASRS) is maintained by Battelle Laboratories under an FAA-funded National Aeronautics and Space Administration contract. ASRS was developed to store reports of situations observed by pilots, controllers, passengers, or mechanics that compromised safety, or had the potential to do so. Before entry into the database, the information is evaluated by ASRS analysts and is edited to ensure the anonymity of the reporting individuals. Limited immunity is provided to reporting individuals for inadvertent violation of FAA regulations.
- Accident/Incident System contains environmental data, contributing factors, weather conditions, and personal and medical data about the people involved in aircraft accidents and incidents. The National Trans-portation Safety Board (NTSB) also investigates accidents involving civil aircraft in the United States and collects data in the NTSB Accident and Incident System on accidents, fatalities, serious injuries, and accident rates per million passenger miles flown and per million aircraft miles flown for U.S. carriers (for scheduled and unscheduled service), commuter carriers, and general aviation.
- Air Traffic Operating Management System contains the number of flights delayed more than 15 minutes by cause of delay (e.g., weather, air traffic control center volume, airport terminal volume) and by airport. (This delay system should not be confused with the On-Time Flight Performance Reporting System operated by the OST Office of Intergovernmental and Consumer Affairs.)

- Air Traffic Activity System includes monthly information about activity at the FAA air traffic facilities—aircraft operations, aircraft handled, and flight plans filed.
- Aeronautical Information System contains operational and physical descriptions of all civil (public and private) airports; selected military airports, navigational aids, and flight service stations; air traffic control towers, air route traffic control centers, and airways; jet routes, military training routes, and preferred instrument flight rule routes; standard instrument approach procedures; standard terminal arrival routes; standard instrument departure routes; fixed reporting points; holding patterns; restricted, warning, alert, prohibited, and military operations areas; part-time control zones; and U.S. notices to pilots, mechanics, and other FAA-licensed aviation technicians.
- National Forecasting System includes annual forecasts of aviation activity and other selected statistics.
- Air Route Traffic Control Center Forecast is a facility level activity forecast.
- Flight Service Station Forecast is also a facility level activity forecast.
- Terminal Area Forecast contains activity forecasts for each of 5,000 public use airports.
- Hub Forecasts are detailed forecasts of major air carrier airports and all other airports within major metropolitan areas.
- National Outage Data Base contains down time and repair time, by cause, for airway and air traffic control facilities (e.g., radar, landing and navigational aids, etc.).
- Air Carrier Aircraft Utilization and Propulsion Reliability System contains monthly reports from air carriers of the flight hours and number of aircraft by manufacturer and model for aircraft used in air carrier service for the month.
- Aircraft Registration System includes registrant's name and address, registration status, and aircraft description for each aircraft registered with FAA.

Federal Highway Administration

Agency Mission

The roads and highways across the nation are used by more Americans more often than any other transportation system. The Federal Highway Administration (FHWA) oversees federal support for the facilities of greatest significance to the nation, including Interstate highways. The agency is concerned with the total operation and environment of highway systems, including highway and motor carrier safety. In administering its highway transportation programs, it gives full consideration to the impacts of highway development and travel; transportation needs; engineering and safety concerns; social, economic, and environmental effects; and project costs.

FHWA meets its data needs primarily through three offices. The Associate Administrator for Policy oversees the Office of Highway Information Management, which is responsible for collecting and publishing highway data from the states, managing related programs such as the Nationwide Personal Transportation Study, and coordinating statistical policy within FHWA. The Office of Policy Development, also under the Associate Administrator for Policy, manages census surveys of truck owners and business establishments. The Associate Administrator for Motor Carriers oversees the Office of Motor Carrier Information and Analysis, which is responsible for collecting and publishing safety data from motor carriers.

Current Data Programs

Data Collected Through States. The Highway Performance Monitoring System (HPMS) is FHWA's on-going, integrated, annual database, which consists of data on systems mileage, physical dimensions, usage, condition, performance, operating characteristics, and fatal and injury accidents. The HPMS data reported annually by each state consist of areawide data reports (e.g., areawide summaries of mileage, travel, accidents, travel activity by vehicle type, and population), universe data (38 data items that identify the nation's total public road mileage by systems, jurisdiction, and operation), and sample section data for approximately 110,000 sample sections of the nation's arterial and collector highway systems (44 additional pavement, improvements, geometric, traffic and capacity, environment, and supplemental items are reported for each sample section).

An equally important part of the overall HPMS is a set of analytical models that are used to assess overall system performance, project future capital needs, and evaluate future system performance under varying assumptions of standards, travel growth, and investment levels. These models, which convert data into useful information, constantly undergo refinement.

Three types of data on traffic characteristics are collected, processed, and analyzed:

- Traffic volumes from continuous automated traffic recorders are reported by the states and used to produce a monthly report on traffic volume trends that tracks changes in travel by state and functional class of highway. Hourly traffic volume data are reported monthly for about 3,000 stations.
- Travel by urban and rural functional systems is furnished annually as part of each state's HPMS submittal. These data are, for the most part, based on traffic counts of the HPMS sections. On part of the HPMS samples, vehicles are classified to provide systemwide estimates of the proportion of travel by 13 vehicle types. Suggested traffic counting procedures are included in FHWA's traffic monitoring guide and in the HPMS field manual.
- Vehicle classification data collected at truck weigh stations and corresponding truck weight data are reported annually by the states. Axle weight data are converted to axle loadings, and a series of tables are produced for use in highway design, bridge design, pavement management, and truck enforcement programs. These data are collected by weigh-in-motion scales that provide the desired data without interrupting traffic flow. The processing of these data is done by microcomputer in a fully decentralized manner, which allows state users to analyze the data themselves while creating the data files for transmittal to FHWA.

The state highway agencies report a series of data elements which form FHWA's highway statistics database.

- FHWA collects motor-fuel use data from the states on a monthly basis. "Motor fuel" applies to gasoline and all other fuels under the purview of state motor-fuel tax laws. In addition to gasoline, motor fuel can include "special fuels," which comprise diesel fuel, liquefied petroleum gases, and similar fuels when they are used to operate vehicles on highways, as well as gasohol and neat alcohol.
- The highway finance database contains information on highway receipts, disbursements, debt status, and other financial information of federal, state, and local agencies. Information included is on intergovernmental transfers of funds from the federal government to states, and from states to local governments. Revenue data includes the amount and source of funds, including tax sources and debt. Expenditure data are broken down by capital and maintenance spending, spending for administration, police and safety purposes, and debt service.
- Motor vehicle registrations are reported to FHWA by major vehicle classes including automobiles, buses, trucks, and motorcycles. FHWA also supplements the data supplied by the states with information obtained from other sources. For instance, the Truck Inventory and Use Survey conducted by the Bureau of the Census is one source that is used to achieve a level of uniformity in preparing various estimates and summaries.
- Each state and the District of Columbia administers its own driver licensing system and provides data to FHWA, which provides the basis for summaries of drivers licenses by type, sex, and age. This information is sometimes used as an exposure measure in the analysis of motor vehicle accidents and fatalities.

The National Bridge Inventory (NBI) is a mainframe computer system that includes detailed identification, classification, condition, appraisal, and proposed improvement information on more than 570,000 bridges on U.S. public roads. Bridge information is submitted by states in tape format at least annually and can be submitted as individual updates or as a replacement of the entire file. NBI data are accessible on line using a report generator that can produce several reports in various formats. NBI data are used to manage the bridge program and answer questions concerning any physical aspect of the bridge system.

Data Collected From States and Motor Carriers. The Office of Motor Carriers (OMC) is responsible for overseeing the safety of the Interstate motor carrier fleet in the United States. The extensive data system that supports this effort is known as the Motor Carrier Management Information System (MCMIS). This is a computerized system that provides a comprehensive record of the safety performance of individual carriers for the use of OMC and authorized external organizations. The state portion of the MCMIS is known as SAFETYNET, which has and will continue to grow into a comprehensive data system for exchanging data among states and with the federal government. Information maintained in the MCMIS includes the following:

- Census: Carrier identification of the 200,000 interstate carriers, type and size of operation, commodities carried, as well as other characteristics of the operation are included.
- Review and Rating: Between 20,000 and 30,000 on-site reviews of carriers and hazardous material shippers are conducted annually by OMC field and state staff; reviews take place in the offices of the company and cover compliance with critical parts of the federal safety regulations.
- Inspections: Data are collected during the 500,000 roadside inspections of vehicles and drivers conducted annually; violations of regulations covering the driver and the vehicle, or specifically related to hazardous materials, are included.
- Accidents: Interstate motor carriers are required to file a standard accident report for accidents that meet or exceed federal reporting thresholds; in addition, states report the occurrence of all reportable truck accidents.

Highway Safety Information System (HSIS) is a new highway safety database developed by FHWA and the University of North Carolina Highway Safety Research Center that provides detailed information linking accident, roadway, and traffic data for analyses of highway safety problems.

The current system includes five years of data (1985-1989) from five states: Illinois, Maine, Michigan, Minnesota, and Utah. Detailed information on accident characteristics, roadway features, and traffic volumes are available from each of the five states. Additional data on roadway geometrics, intersections, and guardrail characteristics are available from one or more states.

Data Collected From Households and Truck Owners. Nationwide Personal Transportation Study (NPTS) data are based on a nationally representative sample of households from which the amount and nature of personal travel by all modes is collected. NPTS has been conducted by the U.S. Bureau of the Census under contract with DOT in 1969, 1977, and 1983. FHWA has had the responsibility for the technical and administrative lead for DOT. Data collection for the most recent survey, using a computer-assisted telephone interviewing (CATI) technique, was completed in March 1991 under contract with the Research Triangle Institute of North Carolina. Substantial funding was provided by FHWA, the National Highway Traffic Safety Administration (NHTSA), and the Federal Transit Administration (FTA). Results are used within the department to address national transportation policy issues, forecast future travel demand on various modes, analyze transit use, and calculate accident exposure rates. NPTS is the only authoritative nationwide source of information that allows a linkage between the characteristics of travel and the demographics of the household. Key indicators available from NPTS include trip generation rates per household; distribution of households by income and vehicle ownership; distribution of person trips by mode, purpose, and time of day; and average annual miles by driver age and sex. Data collection for updates of NPTS is planned for 1995.

The Nationwide Truck Activity and

Commodity Survey (NTACS) is conducted for FHWA by the Bureau of the Census as a follow-on to the Census Bureau's Truck Inventory and Use Survey (TIUS). (See section on U.S. Bureau of the Census.)

National Highway Traffic Safety Administration

Agency Mission

The mission of NHTSA is to improve the safety of motor vehicle transportation through the development of a systematic approach for the identification and elimination of motor vehicle and highway safety problems. The National Center for Statistics and Analysis (NCSA) serves this mission through the collection and analysis of motor vehicle crash data, the development of advanced technologies for data collection, and the creation of improved analysis techniques.

The data are used by NHTSA in support of research and the development of motor vehicle and highway safety policies and programs. The analysis of these data provide the scientific foundation for the agency's legal and regulatory actions. These databases are also the primary source of information on motor vehicle and highway safety to other DOT agencies, especially FHWA, and to the auto manufacturing and insurance industries, state and local governments, and consumer interest groups.

Current Data Programs

NCSA develops and uses large-scale automated databases to support problem identification, program planning, and program evaluation. The main crash data systems supported by the agency are the following:

Fatal Accident Reporting System. The Fatal Accident Reporting System (FARS) provides basic information on all highway traffic crashes in the United States in which one or more persons die of their injuries within 30 days of the accident.

FARS has been in operation since 1975, producing a census of records on more than 825,000 crash-induced fatalities. These data are collected from the 50 states, the District of Columbia, and Puerto Rico. The data provide information on the demographics of the people involved, their injuries, the types of vehicles involved, the roadway and environment, alcohol involvement, restraint usage, and the history of each driver's previous violations and accidents.

National Accident Sampling System. The National Accident Sampling System (NASS) provides information from investigations of a statistical sample of police-reported traffic crashes at all levels of injury severity. NASS consists of two components: the Crashworthiness Data System (CDS) and the General Estimates System (GES).

CDS currently comprises detailed investigations of real world highway crashes involving passenger cars, light trucks, and vans, which provide detailed information on the crashworthiness and occupant protection afforded by these vehicles.

Information is collected on the sequence of crash events, the severity of the crash, occupant injuries and their causes, and details of vehicle crash protection performance. These data provide national estimates of the scope and extent of highway crash injuries and causes. Occupant protection research and rulemaking depend on this database for the detailed crash investigation-related data needed to understand crash injury mechanisms in a real world environment, and for countermeasure development and assessment.

GES currently comprises a uniform data file on a statistical sample of police-reported traffic crashes, which provides the basis for estimates of the general state of traffic safety. The current GES collects more than 40,000 cases per year for the preparation of general estimates of highway crash statistics. They are the only data the agency has that provide national estimates of traffic crash characteristics for all types of vehicles, and this is the only database that provides these estimates with measurable reliability. In cooperation with FHWA, the NASS-GES system has been expanded to include additional data on heavy truck crashes to provide national estimates of heavy truck safety.

State Data Program. This data program provides a large database that consists of all police-reported accidents from a large number of states. This database allows for a wide variety of motor vehicle and highway safety issues to be assessed and currently contains data from 26 states.

The Crash Avoidance Research Data File is currently one of the main constituents of the State Data Systems Program. Its function is to collect and analyze data dealing with factors that contribute to crashes. Ancillary databases, such as the Crashworthiness Data File, are being expanded and will be used in the statistical analyses of motor vehicle and highway safety issues.

The purpose of the State Data Systems Program is to build a large, high quality, statistically useful database. NCSA is currently working with several states in a research program focused on linking diverse state databases. The Crash Outcome Data Education (CODES) data linkage program is attempting to link police crash reports with emergency medical services' data, hospital discharge data, and insurance data on a statewide, population-based design. The linkage of automated state traffic crash data with Emergency Medical Services (EMS) and hospital-collected trauma data will enhance the quality of State Databases dramatically. Currently, crash databases at the state level traditionally provide only a general classification of the seriousness of a victim's injuries available from a police officer's assessment at the crash scene. Crashworthiness analyses often require more detailed descriptions of injuries (e.g., type of injuries and location at which they were sustained). Further, the data will be of vital importance for determining societal costs and who is paying these costs. Both pieces of information can be used to identify and support new highway safety initiatives.

Federal Transit Administration

Agency Mission

The mission of the Federal Transit System (FTA, formerly UMTA) is to assist public and private mass transportation companies in the development of improved mass transportation facilities, equipment, techniques, and methods; encourage the planning and establishment of areawide urban mass transportation systems needed for economical and desirable urban development; and provide assistance to state and local governments in financing these systems.

Current Data Programs

The Uniform System of Accounts and Records (Section 15) Reporting System was statutorily authorized as the basis for formula allocation of FTA's Grant-in-Aid programs in the early 1980s. The Section 15 Reporting System provides data on transit revenues by source; transit expenses by function and object class; nonfinancial operating data, including maintenance, employee counts, and service measures; and performance indicators, which relate measures of service outputs or use (e.g., vehicle-revenue-miles and passenger-miles) to measures of resource inputs (e.g., revenue vehicles and labor hours).

Grants Management Information System. The Grants Management Information System provides comprehensive information on all grants and contracts that FTA has made since the 1960s.

Financial Management System. The Financial Management System provides financial information on allotments, operating budget authority, and disbursements.

Other Data Activities. FTA contracted with the Community Transportation Association of America in 1985 and again in 1989 to prepare a directory of rural (Section 18) and elderly and handicapped [Section 16(b)(2)] transit service providers that includes information about type of service offered, fleet size, and county(ies) in which the service operates.

Federal Railroad Administration

Agency Mission

The mission of the Federal Railroad Administration (FRA) is to promulgate and enforce rail safety regulations, administer railroad financial assistance programs, conduct research and development in support of improved railroad safety and national rail transportation policy, provide for the rehabilitation of Northeast Corridor rail passenger service, and consolidate government support of rail transportation activities, and facilitates the development of new and improved rail technology.

Current Data Programs

Carload Waybill Sample. The annual Carload Waybill Sample contains comprehensive detailed information provided by Class I freight railroads from a stratified sample of rail waybills to the Interstate Commerce Commission (ICC) about actual rail shipments, including commodities carried; railroads involved; origin, destination, and junction points; number of carloads; tons transported; and total revenues. ICC contracts with the Association of American Railroads to collect and process the data. FRA, which provides half of the funding for the waybill sample, uses a confidential version to produce periodic and ad hoc reports for use in traffic and competitive analyses in support of DOT policy development. A more aggregated sample, which does not reveal specific carriers or shipper locations, is available to the public.

Freight Commodity Statistics. This annual database contains detailed commodity data filed with ICC by Class I railroads on tons and carloads of local, forwarded, received, overhead, and total traffic. Revenue for each commodity is also submitted. This source supports inhouse analyses requiring traffic mix information for individual Class I railroads.

National Rail Planning Network. This database contains a digital representation of the major continental U.S. railway systems, covering some 186,000 miles of track. A typical FRA analysis involves flowing the waybill sample data over the network to examine nationwide hazardous materials by rail.

Railroad Inspection Reporting System. The Railroad Inspection Reporting System (RIRS) is used to monitor each FRA-performed inspection and record the nature of each defect uncovered and any follow-up action by the railroad to correct the deficiency. RIRS contains four databases, each with its own forms and reports: (a) Signal, Track, and Motive Power (locomotives); (b) Equipment (cars); (c) Operating Practices; and (d) Hazardous Materials. Reports on inspector activity are generated monthly; other periodic reports summarize railroad noncompliance. FRA also produces ad hoc reports on specific elements of the inspection form by railroad or division.

Railroad Accident/Incident Reporting System. The Railroad Accident/Incident Reporting System includes all railroad accidents, grade-crossing accidents, railroad employee casualties, and any other injuries on railroad property. These databases provide the basis for accident analyses and assessments as well as the annual Accident/Incident Bulletin.

Grade Crossing Inventory System. This system contains a record of every public and private crossing in the United States along with the accident history of each crossing. This database is often used in conjunction with the Grade Crossing Accident Reporting System to generate Grade Crossing Accident Prediction reports requested by states and railroads.

Transborder Surface Transportation Data Project. FRA funded a census study which demonstrated the feasibility of coding the foreign trade data compiled by the U.S. Census Bureau to reflect the ground modes of transportation of U.S. exports to and imports from Canada and Mexico. Based on that study and FRA's data specifications, the Bureau of Census entered into a contract with the Bureau of Transportation Statistics to provide DOT with monthly files summarizing these data. BTS is disseminating the public files with summary statistics compiled by FRA.

Maritime Administration

Agency Mission

The Maritime Administration (MARAD) administers programs to aid in the development, promotion, and operation of the U.S. merchant marine. Financial assistance programs are administered to support provision of essential services on U.S. flag carriers and construction of ships in U.S. shipyards. MARAD helps industry generate business for U.S. ships, conducts programs to promote development of efficient port facilities and intermodal transport, and promotes domestic shipping. It is also charged with maintaining the National Defense Reserve Fleet and its component Ready Reserve Force, and with organizing and directing emergency merchant ship operations.

Current Data Programs

The following is a brief summary of some of MARAD's principal data systems. It is not intended to represent an exhaustive inventory of all databases maintained by MARAD but to indicate the scope and diversity of MARAD requirements, the various sources of such data, and the types of issues to which such data may be applied.

Maritime Statistical Information System. The Maritime Statistical Information System is a relational database that combines MARAD's foreign trade, vessel, and itinerary data. The foreign trade subsystem is primarily Bureau of Census foreign trade data but also includes complete itineraries of more than 35,000 vessels worldwide—data purchased from Lloyd's Maritime Information Service. Foreign trade data obtained from the Bureau of Census includes information that identifies both the vessel and the operator, which is not available to the public. This data is used within MARAD as the basis for calculating subsidy rates and in support of a wide range of agency programs from operating subsidies and ship financing to bilateral trade negotiations.

The vessel subsystem contains detailed vessel characteristics on more than 35,000 merchant vessels worldwide and includes information from a variety of sources on such items as container capacity, and whether the vessels are government or privately owned, were built with subsidy, have outstanding financing guarantees, or participate in the war risk binder program. The data form the basis for many MARAD publications and support, in some way, virtually all of MARAD's commercial and defense-related programs.

Port Facilities Inventory. This system contains detailed information on more than 4,000 major ocean and river port facilities, including location, physical characteristics, cargo handling equipment and capacities. It supports MARAD's program to provide technical assistance in port and intermodal planning and operations to state and local port authorities, private industry, and foreign governments. It also supports MARAD's program to develop contingency plans for the use of ports and port facilities to meet defense needs.

Domestic Trade Data. MARAD obtains domestic waterborne commerce data from the Corps of Engineers and produces a variety of reports in support of the agency's programs dealing with the inland waterways, Great Lakes, and domestic ocean trade—U.S. flag transportation segments that account for more than one billion tons of cargo each year. The database also includes detailed information on vessels and operators engaged in domestic commerce.

Financial Reporting and Contract Surveillance. The Financial Reporting and Contract Surveillance System (FRACS) contains financial reports and vessel operating statements for the more than 200 companies that have been required to submit statements to MARAD. FRACS also contains basic information about the companies and the MARAD contracts to which they are party. It enables MARAD to monitor financial and operating results on a timely basis and gives decision makers the benefits of an automated retrieval system.

Cargo Preference Data. To meet a congressional mandate to monitor compliance with cargo preference laws to maximize the use of U.S. flag vessels, MARAD monitors the shipping activities of federal agencies, independent establishments, and government corporations. To perform this activity, MARAD maintains a computerized reporting system that processes information from bills of lading collected directly from responsible parties.

Intermodal Equipment. MARAD compiles and publishes an annual Intermodal Equipment Inventory—a comprehensive statistical review and classification of equipment owned by U.S.-flag marine carriers and major container leasing companies operating in the U.S.

Maritime Labor. MARAD supports the training of merchant marine officers through operation of the U.S. Merchant Marine Academy and provision of financial assistance to six state maritime academies. MARAD also monitors maritime industry labor practices and policies in conjunction with national and international organizations. In support of these programs, MARAD collects and publishes data on maritime employment—seafaring, shipyard, and longshore. These data are used extensively in developing training programs, making policy regarding academy and state school support, and defense planning.

Sealift Planning. In connection with its national security responsibilities, MARAD maintains databases to evaluate U.S. shipbuilding and repair capabilities and forecast U.S.-flag and U.S.-owned foreign-flag fleets.

U.S. Coast Guard

Agency Mission

The mission of the U.S. Coast Guard (USCG) is to enforce or assist in the enforcement of all applicable federal laws on the high seas and waters subject to the jurisdiction of the United States; administer laws, and promulgate and enforce regulations for the promotion of safety of life and property on the high seas and on waters subject to U.S. jurisdiction, covering all matters not specifically delegated by law to some other executive department or reserved to the states; develop, establish, maintain, operate, and conduct, with due regard to the requirements of national defense, aids to maritime navigation, icebreaking facilities, oceanographic research, and rescue facilities for the promotion of safety on and over the high seas and waters subject to U.S. jurisdiction; maintain a state of readiness to function as a specialized service in the Navy in time of war; and establish and maintain a coordinated environmental program and a comprehensive ports and waterways system, including all aspects of marine transportation.

Current Data Programs

Recreational Boating Safety System. The Recreational Boating Safety database contains reports on recreational boating accidents that occur in state waters or in waters under joint state and federal control that result in loss of life, injury requiring medical attention beyond first aid, damage to the vessel and other property exceeding $200, or complete loss of the vessel. The accident reports provide information on the time of day and year of the incident, environmental conditions, type of incident, and cause. Data are also collected on boat registrations, which provide a basis on which to calculate accident and fatality rates.

Casualty Maintenance System. The Casualty Maintenance System (CASMAIN) is a database administered by the Marine Investigation Division that contains data on commercial vessel casualties, including injuries and deaths. A typical report includes information on case numbers, vessel identification numbers (VINS), casualty coordinates, vessel names and types, gross tonnage, the primary nature and cause of the accident, weather-related information, and reported damage.

CASMAIN queries are solicited from all facets of marine industry (i.e., associations, unions, vessel owners, operators, and manufacturers. Users include Congress; local, state, and federal government agencies; financial institutions; universities; medical research facilities; settlement attorneys; salvage operators; and foreign embassies.

Merchant Mariners Documentation System. The Merchant Mariners Documentation System includes the marine licensing program and is located in the Office of Marine Safety, Security and Environmental Protection. The system, among its other functions, maintains files of shipping articles and master lists for reference in documenting service time for mariners and providing service records to mariners, the maritime community, and other interested parties. It also maintains records of every mariner's service and other related information. This replaces the Seaman Documentation and Records System.

Search and Rescue Management Information System. The Search and Rescue Management Information System is administered by the Office of Navigation Safety and Waterways Services, which provides for the collection, storage, and retrieval of information on the Coast Guard's responses to search and rescue (SAR) incidents. The primary use of the system is to derive a picture of the demands made of USCG by SAR clientele and project these demands to measure unit workloads, determine resource use and needs, justify budget requests, and analyze system operations for potential savings.

Marine Safety Information System. The Marine Safety Information System (MSIS) is a data system that supports USCG marine safety regulatory programs. The system tracks inspections of U.S. and foreign vessels (including their cargoes and equipment), offshore oil and gas facilities, and port facilities (e.g., cargo docks) for such safety-related items as presence of hazardous materials and adequacy of fire-fighting equipment. Vessel inspection and violation histories are used, among other purposes, to assist in USCG boarding decisions. MSIS also records and tracks casualty information for marine accidents by vessel; full investigative reports are contained in CASMAIN, although the two systems will soon be linked electronically. Finally, MSIS tracks information about pollution incidents, including the parties and vessels involved and the costs.

Marine Pollution Retrieval System. The Marine Pollution Retrieval System (MPRS) and its predecessor, the Pollution Incident Reporting System, were designed for the Marine Environmental Response Program to generate a database of pollution incidents. MPRS reports pollution incidents that occur within all navigable waters of the United States. The database tracks the number of pollution incidents; the nature, cause, extent, location, and time of the spill; and the parties involved. Annual summary data are prepared and published periodically in a report entitled Polluting Incidents In and Around U.S. Waters.

Saint Lawrence Seaway Development Corporation

Agency Mission

The Saint Lawrence Seaway Development Corporation (SLSDC), a wholly government-owned enterprise, is responsible for the construction, operation, and maintenance of the St. Lawrence Seaway between the port of Montreal and Lake Erie within the territorial limits of the United States. Traffic development functions are to enhance System utilization without respect to territorial or geographic limits. It is the function of SLSDC to provide a safe, efficient, and effective water artery of maritime commerce, in coordination with the Seaway Authority of Canada (SLSA).

Statistical activities of the SLSDC are used to support these responsibilities. SLSA provides data collection services for both agencies through a memorandum of agreement. Published annual data collection is specific to the Seaway and focuses on the flow of cargo and vessels through the system.

Current Data Programs

SLSDC and DLDA jointly publish an annual traffic report for the Seaway System which includes historical summaries from 1959 forward. The Seaway Corporation participates in the Journal of Commerce's Port Import/Export Reporting System for on-line data service and selected hard copy data distributions.

U.S. Bureau of the Census

Overview and Data Collection Mandate

The Census Bureau is a general purpose statistical agency that collects, tabulates, and publishes a wide variety of data about the people and the economy of the nation. Over the years the Census Bureau has conducted a limited number of transportation statistics programs and currently is significantly expanding transportation industry statistics to meet increased data user needs.

The Bureau of the Census is required by law to collect and publish general purpose data on the state of the economy and the population through censuses and sample surveys. The majority of the data are used directly by other agencies as input to their programs or to supplement other data collections to meet specialized needs such as price indexes, productivity measures, and economic development. The data collection authorization of the census covers all sectors of the economy, except when a regulatory organization requires data collection to complete its own mission. Duplicative data collection is not allowed, and therefore regulatory data is often used for general economic and policy decisions. The bureau serves as the data collecting and compiling agent for other government agencies.

Current Transportation-Related Data Programs

Quinquennial Economic Census Programs. The Census of Transportation, conducted for the years 1987 and 1992, consists of two parts: establishment-based universe statistics for selected transportation industries, TIUS, the Commodity Flow Survey (CFS), and the American Travel Survey (ATS) provide basic commodity and passenger flow data.

The transportation establishment statistics correspond to those collected for other kinds of business in other economic censuses. They provide data on general finances and employment and on number of establishments. They cover only three of the eight major groups in the transportation-related part of the Standard Industrial Classification (SIC) system—42: Trucking and Warehousing, 44: Water Transportation, and 47: Transportation Services.

For many of the industries in the transportation census (e.g., trucking), the establishments have activities, workers, and equipment that may move from place to place. For the census, an establishment is a relatively permanent office, shop, station, terminal, or warehouse. Census figures for states and metropolitan areas reflect permanent establishment location and not necessarily the location where the trucking or other activities take place.

The establishment counted in the Census of Transportation offers services to the general public or to other business enterprises. Establishments that furnish similar services (e.g., warehousing) only to other establishments of the same company are classified as auxiliary to the other units of the company that they serve. Data for auxiliaries are presented in a report issued as part of the 1987 Enterprise Statistics series, but not in the Census of Transportation. The census excludes firms that do not have paid employees. Thus, for example, many independent truckers are not included in the 1987 establishment statistics.

TIUS, taken every 5 years as part of the economic census program, reports on the physical characteristics and operational use of the nation's private and commercial trucks. Unlike other economic census programs, the coverage of TIUS cuts across SIC classifications and even includes personal vehicles, although vehicles owned by federal, state, and local government agencies are not covered. Some private or commercially owned vehicles that do not have to be licensed (e.g., trucks used exclusively on private property) are also excluded. The 1987 TIUS includes physical characteristics of the nation's private trucking fleet, such as vehicle type, gross weight, type and size of engine, type of transmission and braking system, power steering, fuel conversion, air conditioning, type and size of body, power axles, axle arrangements of trailer units, and cab type. The survey also includes operational characteristics, such as base of operation; number of trucks, truck-tractors, and trailers operated from base of operation; area of operations; vehicle miles; miles per gallon; use of vehicle; and type of commodities carried (including hazardous materials).

For 1987, about 135,000 private and commercial trucks were sampled from approximately 44.8 million state vehicle registrations.

The *Census of Manufactures 1982, 1987, 1992* includes establishment coverage of more than 10,000 transportation equipment manufacturers. Coverage includes all eighteen 4-digit industries of equipment manufacturers in SIC 37, from guided-missile to recreational-camper manufacturers. Data include employment, wages, value of shipments, value added, capital expenditures, operating expenses, assets, and inventories.

Coverage of the *Census of Governments 1982, 1987, 1992* extends from the federal government and the 50 state governments to some 83,000 units of local government—counties, cities, towns, school districts, and special districts. Data collected include full- and part-time employment and payrolls; revenues by type and sources, expenditure by character, object, and function (including an array of transportation-related functions); indebtedness by type and purpose; and assets held by the government as cash or investments in securities.

Census of Construction 1982, 1987, 1992 coverage includes transportation-related construction establishments, such as those primarily engaged in highway, street, bridge, and tunnel construction. Data include the value of work done, assets, expenses, capital expenditures, and employment.

Census of Agriculture 1982, 1987, 1992 provides a universe count of farms and farm production by small geographic location is provided by this census. Data highlight the county of agricultural production (which is typically transported by truck, rail, or water) plus expenses and assets, including fuel costs and trucks used.

Enterprise Statistics 1982, 1987, 1992 regroups census data for establishments under common ownership or control to show various economic characteristics of the owning or controlling firms. This program also yields separate data about auxiliary establishments. An auxiliary establishment is one whose employees are primarily engaged in performing supportive services, such as trucking and warehousing, for other establishments of the same company instead of for the general public or other business firms. Information available includes the number of auxiliaries and payroll, the number of employees engaged in several different types of service, sales or receipts, end-of-year inventories, rental payments, selected expense data, and so forth.

Decennial Demographic Census includes questions on the means of transportation people use to get to work by geographic location of their work place have been included in the decennial Census of Population and Housing since 1960. In 1980, items on travel time to work and carpool occupancy during the work trip were added. In 1990 information on the time at which individuals left home to go to work was collected for the first time in the Census of Population and Housing. Data on these topics are made available in printed reports and on computer tapes for geographic areas such as census tracts, places, counties, metropolitan areas, and states.

Existing Economic Survey Programs

- Motor Freight Transportation and Warehousing Survey (WATS) is an annual survey based on a sample of 1,500 firms that represent all employer firms with one or more establishments that are primarily engaged in providing for-hire commercial motor freight transportation and warehousing services. This includes firms that furnish local or long-distance trucking or transfer services and those that store farm products, furniture and other household goods, or commercial goods of any nature. The survey provides about 50 data items on operating revenues and operating expenses, plus inventories of revenue-generating equipment for establishments in SIC 42 for the United States. Comparable statistics are shown for the previous year along with year-to-year percentage changes. Publication is released about 9 months after the period of reference.
- The Nationwide Trade Activity (NTACS) is a DOT-sponsored follow-on survey to the quinquennial TIUS, and has been designed to obtain operational characteristics and activity patterns of trucks by collecting trip-specific information primarily from commodity-carrying trucks. It provides essential information for the analyses of truck size and weight issues, highway user charges, safety issues, energy and environmental constraints, proposed investments in new roads and technology, hazardous materials transport, and other aspects of the Federal-Aid Highway Program. Questions on NTACS also provide linkages between TIUS and other existing sources of truck-related information.
- Annual Survey of Manufactures provides data on domestic manufacturers' production of transportation equipment, including value of shipments, expenses, and other key measures for 18 transportation equipment manufacturing industries.
- Annual Government Finance Surveys provide coverage of the federal government, 50 state governments, and a sample of some 22,000 local governments—counties, cities, towns, school districts, and special districts. Data collected include full- and part-time employment and payrolls; rev-

enues by type and source, including transportation-related sources (e.g., motor fuel taxes, toll charges); expenditure by character, object, and function (including an array of transportation-related functions); indebtedness by type and purpose; and assets held by the government as cash or investments in securities. Surveys of Transportation Equipment Manufacturing provide national estimates of domestic production of aerospace equipment, aircraft, and truck trailers.

- *County Business Patterns* is an annual series of national and state publications presenting county-level data on the number of establishments with paid employees, total employment, and payroll on an establishment basis, with economic activity classification reflecting the principal activity at each individual location. The coverage includes about 45 transportation industries in each of more than 3,000 counties.
- Foreign Trade Statistics provide a monthly census of U.S. export and import transactions on the basis of official documents that shippers and receivers must file with the U.S. Customs Service for each shipment. These figures reflect the flow of merchandise, but not such intangibles as services and financial commitments. The trade figures trace commodity movements out of and into U.S. Customs jurisdictions. Key variables in foreign trade reports are export value calculated free alongside ship (f.a.s.), import value, specific commodities shipped, and foreign country of origin or destination. Additional variables shown selectively include SIC-based product code, methods of transportation (e.g., air, sea, or land), U.S. state of origin or destination, U.S. and foreign ports, quantities shipped, and weight for air and sea shipments.
- Plant and Equipment Expenditure Survey is a quarterly publication of transportation equipment manufacturers that provides investment information for manufacturing and transportation service firms.
- Quarterly Financial Report contains up-to-date aggregate statistics on the financial results and position of U.S. corporations. The report presents estimated statements of income and retained earnings, balance sheets, and related financial and operating ratios for the transportation equipment industry, including detailed information on motor vehicles and motor vehicle equipment, aircraft, and parts.

Existing Demographic Surveys include:

- Information has been collected in the American Housing Survey (AHS) since the mid-1970s on means of transportation to work, travel time to work, and distance to work. Other data items, including information on the geographic location of the work place, have been collected periodically from both the national sample and the individual metropolitan area samples of AHS. Data are available in printed reports, public-use microdata files, and unpublished tabulations for selected large cities and counties, and for the nation.
- Transportation expenses are collected as part of the Consumer Expenditure Quarterly Interview Survey, which provides information on how various groups of U.S. consumers spend. The survey data include large expenditures, such as automobiles, and expenditures that occur on a regular basis, such as gasoline and insurance premiums.

Approved and Budgeted Programs Under Development

The expanded 1992 Census of Transportation will present significantly more transportation establishment statistics on revenues, payroll, and employment by varied transportation classifications. It will provide these data for 43 4-digit industries in the following major SIC groups.

SIC	Major Group Title
41	Local and Suburban Transit and Interurban Highway Passenger Transportation
42	Motor Freight Transportation and Warehousing
44	Water Transportation
45	Transportation by Air (excludes large certificated passenger air carriers)

46 Pipelines, except Natural Gas
47 Transportation Services

This represents an expansion in the scope of the Transportation Census for 15 industries in major groups 41, 45, and 46, incorporating more than 24,000 additional establishments with more than 860,000 employees. General financial and employment data, and number of establishments will be provided.

The questionnaire and collection methodology for these industries were tested as part of the 1989 pretest. Review of the data collected on these questionnaires and the accompanying evaluation forms should provide the information needed to finalize the coverage and questionnaire design for these industries in 1992.

Additionally, collection of data for the railroad industry and large certificated passenger air carriers is under consideration. Review of the data available from other government agencies (ICC and DOT, respectively) and the reportability of requested data and information from the pretest will determine whether these industries should be within the scope of the 1992 Census.

Plans are to publish data from the 1992 Census on a national basis and, where not prohibited by confidentiality restrictions, for selected states and metropolitan statistical areas. Publication plans for 1992 include the release of summary data for nonemployers in transportation industries for the first time.

Future Planned Surveys

Charter, Rural, Intercity Bus Survey. This annual survey would provide a complete enumeration of approximately 2,000 firms offering intercity, rural, or charter bus transportation services. Estimates of annual dollar volume for intercity and charter bus activities range from $5 to $8 billion. The 1982 Bus Regulatory Reform Act seriously reduced the amount of data on intercity bus activity. Although intercity scheduled service has continued to decline, charter and tour ridership is growing. More than 40 data items on revenues and expenses are planned. If approved, the survey, covering calendar year 1992 activities, will be published in December 1993.

Transportation Services Survey. This annual sample survey would cover all employer establishments from a universe of 34,000 establishments providing transportation services (SIC 47). Estimates of dollar volume for services incidental to transportation range from $12 to $14 billion annually.

Regulatory reform has had a profound effect on the structure of freight transportation as traditional lines of delineation between arrangers of freight transportation have become blurred. All public data collection on freight forwarding ceased in 1980. About 35 data items on detailed revenues and expenses are planned. If approved, the survey, covering calendar year 1992 activities, will be published in December 1993.

Water Transportation Survey. All employer firms providing water transportation services would be covered in this annual sample survey. The industry consists of 7,500 establishments with estimated revenues of $7 to $9 billion.

Existing data sources deal almost exclusively with the physical characteristics of the system—vessels, waterways, and port facilities of the industries—or with commodity movements. The passenger transportation segment of this industry is one of the fastest-growing components of the travel sector. About 40 detailed data items on revenues and expenses are planned. If approved, the survey, covering calendar year 1992 activities, will be published in December 1993.

Proposed Joint Projects

State and Local Government Transportation Survey. This proposed survey would fill an important need for information about the resources state and local governments devote to the provision of transportation infrastructure and services. The survey would include all aspects of government transportation services, including highways, water transportation, air transportation, and transit operations. The data would emphasize the financial and personnel resources that state and local governments provide to construct, maintain, and operate these services.

The existing data on state and local government transportation services is fragmented by the diffuse nature of federal, state, and local government organizations. The Census Bureau's data collection programs on state and local government finances and employment provide an ideal base for establishing a comprehensive transportation information system (i.e., uniform time frame, definitions, data classification, and data collection methods).

This would be a voluntary survey of all state governments and a sample of individual local governments—counties, municipalities, townships, school districts, and special districts. The financial data would cover the entire range of financial activities: revenues (motor fuel taxes, transit charges, federal revenues); expenditures (highway construction, transit system current operations); indebtedness (types of debt financing for airports and highways); and gross assets (including highway trust funds). For comparative purposes, the employment data, showing number of employees and payroll, would cover the same functional areas as the expenditure information. In addition, information would be collected from school systems about the costs related to transportation of pupils.

In summary, this survey would provide, for the first time, comprehensive state and local financial data on transportation activities. New consistent data would be published annually for the following categories: (a) gross value of transportation assets by governmental unit by transportation function and (b) specific relationship of governmental financing along with the actual expenditures (e.g., federal government contribution and debt financing by transportation function and purpose). Information on funding sources will include tax levies, debt issues, fees charged, and miscellaneous revenues.

Bus and Government Vehicle Survey. Little is known about the use of the highway system by buses and government-owned vehicles. An estimated two million of these vehicles are currently in use, and they certainly could have an important impact on highway condition. In addition, complete information on bus and government vehicle road use is needed for accurate forecasting of highway capacity and investment requirements.

The Census Bureau and DOT are evaluating existing data sources in these areas and formulating a proposal for efficiently measuring and monitoring annual changes.

U.S. ARMY CORPS OF ENGINEERS

Agency Mission

The United States Army Corps of Engineers (COE) serves as the Army's real property manager, performing the full cycle of real property activities (requirements, programming, acquisition, operation, maintenance, and disposal); manages and executes engineering, construction, and real estate programs for the Army and the U.S. Air Force; and performs research and development in support of these programs. COE manages and executes Civil Works Programs, which include research and development, planning, design, construction, operation and maintenance, and real estate activities related to rivers, harbors, and waterways; and administers laws for protection and preservation of navigable waters and related resources such as wetlands. It also assists in recovery from natural disasters.

Through its Navigation Data Center, COE collects, processes, manages, and disseminates a variety of statistical data relating to foreign and domestic waterborne commerce, vessel and port facility descriptions, and navigation lockages. The reports include annual statistical tabulations of domestic and foreign commodity movements on U.S. waterways and within ports, an annual directory of operating domestic vessels, periodic revisions of port facility descriptions, quarterly detailed statistics for each Corps of Engineers-operated lock, and dredging statistics. Information is provided both in published reports and on data processing software.

The Navigation Data Center provides coordination of navigation information within COE, the U.S. Department of Defense, all federal and nonfederal agencies, and with private partners and the general public, to ensure effective data collection and dissemination strategies. The center consists of the Waterborne Commerce Statistics Center, the Port Facilities Branch, and two teams covering the lock performance monitoring system and dredging statistics.

Current Data Programs

Waterborne Commerce and Vessel Statistics. Waterborne Commerce of the United States (WCUS), Parts 1-5, contains statistics on the commercial movement of foreign and domestic cargo available in both hard copy and computer tape. The Public Domain Data Base of WCUS contains aggregated information on waterborne commodity movements by 26 geographical areas, available in both hard copy and computer tape. The Principal Ports Tonnage Report ranks U.S. ports for a calendar year by total tons, domestic and foreign. The State Tonnage Report contains total waterborne commerce by state. The Transportation Lines of the U.S. lists vessel operators and their addresses, type and physical description of vessels, principal service, location, and commodity served. The Navigation Data Center handles special requests for commerce and vessel statistics, which are not contained in standard products, on a case-by-case basis.

Port Facilities. These data consist of the physical and intermodal characteristics of the coastal, Great Lakes, and inland ports in the United States. Fifty-six Port Series Reports are published at intervals of approximately 7 years, covering more than 200 individual port areas. Reports consist of complete descriptions of a port area's waterfront facilities, including detailed information on berthing accommodations, petroleum and bulk handling terminals, grain elevators, warehouses, cranes, transit sheds, marine repair plants, fleeting areas, and floating equipment. A special 1988 report, *Summary of Commodity Handling Terminals of the United States Inland Waterways*, groups the various terminals by type of commodity handled and includes location, berthing length, cargo direction, operating rate, and storage capacity for each facility.

Lock Performance Monitoring. Lock Performance Monitoring (LPM) data consist of descriptions of the traffic through locks on the inland waterway system as well as the physical aspects of lockages. Specifically, data is collected on vessel name, number, river direction, number of cuts, lockage, entry and exit type, arrival time, lockage time, and factors that may have interfered with the lockage. Vessel data include vessel name and number, flotation dimensions, number of passengers, barge types, number, and type and tonnage. The LPM system produces several reports, including a semiannual *Summary of Lock Statistics and an Overview of the Lock Performance Monitoring System*.

Dredging Statistics. Dredging statistics include data on bid schedules, location of contact, dredge type, and cubic yards. The Navigation Data Center is responsible for defining and developing a new system during fiscal years 1991 and 1992 to provide both industry and the corps with a more current and accurate dredging data program.

Interstate Commerce Commission

Agency Mission

The Interstate Commerce Commission (ICC) regulates interstate surface transportation, including trains, trucks, buses, water carriers, freight forwarders, transportation brokers, and a coal slurry pipeline. The regulatory laws vary depending on the type of transportation; however, they generally cover certification of carriers seeking to provide transportation for the public and their rates, adequacy of service, purchases, and mergers. The commission ensures that the carriers it regulates will provide the public with rates and services that are fair and reasonable.

With enactment of the Railroad Revitalization and Regulatory Reform Act of 1976, the commission's statutory mandate was altered to provide for less regulation over rail freight rates and practices. This fundamental shift in national transportation policy was reinforced by enactment of the Motor Carrier Act of 1980, the Staggers Rail Act of 1980, the Household Goods Transportation Act of 1980, and the Bus Regulatory Reform Act of 1982. These measures provided for a sharply reduced federal role in regulating the trucking, railroad, and bus industries.

Although ICC statistical activities have been reduced, the agency still produces a number of important statistical products.

The areas of coverage include railroads and motor carriers of property and passengers (i.e., trucks and buses).

In each modal area the industry is divided into classes based on revenues. Trucking and intercity bus carriers with more than $5 million in earnings are categorized as Class 1, those with between $5 million and $1 million as Class 2, and those with less than $1 million as Class 3. The revenue thresholds were established in 1980 and are adjusted for inflation each year.

Current Data Programs

Annual Reports to Congress. The commission has provided an annual report to Congress for more than 100 years. These extensive reports draw on the regulatory activities and statistical reports received by the commission and provide a useful summary of the status of regulated transportation.

Transport Statistics in the United States. This report, published annually, provides summary statistics for Class 1 rail and motor carriers, including general balance sheet and financial data, operating income and expenses, and operating statistics. Some information on physical equipment, such as track and operating equipment, is also included.

Motor Carrier of Property Quarterly Freight Revenue Report Form. The Quarterly Freight Revenue (QFR) schedule, substantially reduced from its prederegulation length, covers major financial and operating statistics for trucking firms. Reporting is required on a quarterly and cumulative annual basis. Only the carriers identified as Class 1 or 2 are required to provide significant reporting in the trucking sector. Reporting carriers number approximately 2,000 in contrast with more than 42,000 nonreporting carriers. Class 3 and exempt carriers are only required to provide identification information and revenue data sufficient for classification purposes.

The individual carrier reports are available for inspection in a public reference room. Each quarter, the commission's Office of Economics produces a brief release citing the top 100 carriers and reporting selected earnings data. These are published under the titles: *Large Class 1 Motor Carriers of Property Selected Earnings Data* and *Large Class 1 Household Carriers Selected Earnings Data*. Far more detailed financial and operating statistics from data filed in QFR are provided for a fee by the American Trucking Associations in the *Motor Carrier Quarterly Report: Financial and Operating Statistics*.

Motor Carrier of Passengers Quarterly and Annual Report. Motor carriers of passengers (i.e., intercity bus carriers) complete a substantially abbreviated version of the QFR financial and operating schedule, called MP-1. Only the Class 1 carriers are obligated to provide the required report in the bus sector. The Class 1 intercity bus carriers number about 30 of more than 3,000 bus carriers. Reporting firms provide a mix of scheduled service, tour and charter operations, school bus, and even local transit services. One firm, Greyhound, generates most of the industry's Class 1 revenues. The ICC Office of Economics provides a parallel quarterly release to the trucking report for the top ten bus carriers, *Large Motor Carriers of Passengers Selected Earnings Data*.

Quarterly Report of Railroad Revenues, Expenses and Income. Rail reporting follows a format similar to the motor carrier system, but, because of the nature of the industry structure, Class 1 carriers represent almost all of the industry's activity. Class 1 carriers are defined as those with revenues above a certain threshold ($93.5 million in 1989); the dividing line for Class 2 and 3 carriers is at $18.6 million. Only those in Class 1 are required to report quarterly and annual financial and operating information. Class 1 carriers numbered only 16 in 1990 but accounted for more than 90 percent of total industry revenue. There are approximately 500 non-Class 1 carriers.

Report of Railroad Employment Class 1 Line-Haul Railroads and Wage Statistics of Class 1 Railroads. Because the rail industry does not participate in the social security system of the United States, ICC is responsible for the collection of monthly and annual data on employment and wages for Class 1 railroads. These data are provided to the Bureau of Labor Statistics for such purposes as compiling employment statistics of the U.S., the unemployment rate, and the calculation of productivity measures.

Rail Waybill Statistics. In addition to financial and operating statistical reporting, ICC, in a jointly funded activity with FRA, contracts with the Association of American Railroads (AAR) to produce the Rail Waybill Statistics, which reports on rail origin-destination movements by commodity, based on a sample of shipping documents and computer files. The report is published by FRA (see p. A-31).

U.S. Department of Agriculture

Agency Mission

The mission of the U.S. Department of Agriculture (USDA) is to improve and maintain farm income and develop and expand markets abroad for agricultural products. The department works to enhance the environment and maintain U.S. production capacity by helping landowners protect soil, water, forests, and other natural resources. Rural development, credit, conservation, and research programs are also part of the department's mission. Finally, the department safeguards and ensures standards of quality in the daily food supply through inspection and grading services.

The Transportation and Marketing Division (TMD) of USDA's Agricultural Marketing Service (AMS) helps develop an efficient agricultural and rural transportation system by providing research, technical assistance, and leadership in developing transportation policy and programs within USDA. In doing so, TMD draws on a variety of data sources in both the public and private sectors. TMD is both a data user and a data gatherer.

Current Data Programs

Ocean Grain Freight Rates. TMD has electronically compiled more than five years of grain freight rates from the weekly publication Maritime Research. Both U.S. and foreign origins and destinations are included, along with shipper, volume, rate, and other information. The information is used to determine the U.S. competitive position in worldwide grain markets and estimate USDA export commodity programming levels.

Trucking. TMD monitors trends in agricultural trucking. However, because unprocessed agricultural commodities moving by truck are generally unregulated, the lack of reporting requirements causes a major shortfall in reliable data. Information on rates, tonnage, the number of carriers, and flow patterns is generally nonexistent. Through records kept by the AMS market news reporters, data are available on fruit and vegetable shipments and receipts at major markets. TMD also calculates per-mile costs for exempt owner-operators of truck fleets.

Waterways. TMD collects information on grain flows through seven strategic locks on the Mississippi River system. Although the information is available from USACE, timeliness and accuracy are sometimes an issue. TMD is interested in grain traffic by type of grain, whereas the USACE data sometimes do not distinguish among the various grain types.

Rail. TMD uses a waybill bill sample from the ICC to determine grain movements by rail. However, certain use restrictions are placed on these data, which limit their utility in analyzing the movement of agricultural goods.

The *Transportation Statistics Annual Report* is a long overdue summary of the state of the nation's transportation systems and the issues and consequences of maintaining such a diverse and complex network. All four transportation modes—airways, highways, railways, and waterways—are examined through available data and statistical studies. In addition, it takes a closer look at the statistics themselves and identifies obstacles to attaining both quantity of *and* quality in information on transportation in the United States. A better understanding of the performance of the transportation system and the potential for its improvement requires both better coverage and increased quality of existing data. This report highlights attempts toward the design and implementation of better measures to transform existing and new data into useful information.

The Bureau of Transportation Statistics, is an operating administration of the U.S. Department of Transportation. BTS is responsible for compiling, analyzing, and making accessible information on the nation's transportation systems; collecting information on intermodal transportation and other areas as needed; and enhancing the quality and effectiveness of the statistical program of DOT through research, the development of guidelines, and the promotion of improvements in data acquisition and use.

Information on the *Transportation Statistics Annual Report* and other publications is available by writing BTS Product Information, U.S. Department of Transportation, Room 2104, Washington, D.C. 20590, faxing 202-366-3640, or calling 202-366-DATA.

The *Transportation Statistics Annual Report* is also available on CD-ROM with extensive, additional data files.