PART A
Tenets and Concepts

CHAPTER I
Tenets of the Planning Effort

The tenets upon which this work is based include statutory directions and official statements of transportation policy, a number of economic theories, and an interrelated set of assumptions concerning the future of the Nation.

THE REQUIREMENT

On October 15, 1966, Congress passed the Act that established the U.S. Department of Transportation. In this Act the Congress declared:

> "That the general welfare, the economic growth and stability of the Nation and its security require the development of national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith and with other national objectives, including the efficient utilization and conservation of the Nation's resources."

The Department of Transportation was charged to:

> "Facilitate the development and improvement of coordinated transportation service to be provided by private enterprise to the maximum extent feasible; to encourage cooperation of Federal, State, and local governments, carriers, labor, and other interested parties toward the achievement of national transportation objectives; to stimulate technological advances in transportation; to provide general leadership in the identification and solution of transportation problems; and to develop and recommend to the President and the Congress for approval national transportation policies and programs to accomplish these objectives with full and appropriate consideration of the needs of the public, users, carriers, industry, labor, and national defense."

Special effort was directed to:

> "Preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites."

In the Airports and Airways Act of 1970 the Congress directed:

> "Within one year after the date of enactment of this title, the Secretary of Transportation shall formulate and recommend to the Congress for approval a national transportation policy. In the formulation of such policy, the Secretary shall take into consideration, among other things:
> (1) the coordinated development and improvement of all modes of transportation, together with the priority which shall be assigned to the development and improvement of each mode of transportation; and
> (2) the coordination of recommendations made under this title relating to airport and airway development with all other recommendations to the Congress for the development and improvement of our national transportation system."

TRANSPORTATION POLICY

The Department of Transportation has responded to this direction with a series of reports to the Congress. One of these reports was the *Statement of National Transportation Policy*, which the Secretary of Transportation submitted to the Congress in September 1975. This planning effort is an extension in depth of the 1975 response; it derives from, details, and estimates the consequences of that body of policy. Throughout the document, references are made to applicable portions of the policy.

The *Statement of National Transportation Policy* covered a broader field, in that it emphasized institutional as well as physical and economic aspects of transportation. Figure I.1 summarizes underlying principles from the statement.

1. The Federal Role—Predominant Concerns of the Federal Government

a. The Federal Government should define its role vis-a-vis State and local governments by exercising responsibility pursuant to Constitutional and statutory authority:

(1) In international commerce;

(2) Over interstate commerce, particularly in supporting the development, viability, and modernization of major interstate networks in rail, highways, air, and water;

(3) In defining and working to advance national priorities through persuasion, incentive, regulation and enforcement where the magnitude of the problems and their national importance require a Federal response (e.g., safety, revising the city centers, energy conservation);

(4) In shoring up weak elements of the transportation system on a temporary basis where the national interest is served by helping to preserve diversity and prevent nationalization;

(5) To assist States and municipalities on the basis of shared responsibility and priorities;

(6) In direct, selective investments in research and development, planning and activities that are in the interest of national security and other exclusively Federal concerns.

b. The Federal Government must move in the direction of encouraging more rational public and private financing of capital and operating costs in the transportation sector, consistent with:

(1) Sound fiscal policy and cost controls, including vigorous assessment of the inflationary impact of Federal actions;

(2) Increased participation, where possible, of State and local governments in projects primarily benefiting their residents;

(3) More equitable use of Federal subsidies, insuring that they are necessary to achieve a clearly defined national interest and minimizing their detrimental impact on competing modes;

(4) Careful assessment of the costs and benefits of alternative uses of Federal funds;

(5) Recognition of the real costs of transportation services, including their environmental consequences;

(6) Allocating limited Federal resources on the basis of comparative merit without reference to fixed trust fund revenues;

(7) Encouraging the user to pay for full cost of federally financed services and facilities, except where the public interest correctly dictates a subsidy;

(8) Economic and regulatory policies that enable transportation industries to earn a reasonable rate of return on investment, attract capital, provide expanding job opportunities and protect the legitimate needs of the employee, consumer and investor;

(9) Reasonable labor policies and practices that will enable the efficient use of Federal transportation funds in reducing unemployment and poverty.

c. The Federal Government should improve its performance measures—in assessing the effectiveness of alternative Federal programs and policy options and evaluating the health and progress of the transportation system—even though the diversity in transportation needs and costs of providing services make infeasible the formulation of uniform performance standards for all States and localities.

d. Government must promote consumer participation in public decisionmaking.

2. U.S.-International Transportation Concerns

a. In a world of increasing internal interdependency, transportation must protect vital national interests by:

(1) Enabling the United States to compete effectively in the world market;

(2) Enabling people, freight, and mail to travel abroad at the lowest possible price, consistent with good, safe, and regular service and an appropriate rate of return on capital;

(3) Enabling U.S. carriers to compete effectively with foreign carriers;

(4) Supporting national security requirements;

(5) Reducing dependency on foreign energy resources;

(6) Supporting continued U.S. leadership in technology through sound research and development planning.

3. Federal-State-Local Relations

Most transportation activity involves primarily local movement. Consequently, the largest share of existing Federal assistance programs requires shared Federal, State, and local priorities and decisionmaking. The extent of Federal financial participation and program control is a function of the national priorities served. As we decentralize authority and increase State and local program flexibility, States and localities must improve program management and, where possible, increase their financial participation in projects that primarily benefit their residents. We have a further responsibility to define residual Federal interests—connections to interstate commerce, preserving urban centers, overall national economic and social well-being, civil rights, etc.—and to simplify the process by which responsiveness to these national priorities is assured.

4. Government and the Private Transportation Sectors

a. A dynamic, competitive, and effective private sector should meet the Nation's transportation needs to the maximum extent feasible.

b. The private sector and government should interact effectively, performing functions and pursuing priorities for which each is best suited, working in a mutually reinforcing way where appropriate and at "arms length" where necessary.

c. Representing 10 percent of the Gross National Product, the transportation sector must attract adequate capital for sound investment in the future and promote a stable and growth-oriented economy by exercising fiscal responsibility, helping to control inflation, and creating employment opportunities.

d. The Government must promote increased efficiency, energy conservation, capital development, job opportunity, and productivity through economic and regulatory policies that create a climate conducive to healthy competition among financially viable suppliers, carriers, operators, and modes. In responding to specific short-term economic ills of an industry, direct Federal subsidy should be considered as a last resort.

e. We should seek balanced reform of the Federal regulatory process—not deregulation, sudden chaotic changes, or abrupt policy reversals. We must also realize that financial commitments have been made under existing regulatory ground rules, and we should be cautious in the application of theoretical solutions....Increased emphasis must be given to competition and the market mechanism as a more effective judge of efficient resource allocation and a more reliable barometer of consumer preference.

f. We should determine the most efficient restructuring in various modes and encourage new methods of intermodal cooperation.

g. As economic regulatory changes are implemented, we also recognize that large financial sums have been invested in reliance, in part, on the present regulatory system. Therefore, some otherwise laudatory reforms will have to be altered or staged over a transitional period to enable appropriate adjustment to market conditions. We should evaluate the consequences of each modification to assure that the financial viability of the industry is preserved and other public interests are being served.

h. Whereas less government intervention through economic regulation is desirable, this should not be at the expense of consumer protection or the financial well-being of the industry. Government should devote sufficient resources to the development and enforcement of reasonable standards of safety, environmental protection and civil rights, consistent with cost-benefit analysis where appropriate.

i. The strength of our transportation system lies in its diversity, with each mode contributing its unique and inherent advantages, and responding to different consumer demands at various levels of cost and quality of service. The Government should preserve and encourage this diversity by:

(1) Promoting equal competitive opportunity for all forms of transportation;

(2) Encouraging cooperation, connectivity, and integration among the modes.

5. Public Interests—Enhanced Quality of Life

a. The transportation sector should contribute substantially to an improved quality of life by:

(1) Attaining high standards of safety;

(2) Protecting our air and water from pollution, reducing excessive noise, and supporting sound land use patterns and community development;

(3) Bringing people together and closer to the variety of benefits that our culture and economy offer;

(4) Minimizing the waste of human resources that results from congestion, inadequate transportation service, and inefficiency in transport operations;

(5) Providing the lowest cost services to the consumer consistent with safety, a reasonable rate of return on capital, a sound government fiscal policy, and other public interests;

(6) Promoting the most efficient use of scarce, finite, and costly energy supplies;

(7) Creating and maintaining employment and capital opportunities.

b. Our transportation system should be accessible to and provide equal job opportunities for all our citizens—with special recognition of the needs and potential contribution of the elderly, the handicapped, the poor, minorities, and women. It must respond to varying demands of the tourist, the family, and business. The consumer should be an active participant in the formulation of transportation policy.

Figure I.1. Excerpts from the September 1975 Statement of National Transportation Policy by the Secretary of Transportation.

As made clear by the Legislation that created the Department of Transportation, it is national policy that due consideration be given to national defense transportation needs.

ECONOGOVERNMENTAL THEORY

Transportation is typically an intermediate or linking function between various activities of society and sectors of the economy. Thus transportation is a means to the many ends sought by society. Ideally, it should be assessed in terms of its contributions to these ends compared to the costs involved. Unfortunately, these ends are nowhere defined in detail, and they change as society's perceptions of its needs change. Even if the ends were defined and constant, our ability to place values on various aspects of the quality of life is rudimentary.

Resources in the United States are allocated to various ends through two pervasive processes: the political process, in which the public (or its representatives) votes with ballots, and the market process where the people affect the result with their dollars. The United States traditionally has relied heavily on the market process to provide transportation. The preamble to the Department of Transportation Act reaffirms this thesis (see earlier section, The Requirement). Since the early part of this century, however, the Congress has created and funded a growing number of transportation programs. In recent years, federally controlled and allocated funds have accounted for almost 5 percent of the Nation's total expenditures for transportation. State and local government expenditures have been even greater. All three levels of government, however, have been reluctant to abandon the market process, particularly with respect to vehicle ownership and operation.

Furthermore, the free enterprise philosophy has not prevented Federal subsidies to, and strict regulation of, some segments of transportation. Consequently, the current allocation of resources in the field of transportation reflects neither a preponderantly free market influence nor a comprehensive governmental effort.

This study attempts to serve both the economic and political processes. It visualizes a political process that recognizes the potential inadequacies of an unrestrained market to provide for each individual's basic necessities and that acts to prevent or mitigate market imperfections. And it visualizes a market process operating within such constraints to provide efficiently the transportation the Nation wants and is willing and able to pay for. (See figure I.2.)

PLANNING ASSUMPTIONS

Demands for transportation derive from almost all other human activities. Furthermore, the available transportation may significantly determine the character of many human activities. The development of this study required numerous assumptions concerning the Nation's population, its activities, and the relationship between transportation and these activities. Figure I.3 outlines many of the core assumptions. A number of these assumptions are also part of the OBERS[1] projections, which were used extensively.

Figures I.4 through I.7 show the anticipated growth and redistribution of the U.S. population in the absence of specific policies to change such redistribution. Figure I.8 illustrates the expected changes in sex and age distribution in the population.

The projected increase in the gross national product is shown in figure I.9, and the corresponding increase in per capita income is shown in figure I.10.

Figure I.11 shows the change in the industrial mix of the economy.

Many deviations from the core assumptions are possible, and perhaps even likely. A number of such contingencies are accounted for individually in succeeding sections. Furthermore, the last chapters examine what might happen under several other scenarios.

[1]"OBERS" derives from the initials of the two Federal organizations that developed the projections—the Office of Business Economics of the Department of Commerce (now the Bureau of Economic Analysis) and the Economic Research Service of the Department of Agriculture.

A. Perfect Competition

Economic theory posits that a necessary condition to the maximum welfare of any community is achieved when an individual can be made "better off" without making another "worse off." This state of affairs would result from "pure competition" in a "free market." The definition of "pure competition" and "free market" involves a number of conditions which often do not exist in reality. The theory assumes that each person is able to assess if a given economic act will make him better or worse off—either as a producer or consumer, and that each person will use his personal resources to become "better off." Success depends on the salability of one's time, energies and resources (for wages or interest). The greater a person's marginal productivity (income), the better off he becomes. Assuming the individual is the sole judge of his or her economic welfare is called "consumer sovereignty." According to this economic theory: products are justified only by the willingness of people to buy them, a product should not be sold at a price lower than the costs associated with producing the last unit (marginal cost). This would be achieved in the "free market" because competition would drive prices down to the lowest level at which others are willing to sell. Any departure from this market price, either less or greater, makes someone better off at the expense of making someone else worse off. Any departure is therefore economically undesirable.

B. Government Intrusion Into Market

One widely held view in the United States expressed by some economists is that governmental involvement should be largely limited to instances where the market process does not function in the general public interest. Furthermore, when government involves itself, it should do so in such a way as to approximate the allocation of resources one would expect if the world operated in accord with the theory. It tends to follow that when government provides goods or services, the price to users of such goods and services should include government costs. Thus, any in general government operation which does not imitate private market operation, and which continues when private enterprise can do the job as effectively, might be considered economically undesirable.

C. Economic Development

Transportation loans, subsidies or constraints can be used as a mechanism for shifting economic advantage from one region to another by reducing the cost of accessibility to one region relative to others. This may be economically justified in cases where the favored region has a prospective absolute or comparative advantage over the other regions. This prospective advantage must be sufficiently large, such that economies of scale production in the region can, after an initial start-up period, make production profitable enough to sustain itself and assume the costs of the transportation as well. A possible example is the development of Alaskan oil and gas discoveries. Heavy vehicles used to develop these discoveries have caused abnormal wear and tear on Alaskan roads, and new transportation rights-of-way may be required in the futire to facilitate further development. However, once the oil and gas reach the market, the potential oil and gas profits should be adequate to pay the transport costs.

D. Remedying Market Imperfections

Various conditions may cause markets to inefficiently allocate resources. Such conditions may require governmental remedies if resources are to be allocated properly from the economists' viewpoint. Some of the conditions along with transportation examples are listed below.

E.

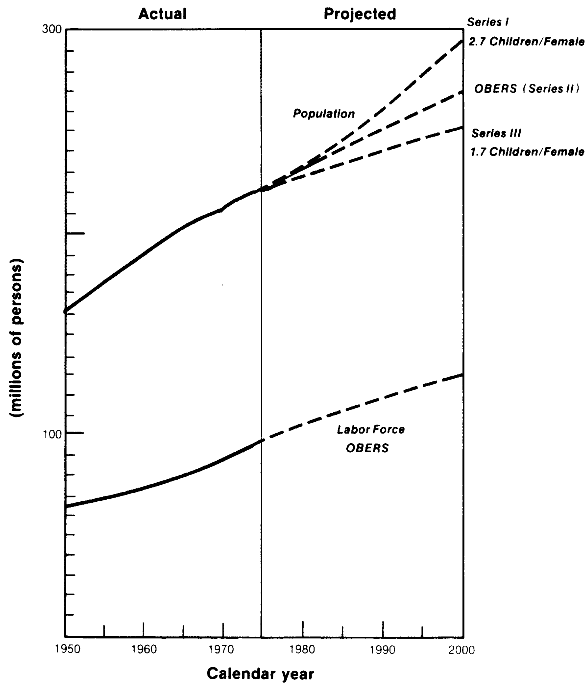
Condition	Transportation Example	Solution Example
1. Lack of information on the part of buyers, sellers, or users of transportation	A traveler or shipper may not know all the travel or shipping options available to him, thus may opt for one that is more costly than necessary.	Development of a national directory or information system that describes the options available.
2. Market prices not reflecting the social benefits and cost allocable to the transportation		
a. Congestion	a. Peak hour pricing is not generally now used on congested public transportation facilities such as bridges, airports, etc.	a. Encourage peak hour pricing on such facilities, if the social costs of collection are less than the costs of congestion
b. External costs such as pollution, noise, hazards	b. Regulations have set emission rates for certain polluters but no costs penalty attached to emissions below this rate even though they may contribute to an unsatisfactory ambient pollution level.	b. Encourage localities to place pollution cost penalties (for example when licensing vehicles) on transportation in addition to emission level standards, where standards are not being achieved.
c. Government subsidy	c. Waterways, general aviation, Amtrak rail passenger service, and urban mass transportation are all heavily subsidized by the Federal Government.	c. Phase out the subsidy by charging user charges or phasing out the Federal activity.
d. Regulated prices	d. All rail tariffs and commercial air fares are Federally regulated.	d. Permit pricing variability where competition exists.
3. Inability to determine or collect a proper price		
a. Public Goods — a good whose consumption by one person in no way reduces the consumption of it by another (national defense, for example).	a. Transportation facilities essential for national defense but which would not be provided by the market.	a. Incorporate such features in the design but attempt to identify the incremental cost over what the market would produce and associate it with a national defense account.
4. Monopoly and Monopsony	Transportation firms often attempt to merge, or may attempt collusion in setting fares and tariffs.	Enforce vigorously antitrust laws and regulations.
5. Unemployed Resources	Cyclical swings in the economy or technological innovation and other changes may result in periods of unemployment in transportation.	a. Phase in user charges in transportation during periods of relatively full employment.
		b. Provide transitional assistance for labor where more efficient operations replace less efficient, reduce labor requirements.
6. Legal or regulated operating constraints that prevent effective market operation	ICC regulations restrict some forms of transportation to haulage of certain types of commodities over specified routes. Such regulations contribute to empty back hauls and circuitous travel. Some carriers are not permitted to abandon uneconomic markets.	Provide for operational flexibility in regulations, and permit orderly withdrawal from uneconomical markets.

Figure I.2. Econogovernmental Theory

ASSUMPTION	BASIS	COMMENT	TRANSPORTATION IMPACT
Population Character			
1. Continued average fertility rate of of 2.11 children per woman[1]	Bureau of Census (Series E Projection)	This is a midrange "replacement level" assumption. Current birth rates considerably lower (1.7), but historical rates have been much higher. The result of this rate is a "small" 15% population increase of 30 million, including approximately six million immigrants by 1990.	Population is a fundamental determinant of transportation demand. Impact of the increase is less than "expected" due to continuous downward revision of the forecasts. All population of driving age between now and 1990 already born.
2. "Baby boom" cohort matures	Historical trend	The extraordinary size of this age group will continue to have repercussions as it proceeds through the age chain. The number of people in the 30 to 44 age group will grow 56% between 1975 and 1990.	This change will be more significant than the population increase factor, due to large increases in heavy-travel age groups. Fewer people in the high accident rate age group implies increasing safety.
3. Ratio of young and elderly to working-age population declines	Bureau of Census (Series E Projection)	This indicates a 25% decline in the number of people under 16 and over 65 years old. Within that declining group,the elderly will be increasing in size, and the young sharply decreasing. There will be 7 million fewer teenagers in 1990.	Working-age population has "freer" time and income. Proportionately fewer school and serve children trips. Transit service characteristics focused more on needs of the elderly.
Population Distribution			
1. The factors influencing historical population distribution trends will continue, workers will migrate to regions of economic opportunity.[1]	Historical trends	Changes in world climate patterns, prolonged shortages of energy due to embargoes, prolonged economic recession, or changes in the national ethos could change the historical patterns.	Determines the distribution of people and their activities and consequently the origin-destination patterns of travel.
2. Growth shifting to "Sun Belt" areas	Recent trend	Shifts in population to Southwest and to rural areas with amenities growing in force.	Shifts in transport infrastructure needs. More open and balanced pattern of national travel corridors. More ubiquitous demand and service patterns.
3. Continued suburbanization	Historical trends	Increasing shares of population living at suburban densities, and adopting suburban lifestyles. Decline in inner city high job and population densities.	Less demand for high density downtown-oriented transit corridors. Increasing difficulty to serve demand with traditional transit. Longer average trip lengths, more ubiquitous travel patterns, lower pollution concentrations, greater total pollution emissions.
Economy			
1. At least 96% average employment of labor force[1]	Statutory national objective	Such high employment rates have been achieved few times in the past decade. Lower rates imply a lesser gross national product.	Lower rates would imply less transportation activity and required investment.
2. An annual average future increase in private output per man-hour at 2.9%[1]	Historical trend	2.9% is slightly less than the rate achieved in the past decade.	Lower rates imply less transportation activity and investment.
3. Continuation of trends in the industrial mix of the Nation's output	Historical trends	War, depression, climatological change, technological surprises, resource shortages, or a change in the national ethos could alter all or parts of the mix.	Different mixes would result in different mixes of transportation.
4. The factors influencing historical shifts in regional export industry locations will continue their trends[1]	Historical trend	Resource shortages and new discoveries of resources, political decisions, major changes in transportation could modify the trends.	Different locations would change the origin-destination of transportation.
5. Regional earnings per worker, and income per capita will continue to converge toward the national average[1]	Historical trend	Combined with higher average earnings, this implies few persons in the "poverty" category.	Greater overall affluence implies design more on the basis of economic efficiency and less on the basis of welfare considerations.
6. Continuation of the trend toward more women in labor force[1]	Historical trend	A larger fully employed labor force implies a bigger gross national product and higher family incomes.	Greater gross national product and family incomes imply more transportation.
D. Ethos			
1. Peace[1]	National objective	The Nation has been at war a substantial part of its history. The national defense considerations provided for the Department by the Department of Defense and the Office of Emergency Preparedness, General Services Administration have been included in this plan to the extent they are unclassified.	War situations change what is transported and the origin-destination patterns of transportation.
2. Continued political support for safety, environmental enhancement, and energy conservation	National objectives	One may speculate about whether present and possible future statutes will be adequately enforced and whether the penalties for violation set by law will be sufficient to bring about the desired ends. However, the political process has the power to increase both enforcement and penalties if it appears the desired ends will not be met.	In general, more laws and regulations in these areas will tend to increase the cost of transportation to the users of it, thus decreasing the amount of transportation actually used.
3. Continuation of historical work ethic[1]	History	It is possible that with increasing affluence, some people may opt for more leisure and less income and, hence, less economic growth.	A change in the nature and amount of various human activities could result in changes in the nature and amount of transportation needs

[1] *These items are assumed by the OBERS Projections also. The plan is based in large part on the OBERS Projections.*

Figure I.3. Core Planning Assumptions.



Primary Source: 1972 OBERS Projections.

Figure I.4. U.S. Population and Labor Force.

Availability of Energy and Critical Materials

The 1973 embargo on oil shipments to the United States highlighted the possibility of shortages of other critical materials. In developing this study, it was assumed that resource shortages would not inhibit continued growth in the economy or in transportation.

Energy. Today, petroleum products account for more than 95 percent of the energy used to operate transportation, and transportation uses more than half of the Nation's annual petroleum consumption. For planning purposes, it was assumed that, as shortages occur, prices will rise, bringing forth additional resources or substitutes while simultaneously lessening demand. Furthermore, Federal statutes contain fuel consumption standards for new cars. Such statutes will serve to hold down future demands for transportation fuel. Figure I.12 illustrates the sources of supply over time to meet national energy demands. Continued imports are assumed. Thus, the possibility of a fuel shortage resulting from cutoff of imports continues to exist. Federal statutes call for the stockpiling of fuel as a short-term solution to such an event. In addition, the Federal Energy Administration has developed contingency plans for fuel allocation and rationing. These would limit fuel demands to the available supply if imports were suddenly curtailed.

In several places, moreover, we raise the question of whether the planning effort should be redirected because there appear to be possible shortages after the year 2000. The planning effort assumes, however, that petroleum or substitute liquid fuels would be available, although their costs may be higher.

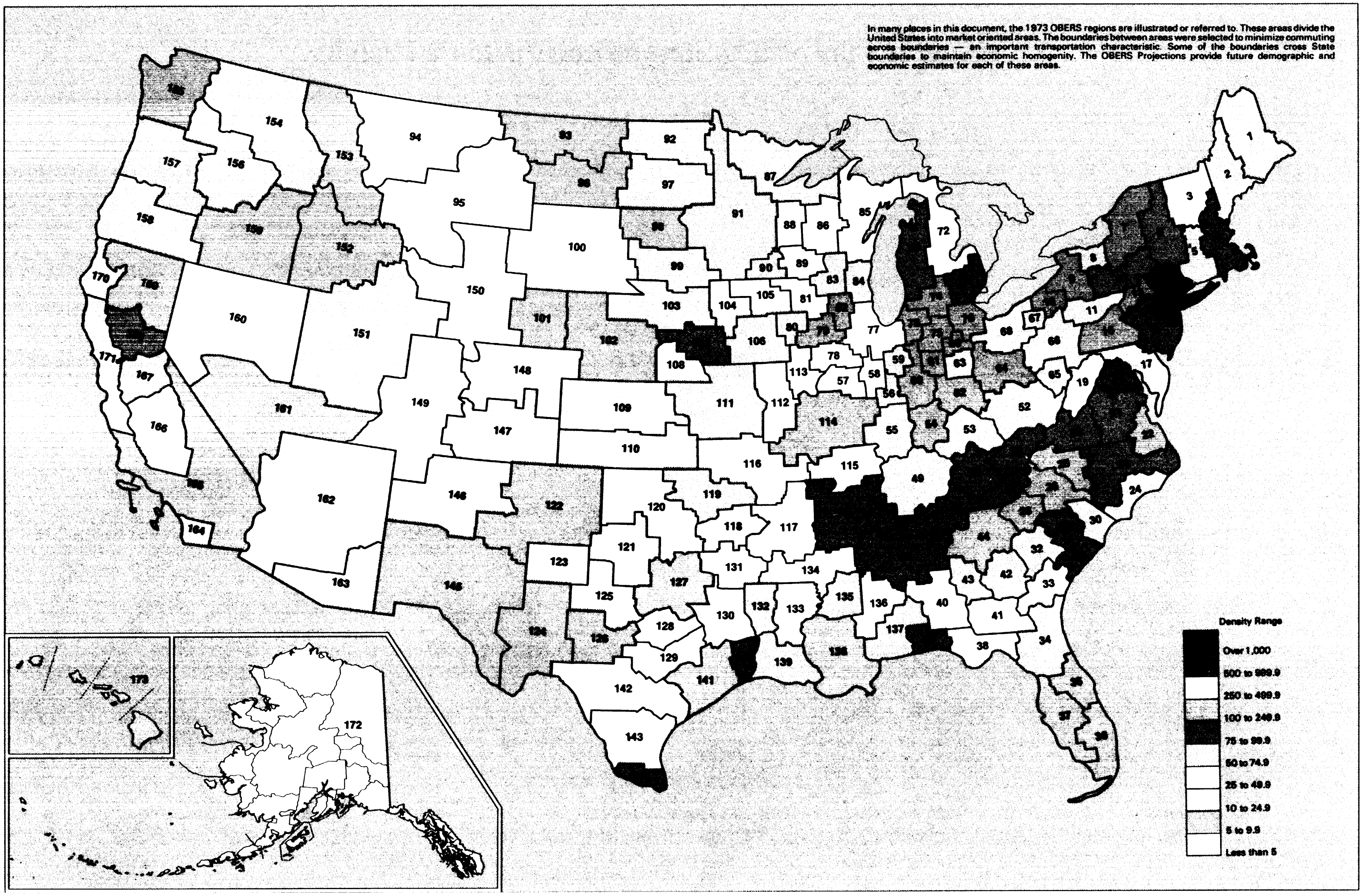


FIGURE 1.5. 1970 POPULATION DENSITY IN BEA[1] AREAS.

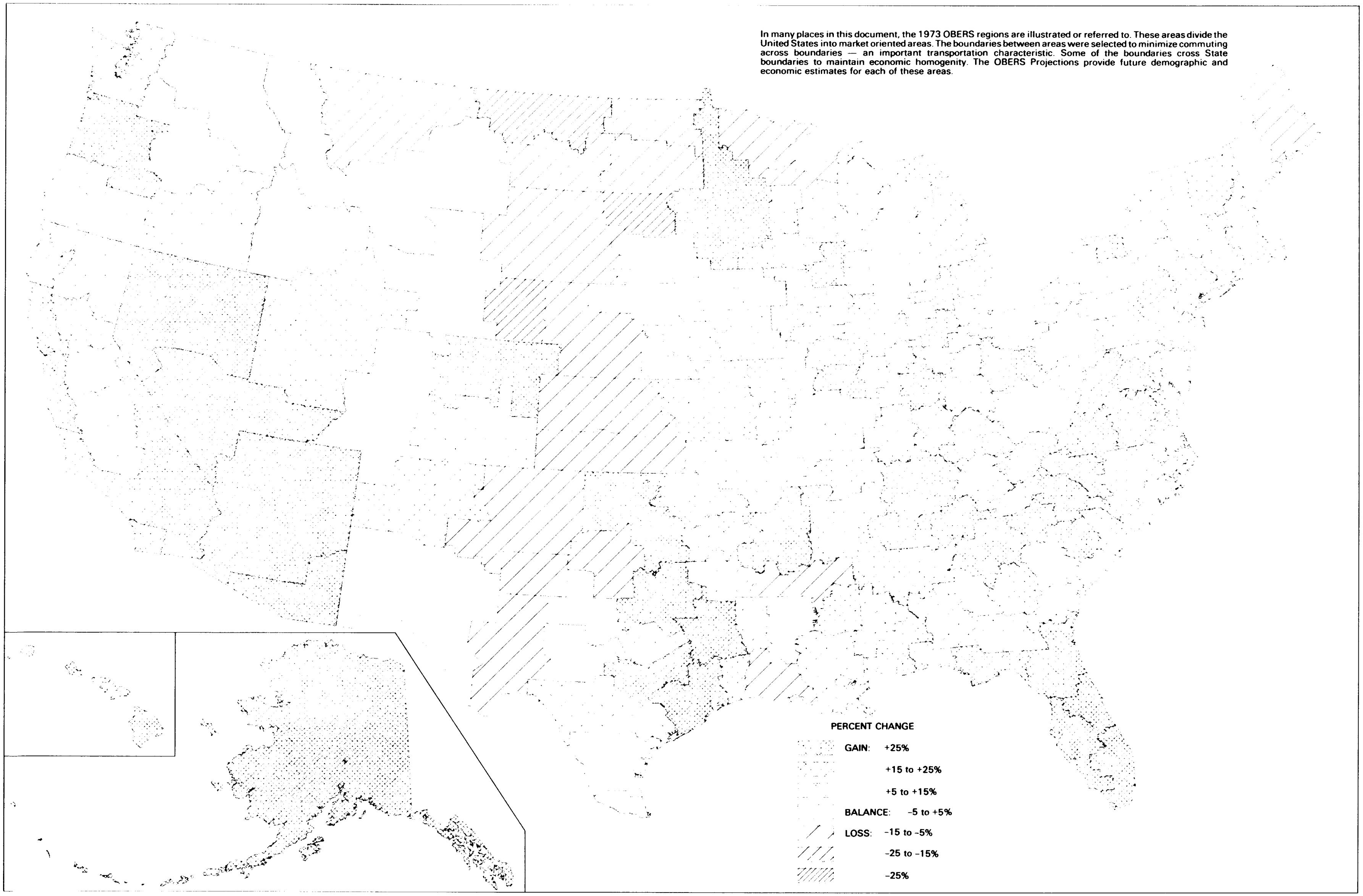


FIGURE 1.6. POPULATION CHANGE BY BEA[1] AREA 1970-1990.

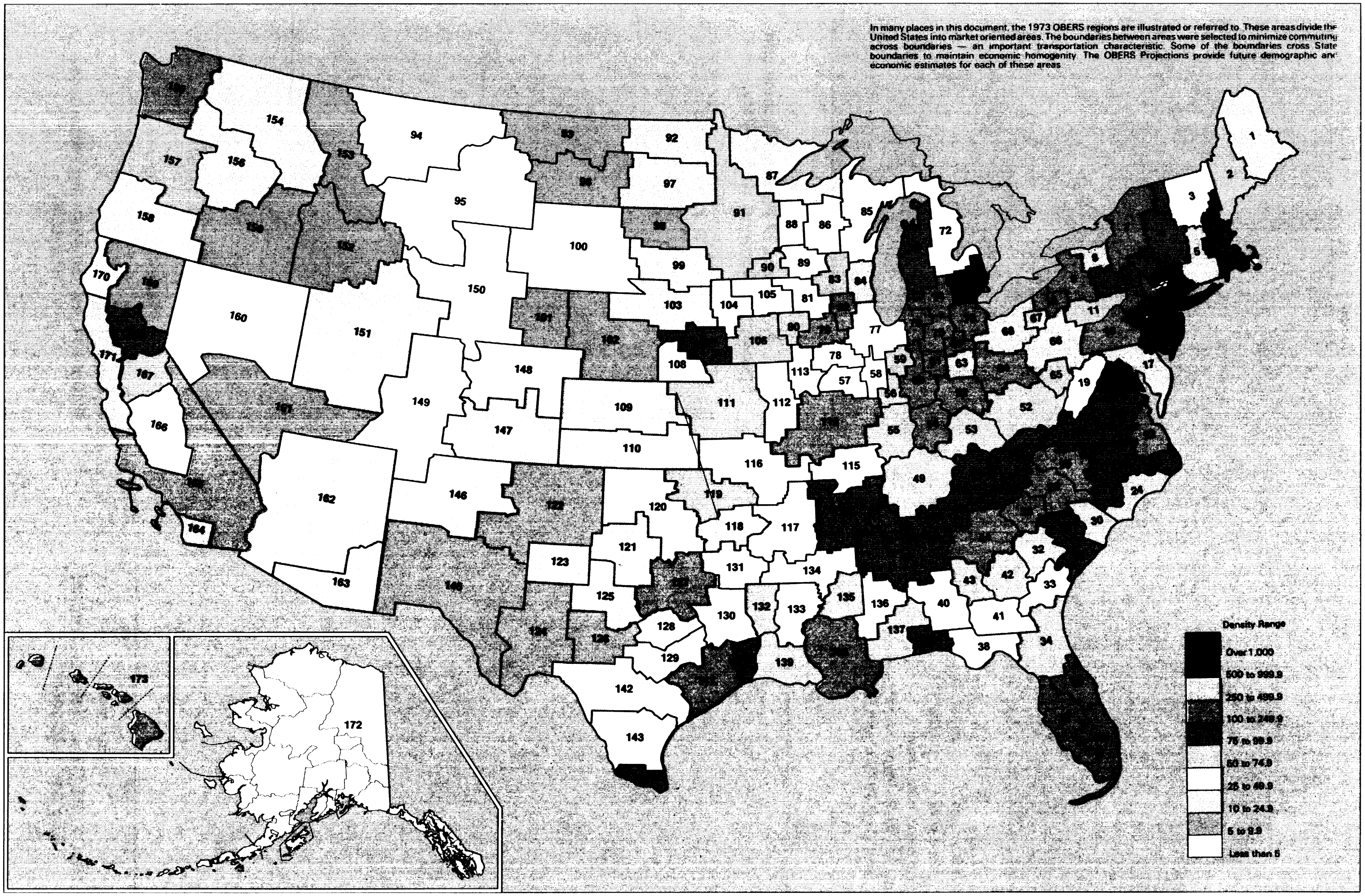
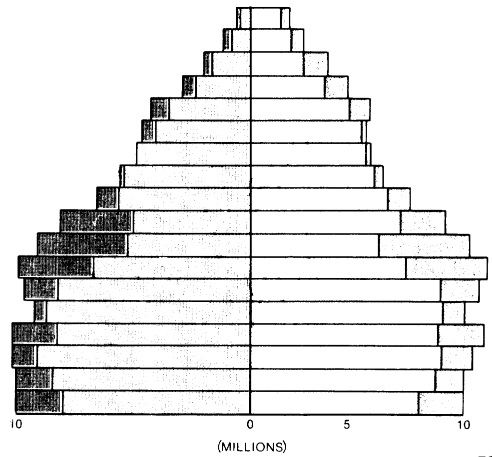


FIGURE I.7. 1990 POPULATION DENSITY IN BEA AREAS.



	MALE	FEMALE	TOTAL
JULY 1, 1975	104,146,000	109,304,000	213,450,000
JULY 1, 1990	119,154,000	125,421,000	245,075,000

Source: Series, 2, U.S. Bureau of the Census.

Figure I.8. U.S. Population by Age and Sex 1975 and 1990.

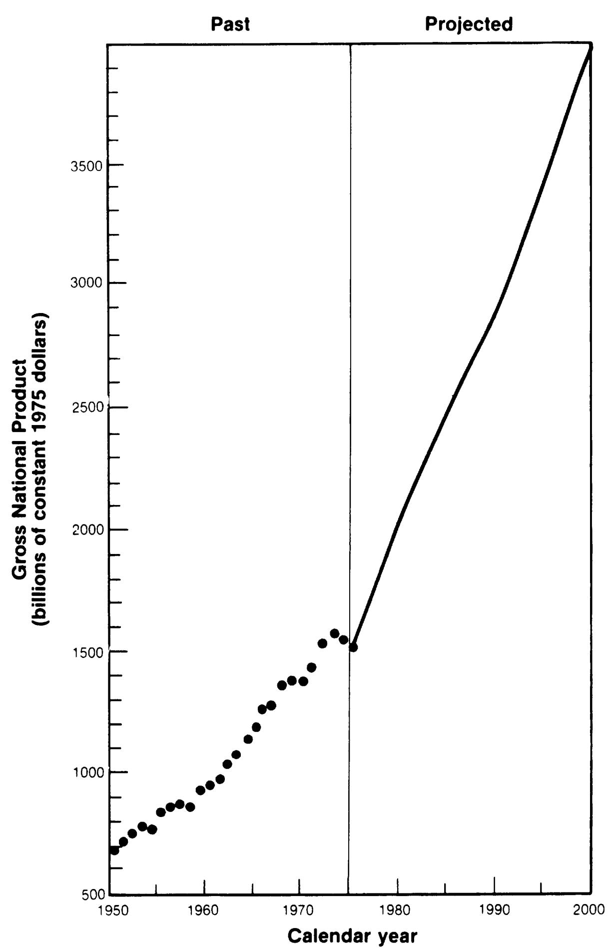


Figure I.9. OBERS Gross National Product Forecast 1950-2000.

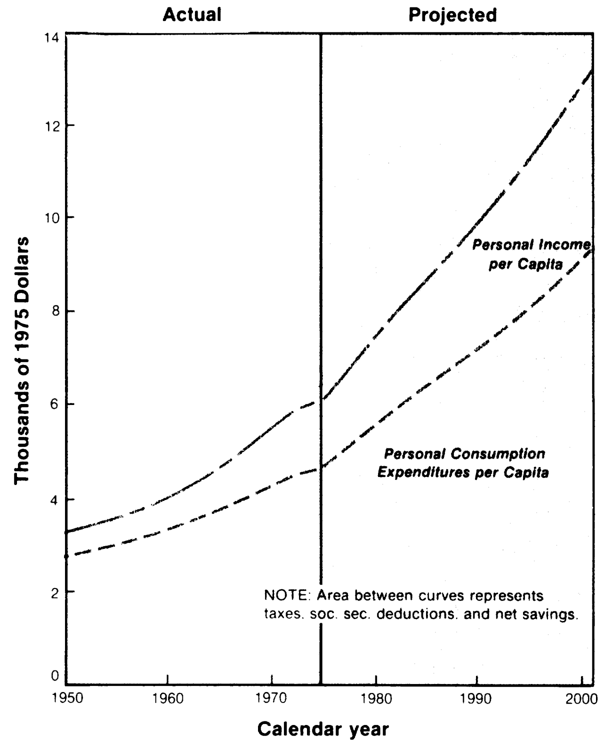
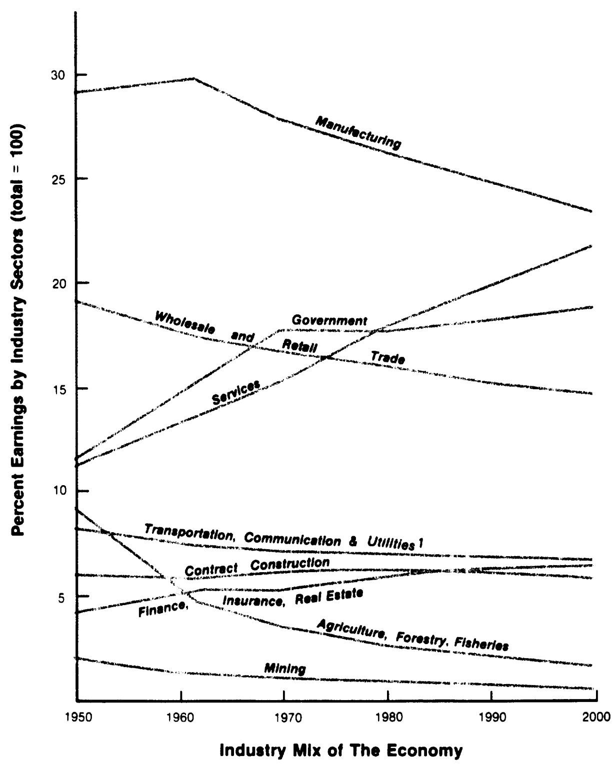


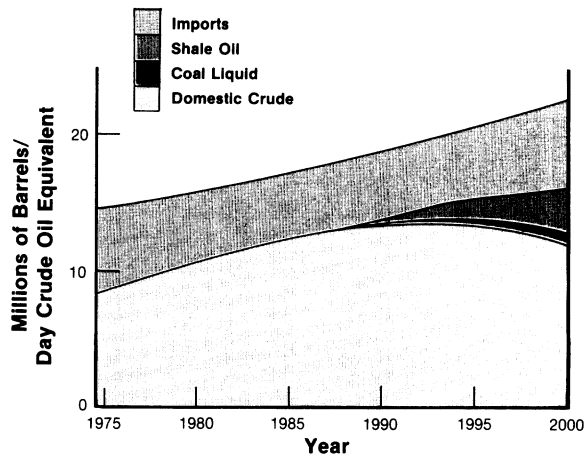
Figure I.10. Projections of Personal Income and Spending in Constant 1975 Dollars.



[1] As defined in the national income accounts which account for only "transportation industry" earning, and exclude business or personally owned transportation.

Source: OBERS

Figure I.11. Industry Earning Percentages 1950-2000.



Source: Energy Resources Council, Recommendations for a Synthetic Fuels Commercialization Program, *November 1975.*

Figure I.12. Projected Sources of Primary Energy Liquids.

Other Materials. Proved world reserves of important minerals vary from more than 100 years for some to less than 10 years for mercury and silver, as shown in table I.1.

The United States imports significant percentages of its needs for several materials shown in table I.2.

Despite our heavy dependence on external sources for materials such as bauxite, chromium, platinum, rubber, zinc, tin, cobalt, and mercury, the likelihood of cartels or cartel-like action on the part of producers appears considerably less than in the case of petroleum. For instance, although reserves[2] of mercury are small, environmental considerations have decreased the demand for that metal and the price is depressed. If prices were to rise, more mines could go back into production and the reserves would increase. The supply is considered adequate through the end of the century.

It is assumed there will be no major shortages or extraordinary price increases through the end of the century for the items shown in tables I.1 and I.2.

[2]A "reserve" is defined as the quantity that can be economically extracted at current prices.

Table I.1.
Proved World Reserves of Selected Minerals

More Than 100 Years:	Columbium Potash Phosphorus Magnesium
51-100 Years:	Iron Ore Chromite Nickel Vanadium Cobalt Asbestos Molybdenum
26-50 Years:	Manganese Bauxite Platinum Titanium Antimony Sulfur
15-25 Years:	Copper Lead Tin Zinc Tungsten Barite
10-15 Years:	Mercury Silver

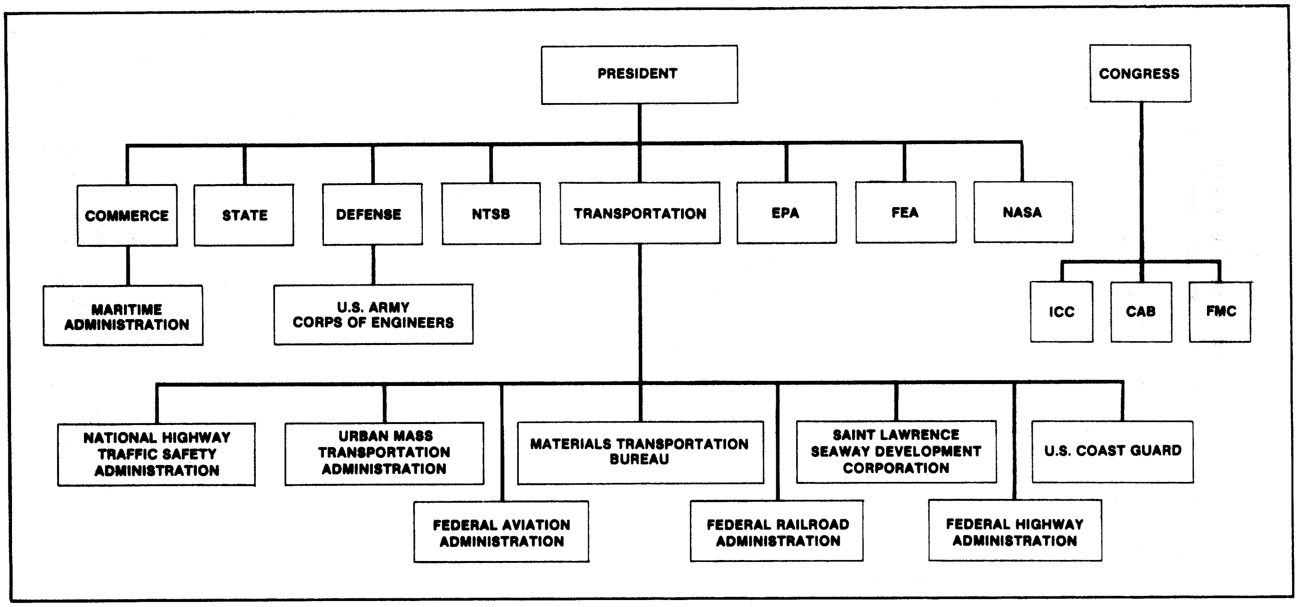
Source: Executive Office of the President, Council on International Economic Policy, Special Report, Critical Imported Materials, *U.S. G.P.O., Washington, D.C., December 1974, p. 15.*

Table I.2
U.S. Net Imports of Selected Commodities

	Net Imports 1973 $ Millions	Net Imports as % 1973[1] Consumption	Major Suppliers 1969-1972 - %
Alumina	209	35	Australia (50) Jamaica (22) Surinam (18)
Bauxite	143	90	Jamaica (54) Surinam (23)
Chromium	63	70	USSR (32) South Africa (30) Turkey (18)
Platinum group metals	145	95	UK (39)[2] USSR (32) South Africa (12)
Iron Ore	534	28	Canada (50) Venezuela (31)
Nickel	544	65	Canada (82) Norway (8)
Natural Rubber	347	100	Malaysia (40) Indonesia (39)
Manganese	100	82	Gabon (35) Brazil (33)
Zinc	303	48	Canada (60) Mexico (24)
Tin	215	66	Malaysia (64) Thailand (27)
Titanium	48	29	Japan (73) USSR (19) UK (27)
Cobalt	54	95	Zaire (45) Belgium-Luxembourg[3] (29)
Mercury	12	78	Canada (59) Mexico (17)
Tungsten	27	41	Canada (61) Peru (9)
Lead	27	17	Canada (29) Peru (21) Australia (21) Mexico (17)
Columbium	NA	63	Brazil (62) Canada (16)
Vanadium	NA	25	South Africa (55) Chile (35)
Fluorspar	52	83	Mexico (77) Spain (12)
Copper	143	5	Canada (31) Peru (27) Chile (22)

[1]*In quantity terms. Calculated by dividing net imports by total consumption. In some case, consumption includes withdrawals from (or additions to) Government and/or private stocks.*
[2]*U.K. sources for raw materials are South Africa, Canada, and USSR.*
[3]*Or Zaire origin.*

Source: Executive Office of the President, Council on International Economic Policy, Special Report, Critical Imported Materials, U.S. G.P.O., Washington, D.C., December 1974, p. 24.



OFFICE OR AGENCY	RESPONSIBILITY
President	Rules on matters relating to international air transit by U.S. air carriers and foreign air carrier operations to the U.S. Appoints members of Federal agencies and appoints chairman of CAB and FMC.
Department of State	Develops policy recommendations and approves policy programs concerning international aviation and maritime transportation.
Maritime Administration	Promotes merchant marine; grants ship mortgage insurance; determines ship requirements, ocean services, routes and lines essential for development and maintenance of the foreign commerce of the United States, maintains the National Defense Reserve Fleet; develops ship designs, marine transportation systems, advanced propulsion concepts, and ship mechanization and management techniques. The Maritime Subsidy Board awards subsidies and determines the degree of services and specific routes of subsidized operators.
Corps of Engineers	Constructs and maintains river and harbor improvements. Administers laws for protecting navigable waterways.
Environmental Protection Administration (EPA)	National air and water pollution and noise control programs and regulations. Sets emission standards and noise standards.
Federal Energy Administration (FEA)	Energy conservation programs and regulations, contingency planning for allocation and rationing of energy.
National Aeronautics and Space Administration (NASA)	Aeronautical and space research.
National Transportation Safety Board	Determines and reports causes, facts, and circumstances relating to transportation accidents; reviews on appeal the revocation, suspension, or denial of any certificate or license issued by the Department; and exercises all functions relating to aircraft accident investigations.
Interstate Commerce Commission	Regulates, in varying degrees by mode of transport, surface carrier operations, including rates, routes, operating rights, abandonment and mergers; conducts investigations and awards damages where applicable and administers railroad bankruptcy. Prescribes uniform systems of accounts and records, evaluates property owned or used by carriers subject to the Act; authorizes issuance of securities or assumption of obligations by carriers by railroad and certain common or contract carriers by motor vehicle. Develops preparedness programs covering rail, motor, and inland waterways utilization.
Civil Aeronautics Board	Regulates carrier operations, including rates, routes operating rights, and mergers; determines and grants subsidies. Assists in the development of international air transport and grants, subject to Presidential approval, foreign operating certificates to U.S. carriers and U.S. operating permits to foreign carriers.
Federal Maritime Commission	Regulates services, practices, and agreements of water common carriers in international trade. Regulates rates and practices of water common carriers operating in domestic trade to points beyond continental U.S.

Figure I.13. Transportation Organizations.

Changes in Economic Regulation

Regulatory change is receiving a great deal of attention because it could enable the transportation sector to approach more closely its potential efficiency.

All forms of transportation currently operate under some degree of economic regulation, and it is assumed that within the next few years many economic restrictions on the carriers' activities will be modified. The Railroad Revitalization and Regulatory Reform Act already is law. President Ford recommended and the Congress is now considering legislation in the aviation and motor carrier fields.

The three independent agencies whose powers could be affected by such legislation are the Civil Aeronautics Board (CAB), the Interstate Commerce Commission (ICC), and the Federal Maritime Commission (FMC). The CAB regulates all interstate commercial air service. The ICC has jurisdiction over all rail freight traffic, approximately 40 percent of intercity motor freight ton-miles, and smaller portions of waterway and pipeline haulage. The interstate segments of all three modes are regulated with respect to entry, rates, and mergers. In addition, air and rail carriers are not allowed free exit from a market; theoretically, motor carriers can abandon any route they choose, but the present system contains inherent practical constraints that serve to discourage voluntary exit. The FMC regulates services, practices, and agreements of water common carriers in international trade, and regulates rates and practices of water common carriers operating in domestic trade to points beyond the continental United States.

FEDERAL TRANSPORTATION ORGANIZATIONS

To clarify some of the references to organizations and agencies in this document, brief descriptions of the major Federal transportation agencies are presented in figure I.13.

It should be recognized that very real differences in function exist among these agencies. Some, such as the U.S. Army Corps of Engineers and parts of the Department of Transportation, provide facilities and services directly to users. The others are concerned primarily with the funding, regulation, and policy-setting functions of transportation.

AFFIRMATIVE ACTION

We have tried to motivate transportation policy by civil rights considerations in three important areas—employment, minority contracting opportunities, and the provision of services and benefits. Transportation employers have in the past hired relatively few females and minorities as table I.3 illustrates. The goals of increased employment of females and minorities in transportation and other sectors has been effectuated by Executive Orders covering employment practices by the Federal Government, government contractors and subcontractors, and federally assisted construction contracts. They require the elimination of employment discrimination because of race, color, religion, sex, or national origin and affirmative action in such areas as employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

Table I.3
Women and Minorities Employed in Selected Transportation Occupations

Occupation	Total Employed	Female (percent)	Black and Other Minorities (percent)
Airline Pilots	60,000	00	1.7
Automobile Mechanics	1,102,000	0.5	7.9
Railroad and Car Shop Mechanics	53,000	00	7.5
Transport Equipment Operators:	3,219,000	5.7	14
Bus Drivers	310,000	37.7	19
Delivery and Route Workers	583,000	4.5	8.6
Fork-lift and Tow-motor Operators	314,000	1.6	20.4
Railroad Switch Operators	53,000	00	7.5
Taxi Drivers and Chauffers	161,000	8.7	24.2
Truck Drivers	1,694,000	1.1	12.9
Other Transportation Equipment Operators	105,000	1.9	15.2

Source: Employment and Earnings, *January 1976, U.S. Department of Labor, Bureau of Labor Statistics, Volume 22, No. 7.*

In the future, the percentage of females and minorities working in transportation is expected to increase. The Department of Transportation should set an example for the transportation industry by its internal hiring practices and its recruiting and training policies.

Higher levels of minority and female employment in transportation agencies at all levels of government should increase sensitivity of those agencies to the transportation needs of these groups. Affirmative actions that can be taken are: grant approvals to be contingent on the inclusion of affected citizens in the participation process, and representation of women and minorities on advisory committees both at local and Federal levels. In addition, grant-program reviews can assure that adequate consideration is being given to the distribution of benefits among subsets of the population.

Finally, DOT has led the way in having inserted in legislation authorizing grants of federal money for transportation that minorities and females be assured of contracting opportunities. Models of such legislation are contained in the Rail Revitalization and Regulatory Reform Act of 1976, and the Airport Development Aid Program Act of 1975.

CHAPTER II
Conceptual Overview

TRANSPORTATION AND NATIONAL DEVELOPMENT

Transportation affects and is affected by the growth and development of the national economy, individual regions, and local communities. Transportation is a necessary condition for growth and development but not a sufficient condition by itself. The location of transportation facilities and services may also be used to help achieve desired distribution of social and economic activities within and among areas.

The relationships between transportation and growth and development fall into five categories—social, economic, physical, environmental, and national security.

The *social aspects* include contributions of transportation to social interaction, neighborhood cohesion, and community identification. They also include the relationships between transportation and concerns such as employment, housing, recreation, shopping, and public services. A third dimension of this category relates to the transportation demands of the disadvantaged, particularly those without access to private automobiles. Often these demands are latent, because transportation service for this group is either nonexistent or inadequate.

The *economic aspects* relate to the amounts and allocations of the benefits and costs of transportation facilities and services, including their distribution between users and nonusers and among various classes of users. This category also includes the external (nonmarketplace) and secondary effects of transportation, the impacts of transportation facilities and services on land values, and the effect of transportation on the economic bases of urban areas.

About one-tenth of the gross national product (GNP) of the United States is devoted to transportation. The private sector—both households and businesses—spends vast amounts on the transportation of goods and passengers. The public sector, including governments at all levels, exerts extensive influence over transportation through regulation and spends large amounts on the construction of transportation facilities, the purchase of transportation equipment, and the provision of transportation services.

The Federal Government spends over $14 billion a year to support transportation, in addition to the transportation costs included in its own purchases of goods and services. The Federal Government's transportation programs are even more significant than these figures would suggest, because they have an enormous impact on community growth and development, land use patterns, physical form, and social interactions, as well as on economic activity in general and job opportunities. Moreover, the effects are long lasting because transportation facilities tend to have a long economic life.

The *physical aspects* include the population densities encouraged by the nature and quality of transportation and the distribution of land for transportation, residential, industrial, commercial, agricultural, and recreational purposes.

The *environmental aspects* include such adverse effects as air and water pollution and noise. They also relate to the esthetics and design of transportation facilities and their compatibility with neighboring structures. And they are concerned with effects of transportation on parks and recreational facilities and on the ecology.

The *national security aspects* deal with the provision of adequate transportation to meet the needs of national emergencies. Better transportation strengthens national security.

Longer Range Decisions

The goal of this planning effort is to forecast potential transportation problems so that they may be avoided, and to suggest ways in which transportation might increase net social benefits. Most transportation investment decisions require long-term planning. The time between initial recognition of need and completion of major right-of-way improvements (commonly referred to as leadtime) may be a decade or more. Land use and other impacts of the change may last for centuries. Furthermore, right-of-way improvements typically require land acquisition through government powers. Except in the case of rail, there are many different users of rights-of-way. It is, therefore, reasonable for governments to insure adequate right-of-way capacity for economically efficient regional or national growth. In the private sector transport cost decisions must be balanced with overall distribution costs including inventory requirements, packaging costs, and employee salaries.

Both of these concepts of public and private cost analysis are described in figures II.1 and II.2. Estimating minimum cost requires planners to predict all economic activities that affect transportation or are affected by it, and to consider foreseeable transportation alternatives. This process is complex and inexact. The economic effectiveness of national transportation decisions depends heavily on our ability to predict the future.

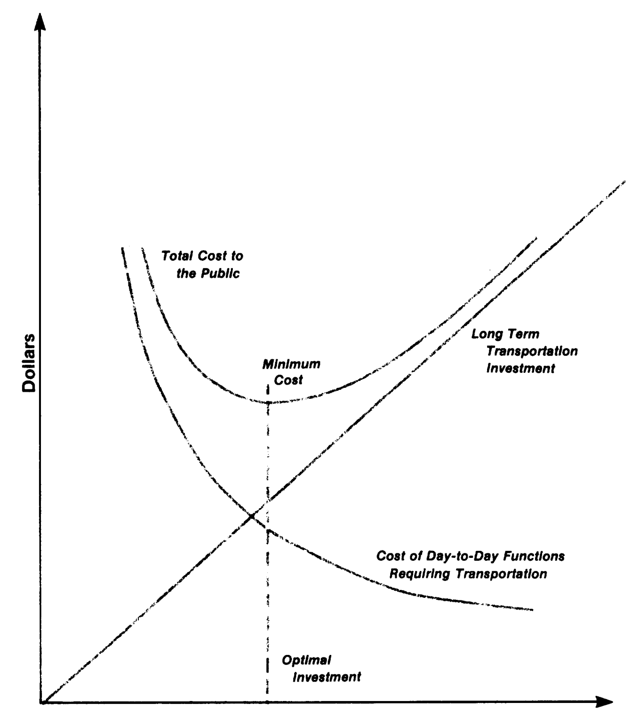


Figure II.1. Optimal Investment for Long-Range Transportation Facilities.

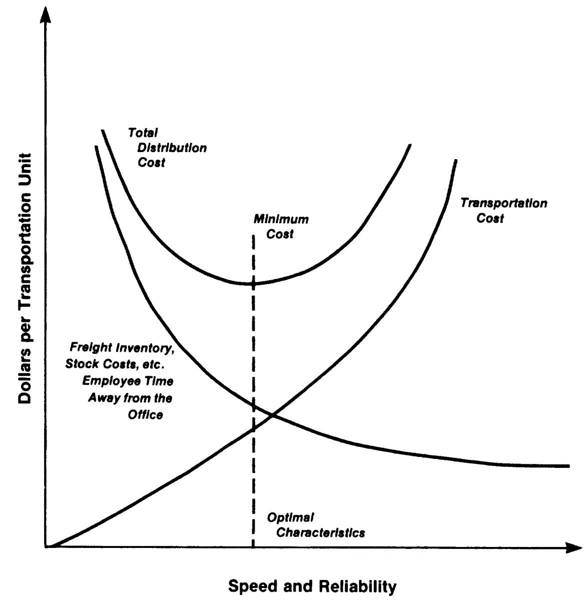


Figure II.2. Cost Service Trade-Offs.

Capacity

Planning future transportation inevitably gives rise to questions of the adequacy of facilities and services—and especially to the question of capacity. Capacity, though frequently discussed, is difficult to define. It means different things for different modes of transportation and sometimes within a single mode.

In general, capacity may be categorized in three ways:

- Physical capacity
- Practical physical capacity
- Economic capacity

Physical capacity considers only the physical aspects of transportation, independent of demand. For example, a pipe may have a maximum rate of flow based on its physical dimensions alone. Most other rights-of-way are used at rates that depend on demands.

Practical physical capacity takes into account the way the facilities are used. An example is the rush hour burden on transportation facilities. The practical physical capacity is almost always less than the physical capacity. Transportation is rarely used at maximum physical capability. Typically it is used either below the practical physical capacity or above it, which causes traffic jams. Congestion is more likely when traffic consists of vehicles with different operating characteristics (such as size, starting speed, and acceleration) and when the roadway vehicles entering and leaving disrupt flow. Congestion causes the costs to users (in terms of operating costs and delays) to increase faster than the traffic involved. Furthermore, congestion may increase fuel use and pollutant emissions. Practical physical capacity may be increased by smoothing out peaks through methods such as staggering work-hours, using larger vehicles, using vehicles more effectively, and making physical changes in the rights-of-way. Congestion pricing (charging more during periods of heavy use) can help to improve vehicle flow. However, the costs, the political practicability and inconvenience of such schemes must be carefully weighted against the benefits to those most able to pay for them.

Economic capacity is the physical capacity that, during the life of the transportation activity, is expected to yield benefits exceeding the associated costs—both public and private. The cost to buy and operate the transportation, its physical operating economic qualities, the life expectancy of the investments, and the characteristics of the users are all involved in estimating economic capacity.

Estimating practical physical capacity and economic capacity usually requires that long-term possibilities be considered.

In general, various elements of transportation capacity (such as vehicles and rights-of-way) require different leadtimes for their implementation and for their economic or useful lives. Vehicles and equipment usually can be produced and put into operation in a few years; they may last one to several decades. Terminal facilities take somewhat longer to produce and last longer. Changes in rights-of-way typically have the longest leadtimes before they can be used—often a decade or more. If properly maintained, they may be useful for many decades. The long leadtimes and long lifetimes of transportation rights-of-way require long-term planning to insure that their economic capacity is maintained. This is illustrated by figure II.3. The costs associated with adding right-of-way begin when someone first recognizes a possible future need and initiates planning to meet it. The planning, initial property acquisition, hearings, and so forth, that precede construction often require several years. Thus, there are many years of effort and expense before a new right-of-way can be used (see top graph, fig. II.3).

Traffic volumes in the early stages of the life of a facility are usually below the practical physical capacity or economic capacity of the facility, with the result that the facility may appear overdesigned and wasteful. If traffic grows as anticipated, however, the facility may eventually exceed the practical physical capacity for longer periods of time (shown by the areas marked "congestion" in the second graph in fig. II.3). The facility may then appear to have been underdesigned, resulting in wasteful congestion. Meanwhile, it is likely that plans already have been made for, and construction started on, capacity additions. User benefits begin when the facility opens (shown on the third graph of fig. II.3) and increase with the number of users to the point where congestion increases cause losses (marked "user losses due to congestion" in fig. II.3). The losses resulting from congestion might be reduced by congestion pricing. Congestion-pricing revenues that exceed the costs of collection may logically be used to help defray the costs of capacity additions needed to better serve the users.

Capital Investment

Considerable capital investment is associated with maintaining or providing adequate capacity as discussed in the previous section. Traditionally, in the United States the shorter term investments in vehicles and terminal facilities have been left to the marketplace, while the longer term rights-of-way have had heavy government involvement. However, there are exceptions to this pattern. The Federal Government heavily subsidizes urban mass transportation vehicles, facilities, and operations. Because of the lengthy time periods involved, estimates of total capital invested in transportation are likely to be subject to certain errors. Economic conditions change, as does the value of the dollar. Costs of identical items may change from year to year, and the anticipated benefits of an investment may change as a result of actual or anticipated changes in eco-

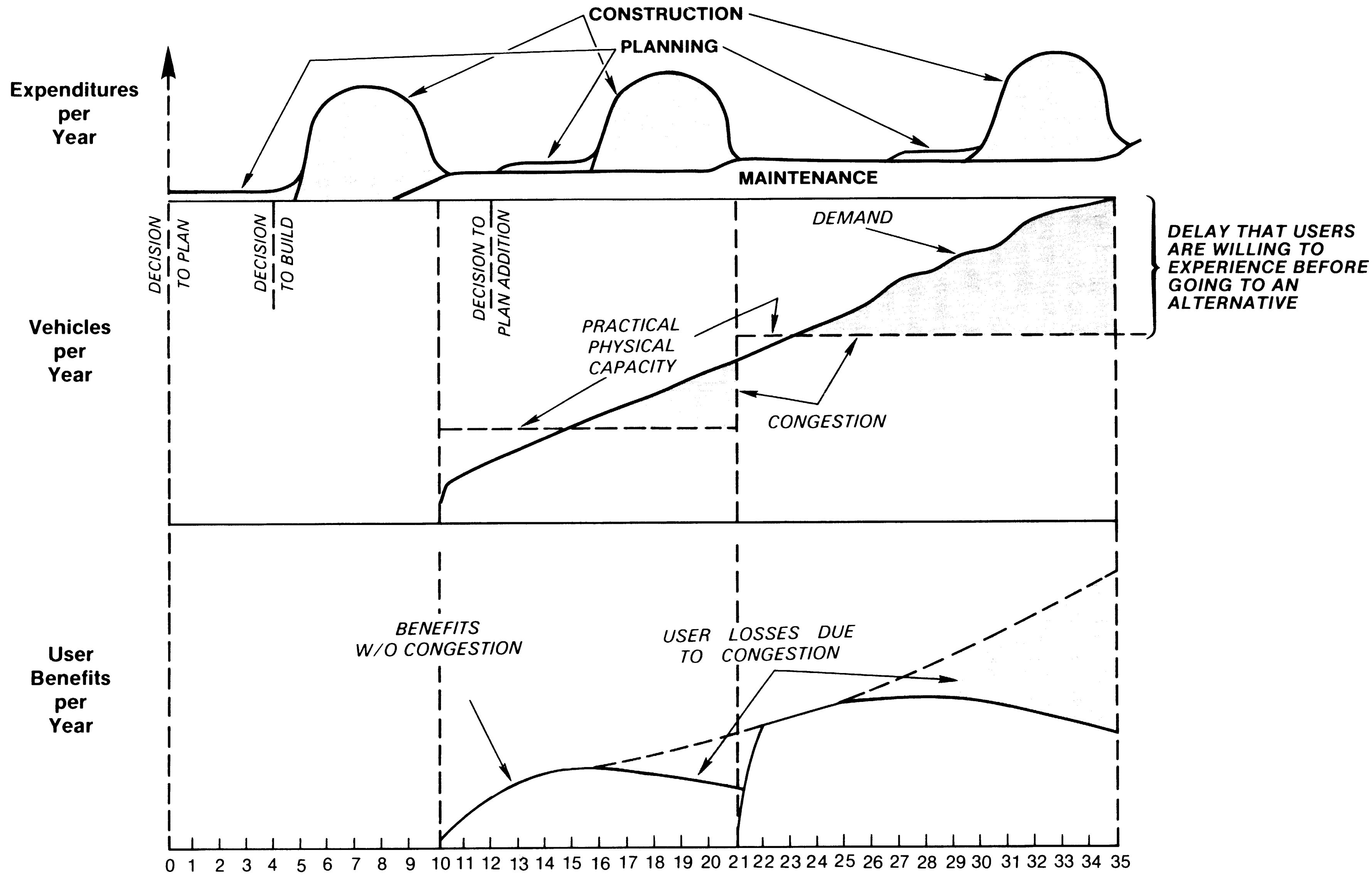


Figure II.3. Capacity Additions.

nomic conditions. The value of capital investment carried in the books of firms or governments may bear little resemblance to the replacement costs or the true current value of a past investment.

Two different techniques have been used to estimate the capital investments associated with this planning effort.[1] One is based on long-term trends in capital-to-output ratios. Output is defined as the constant dollar expenditures for transportation in a given year. Capital is the sum (in constant dollars) of investments in the mode. The second method consists of forecasting or planning for future activities, estimating their costs in detail, and totaling these costs for each mode. In general, where such detailed estimates of capital investment are available, they have been used. The capital-to-output ratio techniques were used for comparison with the detailed estimates to fill in the gaps where more detailed estimates were not available, and to estimate the investment consequences of the suggested changes.

Table II.1 summarizes the investments needed. The "public" investments in "structures" requiring long-range planning are highlighted in a separate color. These investments have been estimated by States and local governments in some cases assuming federal shares based on historical trends (highways, airports). In other cases the investments represent federal program estimates (waterways, FAA airways costs, etc.). Where there has not been a history of governmental funding the capital-to-output technique described above was used. If the various suggestions are implemented, the investments in the 1975–1990 period would be reduced by more than $5 billion. Subsequent chapters provide greater detail on capital investments for specific forms of transportation.

Figure II.4 shows that the need for annual investments is expected to grow rapidly with the growth in overall transportation activity and expenditures.

MEASURES OF PERFORMANCE

As we plan for improvements in transportation, we must have a clear notion of the criteria for evaluating the system. We must have criteria for measuring system performance and for determining the improvements needed to satisfy the users of transportation—the decisionmakers who have various and sometimes conflicting objectives. We measure performance by estimating in dollars all the costs to society resulting from each type of transportation activity. These include:

- What is paid in the marketplace for transportation
- What is paid in terms of time spent transporting people and goods
- External costs of transportation, such as hazards, air pollution, noise, and dependence on foreign resources
- What the taxpayer pays for items such as subsidies to transportation

Inasmuch as our work in developing performance measures is still in a formative state, a simplified set of measures was used. The measures listed in table II.2 and explained in figure II.5 represent a first, crude attempt to construct a system that accounts for what society pays for transportation.

If such a system of accounts were fully developed, the costs of each of the modes of transportation to the Nation could be estimated, and the cost of any proposed changes in transportation services explained (e.g., shifts from one mode to another; shifts in the distribution of cost within a given mode; or shifts in the external costs or subsidies to the marketplace through user charge taxes, pollution taxes, regulations. Such a system is almost possible, but still involves many subjective judgments. Furthermore, it is not easy to account for some costs, such as those associated with transportation air pollution, and further research appears to be needed.

Future Performance

Table II.2 presents the evolution of the transportation system in terms of selected measures of performance for 1975, 1980, and 1990. Two 1990 columns are presented. The first shows forecasts assuming that the suggestions in this document are not implemented. The second shows the comparable figures assuming the recommendations are implemented. The performance measures are grouped under the

[1] The transportation investments covered here differ from those published in the *National Income and Product Accounts* of the Department of Commerce. The estimates in this document include government and consumer investments in transportation as well as those of transportation and other industries.

Table II.1
1976-1990 Transportation Investment
(Millions of constant 1975 dollars)

Mode	Replacement Investment			Expansion Investment			Total Investment		
	Equipment	Structures	Total	Equipment	Structures	Total	Equipment	Structures	Total
Total Private	829,470	None	829,470	342,528	None	342,528	1,171,998	None	1,171,998
Auto	700,325	None	700,325	281,128	None	281,128	981,453	None	981,453
General Aviation	18,106	None	18,106	15,537	None	15,537	33,643	None	33,643
Boating	18,337	None	18,337	8,437	None	8,437	26,774	None	26,774
Trucking (local and intercity)	92,702	None	92,702	37,426	None	37,426	130,128	None	130,128
Total Public	24,939	199,995	224,934	7,533	254,006	261,539	32,472	454,001	486,473
Airports	532	13,876	14,408	246	19,606	19,852	778	33,482	34,260
Airways	2,045	539	2,584	2,005	795	2,800	4,050	1,334	5,384
Waterways	630	28,223	28,853	855	14,674	15,529	1,485	42,897	44,382
Highways	21,732	157,357	179,089	4,427	218,931	223,358	26,159	376,288	402,447
Total Intercity	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	281,869
Railroads	40,354	39,686	80,040	37,631	38,144	75,775	77,985	77,830	155,815
Trucking (local and intercity)	37,002	3,173	40,175	15,737	15,618	31,355	52,739	18,791	71,530
Bus	1,286	33	1,319	154	4	158	1,440	37	1,477
Oil Pipelines	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	17,182
Air	16,629	628	17,257	13,062	1,616	14,678	29,691	2,244	31,935
Water	3,387	78	3,465	465	0	465	3,852	78	3,930
Total International	25,261	307	25,568	12,309	596	12,905	37,570	903	38,473
Air	5,838	143	5,981	7,786	247	8,033	13,624	390	14,014
Water	19,423	164	19,587	4,523	349	4,872	23,946	513	24,459
Total Local	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	69,865
Transit, Bus	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	12,790
Transit, Rail	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	42,438
Commuter, Rail	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	6,254
Taxi	5,167	None	5,167	246	None	246	5,413	None	5,413
School Bus	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	N.A.[1]	2,970
TOTAL									2,048,678

[1] *Not available.*

following transportation topics:

- Economics
- Service
- Safety
- Air pollution and noise
- Energy consumption

For comparison, statistics on the assumed population and GNP are provided at the top of table II.2. The measures presented are national statistics. Components of these nationwide totals appear in subsequent sections covering the various elements of U.S. transportation. The statistics for the second 1990 column represent future performance in that they assume implementation of the suggestions. This does not necessarily imply, however, that the Federal Government intends to fund their implementation.

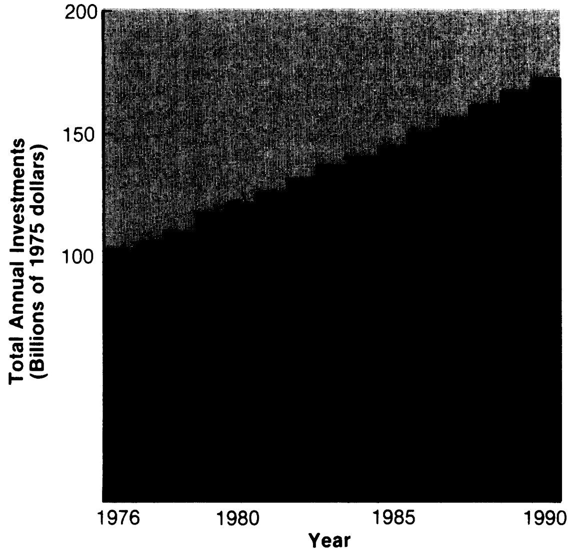


Figure II.4. Projected Annual Capital Investments.

Economics

If the suggestions in this document are implemented, the overall social and economic cost of transportation will decrease relative to the GNP. The cost of transportation to users would increase slightly relative to the GNP. This increase reflects shifts from Federal subsidies to market pricing through increased user charges. That is to say, the user will pay more, but the general taxpayer less. The increase also reflects an effort to place more of the burden of indirect costs (such as congestion, air pollution, and excessive petroleum use) on users rather than the general public through increased use of congestion pricing and more effective safety, environmental, and energy consumption regulation. The net result is that users pay more and the public suffers less. Implementation of the suggestions would result in an estimated $874 million annual increase in the transportation bill by 1990.

The capital investments needed to provide the transportation called for in this study will increase with transportation activity, but they are expected to be a decreasing share of the total transportation bill.

Implementation of the suggestions would reduce annual Federal subsidies out of general revenues to transportation by $2.128 billion in 1990. The taxes individuals would have to pay to subsidize transportation would decrease—

Table II.2
Planned Transportation Performance
(Billions of constant 1975 dollars)

Category	1975	1980	1990 Baseline	1990 Suggested Changes
Population (millions of persons)	214	224	247	247
GNP (billions of dollars)	1,516	2,048	2,830	2,830
Economics				
Transportation Bill (billions of dollars)	309	427	565	566
Transportation Bill GNP	0.20	0.21	0.20	0.20
Capital Investment (billions of dollars)	95.0	127	160	160
Capital Investment Transportation Bill	0.31	0.30	0.28	0.28
Federal Subsidy (billions of dollars)	4	7	8	6
Federal Subsidy Transportation Bill	0.01	0.01	0.01	0.01
Service				
Ton-Miles (billions)	6,371	8,280	10,800	10,800
Ton-Miles GNP	4.2	4.0	3.8	3.8
Ton-Miles Capita	29,827	36,900	43,700	43,600
Passenger-Miles (billions)	2,580	2,990	3,850	3,850
Passenger-Miles GNP	1.7	1.5	1.4	1.4
Passenger-Miles Capita	12,079	13,300	15,600	15,600
Safety				
Fatalities	49,712	56,700	70,300	45,400
Fatalities 1,000 Capita	0.23	0.25	0.28	0.18
Fatality Cost (billions of dollars)	19.88	22.70	28.1	18.2
Total Accident Cost Transportation Bill	0.06	0.05	0.05	0.03
Total Accident Cost Capital (dollars)	93.09	101	114	73.6
Environment				
Air Pollution-National				
CO (million tons)	73.63	52.5	44.2	27.0
NO_x (million tons)	9.78	9.02	9.08	8.82
HC (million tons)	11.55	9.52	7.86	4.36
Noise				
Millions of people (30 + NEF)	7.32	7.34	7.40	6.80
Energy (trillions of Btu)				
Transportation[1]	18,500	19,800	20,800	20,200
U.S. Total[2]	71,100	82,200	108,000	107,400
Transportation as a percent of the Total	26.0	24.1	19.3	18.8

[1]includes military and international
[2]excludes non-energy industrial feedstock

absolutely and relative to the total transportation bill. International maritime and urban mass transportation subsidies will account for 95 percent of the expected 1990 Federal subsidies if the suggestions are implemented. Furthermore, these subsidies account for all of the growth anticipated in Federal subsidies. International maritime subsidies were not subjected to detailed analysis, and their indicated growth is not a recommendation or endorsement. The urban mass transportation subsidies were based on data submitted by State and local planners. The Federal Government's share of these subsidies was assumed to be similar to its percentage in 1975.

Service

It is difficult to describe the scope and nature of the Nation's transportation services in a small set of measures. Quantity of service, speed of movement, frequency of departures, schedule reliability, and availability and accessibility are factors applicable to both goods and passengers. Loss and damage to freight en route and special handling capabilities for different commodities are additional factors. Comfort, convenience, cleanliness, food service, personal security and safety, entertainment, and other fac-

Unless otherwise reported, all dollar costs are in 1975 constant dollars. The table below facilitates estimation of the 1980 and 1990 costs in actual dollars for different assumed average rates of inflation.

Average Annual Future Inflation Percent Rate	Factors for Calendar Year		
	1975	1980	1990
0	1.0	1.0	1.0
1	1.0	1.05	1.16
2	1.0	1.10	1.35
3	1.0	1.16	1.56
4	1.0	1.22	1.80
5	1.0	1.28	2.08
6	1.0	1.34	2.40
7	1.0	1.40	2.76
8	1.0	1.47	3.17
9	1.0	1.54	3.64
10	1.0	1.61	4.18
11	1.0	1.69	4.78
12	1.0	1.76	5.47

Transportation Bill—This measure, in billions of dollars, shows what the Nation paid and an estimate of what it would pay in its markets for transportation. For commercial transportation, it is the sum of the revenues of the operators. For private transportation, it is the sum of costs associated with ownership and operation.

Transportation Bill/GNP—This ratio indicates transportation growth relative to that of the economy in general.

Capital Investment—Measured in billions of dollars per year, these figures illustrate the level of investment represented. New capital costs have been converted to equivalent annual costs using standard methods. Old capital costs have been considered "sunk" costs except where owners still have outstanding debts, or where governments have instituted cost recovery programs. In these cases, the annual payments on past capital investments may have been included. The investment cost may be viewed as included in and a part of the Transportation Bill.

Capital Investment/Transportation Bill—This ratio provides a crude capital to output ratio for transportation.

Federal Subsidy—This shows annual Federal expenditures in billions of dollars for transportation net user charge receipts. State and local governments also subsidize transportation, but these subsidies are not included. Increased Federal user charges or decreased Federal program shifts of Federal activities to private industry would tend to shift these costs into the transportation bill.

Federal Subsidy/Transportation Bill—This ratio indicates the magnitude of Federal subsidies relative to the transportation bill.

Figure II.5. Explanation of Economic Performance Measures.

tors may be important to passenger travel. Unfortunately, a statistical picture encompassing all these factors cannot be provided at this time.

Different measures of service are used in different sections of this study. Figure II.6 explains the measures used in table II.2 to summarize services nationwide. The two estimates of ton-mileage assume the same origin-destination flows of commodities in 1990. The 1 billion ton-mile reduction results solely from modal shifts to less circuitous modal networks. The estimates of passenger-miles likewise assume the same origin-destination flows. Thus, the foregoing reductions in the 1990 total cost of transportation relative to the GNP attributed to implementing the suggestions would be achieved without reducing the total national passenger and freight movements.

Ton-Miles. Ton-miles are a commonly used measure of freight movement activity. However, the dividing line between freight and passenger movement is not clear. For example, most consumer goods make the last leg of the journey to final consumption in the private auto as part of a shopping trip. On the other hand, much truck travel appears to be use of smaller trucks for moving people. However, the accounting practice used does not count the ton-miles moved in auto shopping trips, and tends to classify truck movements into the freight category.

In spite of such deficiencies, the ton-miles indicate how much freight travel will be needed to support the assumed economic growth.

Ton-miles alone, however, may be an inadequate measure. For example, a ton-mile of gravel translates into a different movement requirement than does a ton-mile of delicate,expensive electronic equipment. In the former, weight may be a critical parameter; in the latter, volume may be more important. Furthermore, the value per ton is quite different. Value per ton is important because the goods in transit may be considered as being part of someone's inventory, and usually the capital costs of carrying this inventory increase with its value.

However, attaching such a value to freight must be done with caution. Depending on the situation, the value may vary over a wide range. For example, some shippers may even want to age their products enroute, making slower travel preferable. On the other hand, shippers of perishable materials, or operators of expensive machinery stalled until they receive critical parts, may place very high premiums on speed.

Ton-Miles/GNP and Ton-Miles/Capita. These ratios show the expected changes in ton-miles relative to the economy in general, and the population.

Passenger-Miles. Passenger-miles are a commonly used measure of travel. However, such a measure alone has many of the deficiencies described for ton-miles. People put a different premium on different forms of transportation depending on their circumstance. For example, Sunday drivers may prefer to drive slowly in comfort and enjoy a spring view, while a businessman, anxious to beat his competition, may put a very high value on speed relative to other travel attributes.

The passenger-miles shown in Figure II.2 are estimates of actual miles traveled as distinguished from the straight-line distances between origins and destinations multiplied by the number of persons traveling between these points. A considerable amount of passenger travel involves trips that start and return to the same dock, or airport, or begin at the family garage and return without intervening stops.

Passenger-Miles/GNP and Passenger-Miles/Capita. These ratios show the expected changes in passenger travel relative to economic and population growth.

Figure II.6. Nationwide Service Measures.

Safety

Transportation accidents often result in fatalities, injuries, and property damage. To the extent that such losses are covered by insurance, they are reflected in transportation prices and, hence, in the total transportation bill. Insurance only tends to mitigate some of the financial consequences of accidents to individuals by spreading the risk. In doing so, it imposes additional "overhead" costs attributable to accidents. Insurance does little to prevent or reduce the loss. Apparently only a small percent of the Nation's accidental losses are covered by insurance. Figure II.7 details the types of losses that may result from an accident.

Federal, State, and local governments are all heavily involved in safety. To the extent that safety laws and regulations place all costs on producers or sellers, and governmental safety and other program costs are recovered through user charges, market prices reflect such costs and safety is properly accounted for in market transactions.

Social accounting for safety is complicated by the lack of generally accepted values for life and human suffering. Every major public safety decision implies such values, but rarely are they stated.

Deaths result in a loss to society. Lost productivity accounts for part of the loss. Other parts, such as emotional stress, and family readjustment, do not lend themselves easily to quantitative or monetary evaluation. Nonetheless, in designing tomorrow's transportation choices had to be made among projects with different safety and other cost impacts. Implicit in such decisions is a value placed on human life. Where it was necessary to apply an average value on lives lost, the "interrupted-earning-stream" method was used. This method has been commonly used for assigning a value to loss of human life in court cases and in benefit-cost analyses in health, air pollution, air safety, and automotive safety. For the estimates shown in table II.2, $400,000 per life lost was charged against every expected fatality. This value includes other benefits associated with reduced fatalities, such as fewer injuries and less property damage.

Using such values, table II.2 presents the number of fatalities and injuries and their crude economic loss values.[2]

Transportation deaths currently account for about half of all the Nation's accidental deaths as shown in figure II.8; they are the major cause of death for persons 15 to 24 years old and a lesser factor in older age brackets.

Recently, highway-related accidents have accounted for the preponderance of transportation fatalities and accidents (fig. II.9).

Historically, the accidental death rates in most modes, as measured in fatalities per billion ton-miles or passenger-miles, have decreased. However, the growth of activity has produced an increasing number of fatalities. A recent exception to this increase resulted from the 1973–74 oil embargo and the national speed limit. But even if the 55-mph speed limit is retained and the accident rate continues to decline, the absolute number of fatalities would be expected to rise because of increasing traffic. The suggestions are expected to result in impressive increases in safety. In spite of great increases in ton-miles and passenger-miles, the absolute number of transportation fatalities in 1990 would be less than in 1975. It is estimated that the recommendations would result in a decrease of more than 24,000 fatalities per year by 1990. Multiplied by $400,000 per life, this figure amounts to an annual saving of more than $9.5 billion.

Environment

Transportation affects our environment in many ways. Vehicle exhaust emissions pollute the surrounding air; oil spills pollute waterways; noise becomes annoying. New transportation construction may displace residences and business, change drainage patterns, and affect wildlife.

Air Pollution. The principal air pollutants emitted by transportation are carbon monoxide (CO), oxides of nitrogen (NO_x), hydrocarbons (HC), photochemical oxidants, particulates, and sulphur oxides. Figure II.10 describes each of these pollutants.

[2]Unfortunately, the definitions of a fatality or an injury may vary, depending on the mode of transportation and where the accident occurred. No attempt has been made to correct such difference in the safety statistics presented. For the purpose of this planning effort, such errors are believed to be of minor importance.

A. Goods and Other Property Consumed

1. Parts and labor for restoration of damaged property—motor vehicles, rights of way, buildings, and other items
2. Clothing and personal property damaged
3. Cargo in freight vehicle
4. Meals away from home
5. Medicines, appliances, medical supplies not included in physicians' fees or hospital charges
6. Flowers, candy, gifts, and special purchases only because of accident
7. Domestic animals and wildlife killed on highway

B. Transportation and Communications

1. Ambulance and other rescue vehicles
2. Tow truck
3. Taxi
4. Hire of other vehicles by all concerned, including transportation for the disabled
5. Public transportation—from far and near—by those involved
6. Extra travel by motor vehicles for trips pertaining to accident by all persons for all purposes, including police vehicles.
7. Lost use of damaged commercial vehicles
8. Motor vehicle operating expense to traffic for delays, extra distance routing, and speed changes at time of accident
9. Extra use of mail, telephone, telegraph, and other communications
10. Newspaper, television, magazine, and other coverage of accidents
11. Search and rescue costs

C. Personal Services Rendered, Including the Overheads, Goods, Supplies, and Rents Included in the Wages and Fees of Those Rendering the Services

1. Physicians' and dentists' fees, including total expenses
2. Lawyers' fees
3. Nursing fees other than received through hospital service
4. Hospital services—entire staff—and goods and other services included therein
5. Court costs and fines assessed to accident-involved persons
6. Witness fees and costs
7. Additional hire at home—domestic help
8. Additional hire at work place to replace absentees
9. On site and other assistance from bystanders and passersby

D. Time Consumed by all Persons Affected

1. Lost work time of those persons—injured ones and others—involved in the accident—all purposes
2. Lost work time of those concerned or affiliated with persons involved in accident
3. Nonwork time of relatives, friends, associates devoted to any aspect of the accident—accident reporting, court witnesses, consultation, repair or replacement of damaged property, telephoning, etc.
4. Probable future work time of deceased and permanently injured persons
5. Delay time and other travel time of motor vehicles as a result of the accident

E. Unclassified, Including Insurance

1. Damages awarded above the costs otherwise accounted for
2. Present worth difference in funeral cost now and the future time of expected death
3. Financing expense—loans and loss of returns on investment withdrawn to pay accident costs
4. Illness and accidents to others brought on because of the case accident
5. Liability insurance overhead cost—premiums paid by the insured less claims paid
6. Workmen's compensation insurance programs—pro rata share of net cost assignable to accidents

F. Anguish, Anxiety, Misery, and Suffering

1. Misery, grief, distress, and suffering by all concerned
2. Loss of sleep, fatigue, and inconvenience to all concerned
3. Mental and physical breakdowns
4. Pleasures and duties foregone

G. Governmental Service and Operations

1. Court costs not compensated for by fines and fees
2. Criminal and other prosecution procedures
3. Police and highway patrol salaries and expense—overhead and operations
4. Ambulance and rescue services (some private, some public, and some volunteer organizations)
5. Collecting, reporting, filing, analyzing, investigating, and publishing reports and statistics related to accidents
6. Administrative costs of financial responsibility and compulsory insurance laws
7. Future income taxes not received on probable earnings not earned because of injury or death
8. Net of income taxes not paid because of deductions for medical expense and losses
9. Inheritance taxes not paid because of less wealth at death—now or later—resulting from accident expenses, reduced income, or future income not earned

H. Activities to Reduce the Number of Accidents and Their Severity

1. Construction of facilities and maintenance work for specific purpose of accident prevention including spot improvements
2. Traffic engineering surveillance and studies
3. Traffic officer operations
4. Education and training programs for drivers, maintenance personnel, and operators
5. Emergency medical services
6. Community safety programs
7. Committees, boards, councils, and group activities pertaining to safety
8. Items on the vehicle designed for accident prevention or reduction of accident severity—for example: seat belts, collapsible steering columns, dual brake cylinders, signal systems, padded interiors, etc.
9. Research and development costs on traffic accidents, their prevention and treatment

Source: This modified list is based on The Social Cost of the Automobile *by William Hyman, 1974; see also* Economic Analysis for Highways, International Textbook, *R. Wintry, 1969, pp. 368-371.*

Figure II.7. Elements of Cost Associated with Transportation Accidents.

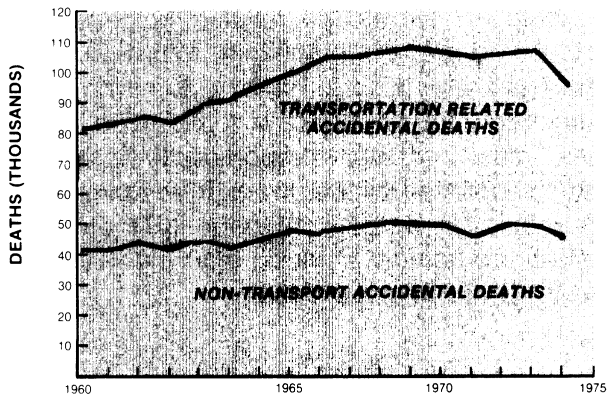
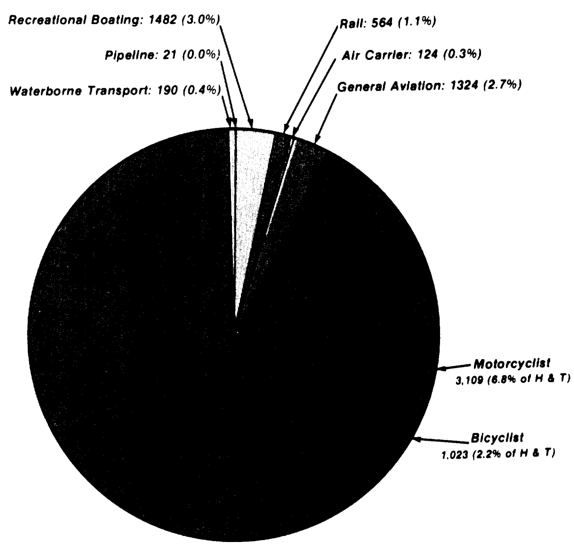


Figure II.8. Accident Death Trends.



TOTAL FATALITIES: 49,379

Figure II.9. 1975 Transportation Fatalities.

Carbon monoxide (CO), a clear odorless gas, results from the incomplete combustion of carbonaceous fuels. In high concentrations, it can be fatal. In lesser concentrations, it can be tolerated, but often at the expense of headaches, malaise, and a slowing of mental and physical activity. In addition to the direct health effects, the change of CO to CO_2 in the atmosphere might contribute over the long term to a warming of the earth's atmosphere with far reaching ecological consequences.

Nitrogen Oxides (NO_x) are formed by atmospheric combustion. Natural background levels in the atmosphere exist; however, continued human exposure at very much higher concentrations tends to increase the risk of upper respiratory disease.

Oxides of nitrogen may also cause dyes and paints to fade, and, combined with water vapor, corrode metals, and produce other negative consequences.

Hydrocarbons (HC) Incomplete combustion of fuels and evaporation of fuel from tanks and elsewhere, introduce Hydrocarbons (HC) into the atmosphere. Hydrocarbons are emitted in greater amounts from natural sources than from man-made ones, but the technological contribution may raise HC concentrations to harmful levels. In sufficient strength, some HC's irritate the upper respiratory tract and skin, and damage plant life.

Sulphur oxides (SO_x) can be hazardous pollutants. However, transportation contribution to such SO_x concentrations tends to be much less than from other sources. SO_x can cause permanent damage to the respiratory system, harm plants, electronic equipment, fabrics, leather and a variety of building materials.

Diesel fuels tend to be more sulphurous than gasoline; however, if certain catalytic convertors are used to control vehicle emissions, auto vehicle SO_x emissions might increase.

Combinations of the above pollutants with each other or other air pollutants in the presence of sunshine may result in other types of harmful substances.

Transportation also emits **particulate matter**—fine grains of solid matter. However, transportation's contributions are usually considered small, relative to the amounts emitted from other sources. Particulates have been associated with infections in the upper respiratory tract. Some scientists feel there is evidence that they also may affect precipitation patterns and other climatological conditions.

Figure II.10. Air Pollutants.

Transportation's contribution to CO, NO_x, and HC concentrations is probably the most serious. Therefore, this report treats these emissions in more statistical detail. The amount of transportation emissions is expected to decrease dramatically between 1975 and 1990. Most emissions are produced by automobiles; their reduction is mandated in existing statutes and legislation. Because of suggestions in this document, truck CO and HC emissions would be lower in 1990. As a result of the sharp drop in emissions by highway traffic, total transportation emissions will be reduced during the period by 63 percent for CO, 10 percent for NO_x, and 62 percent for HC.

There are both long-term and short-term air pollution problems. The long-term problem arises because, as some scientists hold, continued high growth rates of some pollutants may adversely affect the world's climate and all life. Responses to the short-term problems, such as the automotive emissions standards already enacted into law, should decrease total nationwide pollutant emissions and, therefore, the likelihood of the long-range problem. This report makes no attempt to frame the long-term problem quantitatively.

In the shorter term, air pollution exacerbates poor health, injures crops, and corrodes or ages materials. With some limited success, efforts have been made to estimate the complex short-term social costs of air pollution. The short-term problem may be viewed as:

Spatially Focussed — Emissions and certain types of receptors are often concentrated in specific geographic areas. For example, more than 60 percent of the transportation emissions probably are concentrated in just over 2 percent of the Nation's land area, containing some 60 percent of the Nation's population and its investment in capital.

Temporally Focussed — Air pollution problems tend to be greatly influenced by climatological factors such as winds and temperatures. In some areas, the bulk of social costs may be concentrated in several months of the year and possibly in several days.

Receptor Focussed — Each pollutant affects humans, plants, and materials in different ways. Different locations are prone to concentrations of different mixes of pollutants. Finally, pollutants sometimes interact to produce effects different from those they would be expected to have individually on each type of receptor.

It is not yet possible to:

- Measure nationwide the distribution of all the various types of air pollutants.
- Determine accurately all of the changes caused by all types of pollutants.
- Assess well the social costs associated with air pollution. What value is put on cleaner air by those who would breathe it?

The relative social costs of air pollution by area could be crudely assessed by multiplying an index of harmfulness of the pollutants by the number of receptors expected to be harmed, weighted by type (humans and animals, plants, and materials).

The current clean air standards provide a crude mechanism for weighting the relative harmfulness of the principal air pollutants generated by transportation. Regulatory standards established for each pollutant make it possible to compare the concentrations of each pollutant that will exceed the standard.

Table II.3 shows the relative weightings compared to carbon monoxide. When such weightings are applied to nationwide air pollution emission, transportation's contribution becomes much smaller proportionately than would be indicated by the unweighted tonnage figures. In other words, transportation's emissions tend to be concentrated more heavily at the less harmful end of the scale.

Table II.3[1]
1974-1975 Air Pollutants

Pollutant	1974 National Tonnage[2] (Millions)	1975 Transport Tonnage (Millions)	Weight Used	1974 National Weighted	1974 Transportation Weighted
CO	94.6	73.0	1	94.6	73.0
HC	30.4	13.4	60	1,824.0	804.0
NO_x	22.5	9.4	78	1,755.0	733.2
SO_x	31.4	0.6	23	722.2	13.8
Particulates	19.5	1.0	133	2,593.5	133.0
Total	198.4	97.4		6,989.3	1,757.0
Percent	100	49.1		100	25.1

[1]*Since air quality standards for different pollutants have been specified by EPA in different terms (permissible 1-hour, 8-hour, 24-hour concentrations, etc.) and since some States employ different standards, different investigators have arrived at different severity factors, using their own preferred procedures. The spread in the range of severity factors for some pollutants is large.*
[2]Statistical Abstract of the United States — 1975.

Few such studies have been done, but the approach is useful. Areas appear to vary tremendously with respect to the social losses resulting from air pollution. Therefore, the cost effectiveness of various types of air pollution control strategies could be expected to vary greatly from one area to another. It follows that a cost-effective strategy for minimizing the social costs of air pollution must be tailored to individual geographic situations and must consider a broad range of alternatives, including different land-use patterns (lower density living might be better), different emissions controls on stationary emitters, different emissions controls on transportation emitters, and different mixes in the type of energy used.

The Environmental Protection Agency (EPA) has sponsored the development of regional air quality control plans throughout the United States. During this process, some of the regional planners and EPA found that special transportation control plans were warranted to meet clean air standards in a number of regions. Figure II.11 shows these regions.

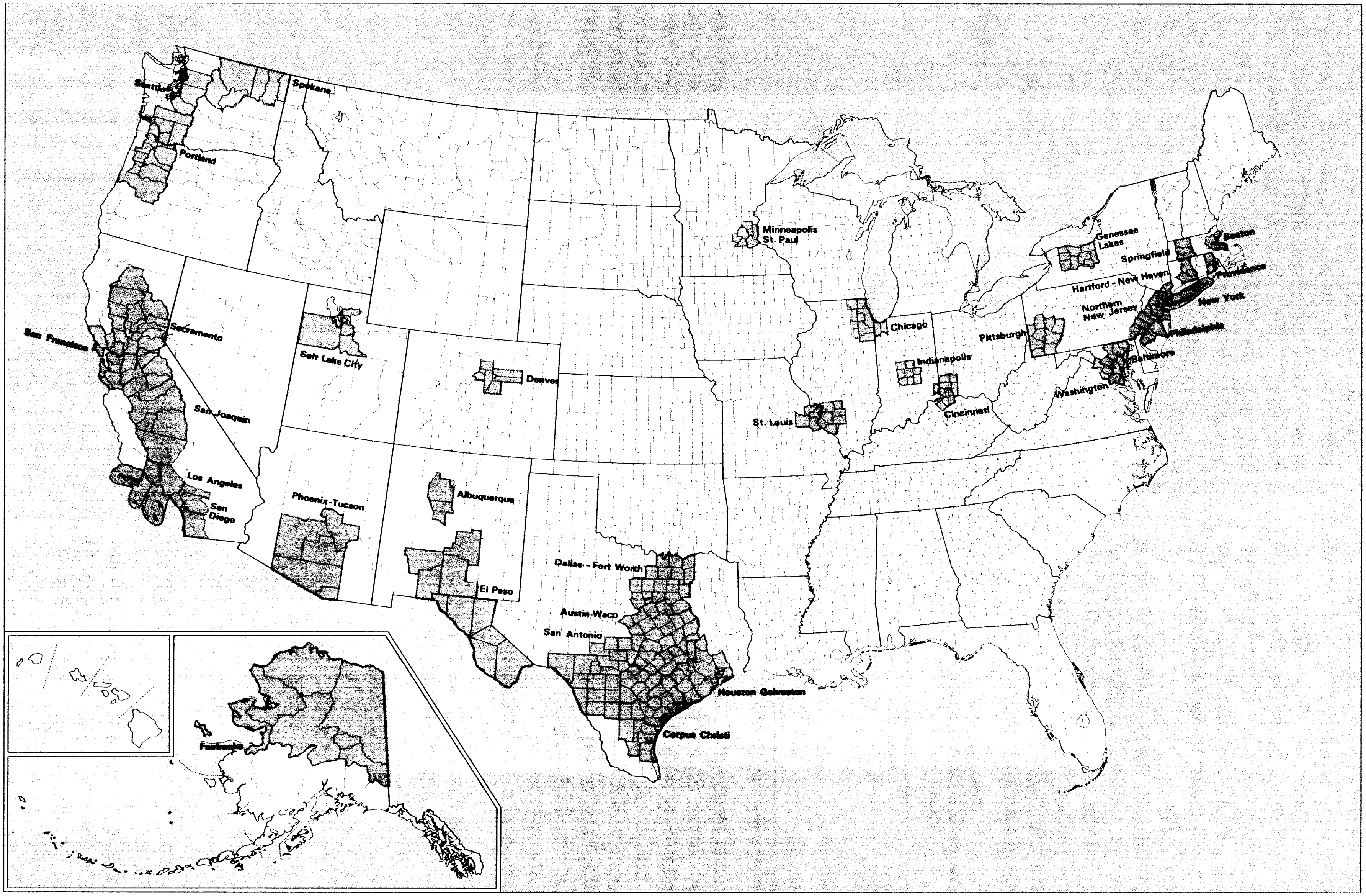


FIGURE II.11. 1976 FEDERAL AIR QUALITY CONTROL REGIONS WITH TRANSPORTATION CONTROL PLANS.

Transportation emission totals for each of the pollutants were presented for the entire United States in table II.3. No attempt was made to place a dollar-loss value on transportation's air pollution because of the locational differences in social cost and the difficulties involved in determining transportations share of the responsibility.

Transportation's total emissions have been decreasing, however, largely as a result of a number of governmental programs. They are expected to continue to decrease as more of the Nation's automobiles meet the increasingly severe emission standards (table II.4).

Table II.4
Automobile Emission STandards
(Grams per mile)

Pollutants	1975	1977	1978[1]
Hydrocarbons (HC)	1.5	1.5	.41
Carbon Monoxide (CO)	15.0	15.0	3.4
Nitrogen Oxides (NO_x)	3.1	2.0	.4

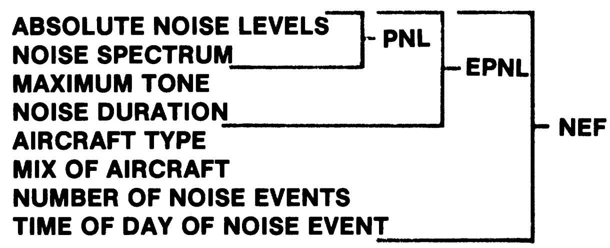
[1] *Congress is considering delay of parts of the standards for several years.*

Noise. Noise, as pollution, is usually defined as unwanted sound. Sound can be objectively described in terms of magnitude and frequency over time, but its annoyance potential is a subjective quality that defies simple measurement. Sounds have a wide range of irritating characteristics, and because of the difficulty in comparing annoyance on a common scale, several measures of important factors are used.

Sound travels through the air in the form of small waves of air pressure fluctuations. It is measured in decibels (dB), a quantity of sound wave energy. Because decibels are a logarithmic function, an increase of 10 dB is equivalent to doubling the loudness. Because the human ear is not equally sensitive to all frequencies of sound, a scale has been devised to weight the sound level at each frequency band according to its perceived loudness. The resulting measure is equivalent to the human ear response to sound, expressed in A-weighted decibels, dB(A).

The capacity of noise to annoy is a function of many subjective factors. While the dB(A) scale relates the absolute sensitivity of the ear to sounds of different frequency, the ear is less annoyed by low-frequency than high-frequency noise. A measure of noisiness, accounting for amplitude and frequency, is the perceived noise level (PNL), measured in perceived noise decibels (PNdB). This measure is slightly different from the dB(A) scale; it is best used in describing rather continuous sources of noise.

To gauge aircraft noise effectively, two more scales have been developed for the effects of separate noise events. These are described below and diagramed in figure II.12.



LEGEND:
PNL — Perceived Noise Level
EPNL — Effective Perceived Noise Level
NEF — Noise Exposure Forecast

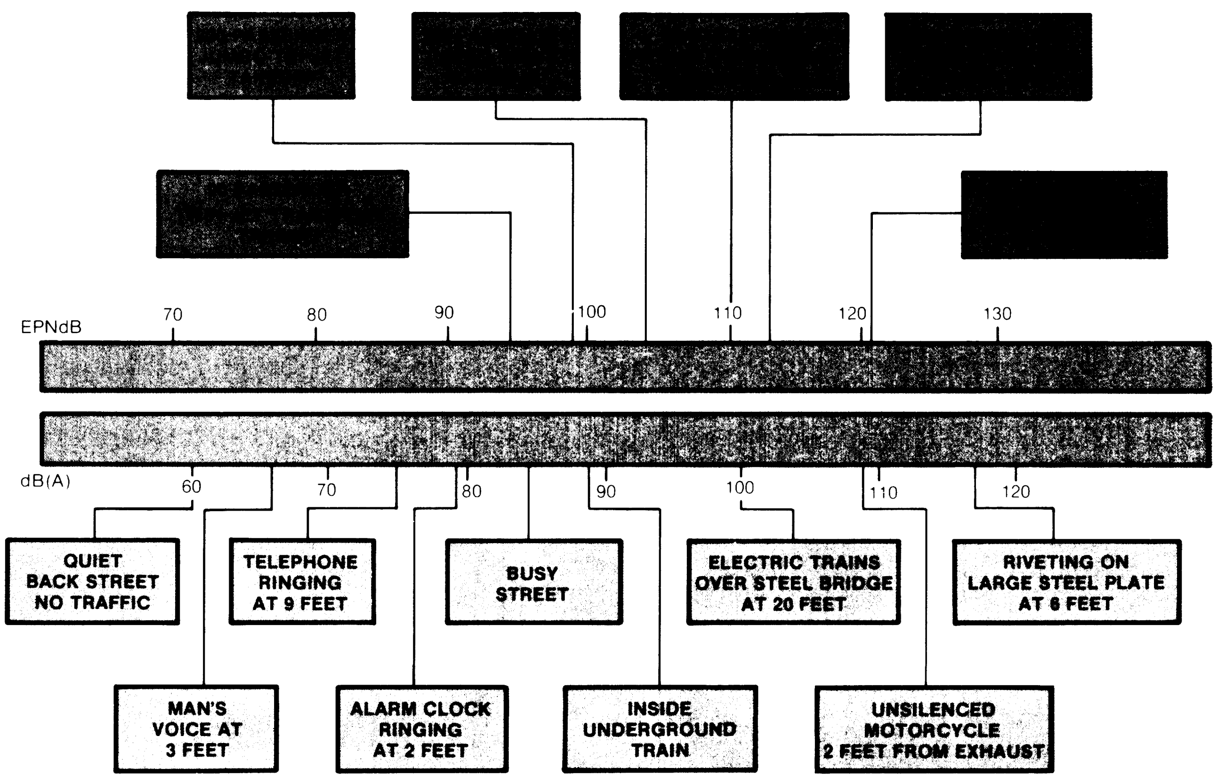
Figure II.12. Noise Factors.

For measuring the noise level of individual aircraft flyover events, the effective perceived noise level (EPNL, measured in EPNdB) incorporates several more factors that contribute to perceived annoyance. Figure II.13 indicates the relative values of typical noise sources for both the EPNdB and dB(A) scales.

Another level of sophistication is the noise exposure forecast (NEF), which attempts to measure the cumulative noise effect of aircraft operations. The NEF is a computed value based on the factors listed in figure II.12; it is used by land-use planners to describe areas adjacent to airports that are exposed to high levels of cumulative noise. For example, an NEF value of 40 generally indicates that a high percentage of people would be annoyed by the aircraft noise. Consequently, land within the 40+ NEF noise contour is not considered suitable for residential use.

As shown in table II.2, the number of people in higher level NEF contours near the top 23 airports is expected to decrease as new, quieter aircraft, meeting increasingly stringent Federal noise standards, enter the fleet, and as additional operating procedures are implemented. This topic is covered in greater detail in chapter VIII.

TYPICAL NOISE LEVELS



[1] 3.5 N. Mi. from brake release
[2] 1 N. Mi. from runway threshold

Source: Transportation Noise and Its Control, U.S. DOT

Figure II.13. Typical Noise Levels.

Energy

Energy consumption by transportation is expected to increase slightly between 1975 and 1990. Changes in consumption for most modes reflect changes in passenger-miles and ton-miles. The decreased automobile fuel consumption is attributed to improvements required by existing policies, regulations, and laws. The suggestions in this study reduce the expected 1990 truck fuel consumption by 494 trillion British thermal units (Btu). Two factors contributing to the improved truck performance are more energy-efficient engines and increases in truck sizes and weights.

The 1973 embargo on oil to the United States by several Middle Eastern nations made this Nation aware of its growing dependence on foreign oil. It became Federal policy to decrease this dependence. In pursuit of this and other objectives, the Energy Policy and Conservation Act of 1975 was signed into law. This law set the automobile fuel consumption standards shown in table II.5.

Table II.5
Average Fuel Economy Standards

Year	Standard (Miles per gallon)
1976	18.0
1979	19.0
1980	20.0
1981-1984	To be prescribed by the Secretary of Transportation
1985	27.5

The Act also allows the price of "old" petroleum (petroleum taken from producing wells as distinguished from new production) mined in the United States to rise up to 3

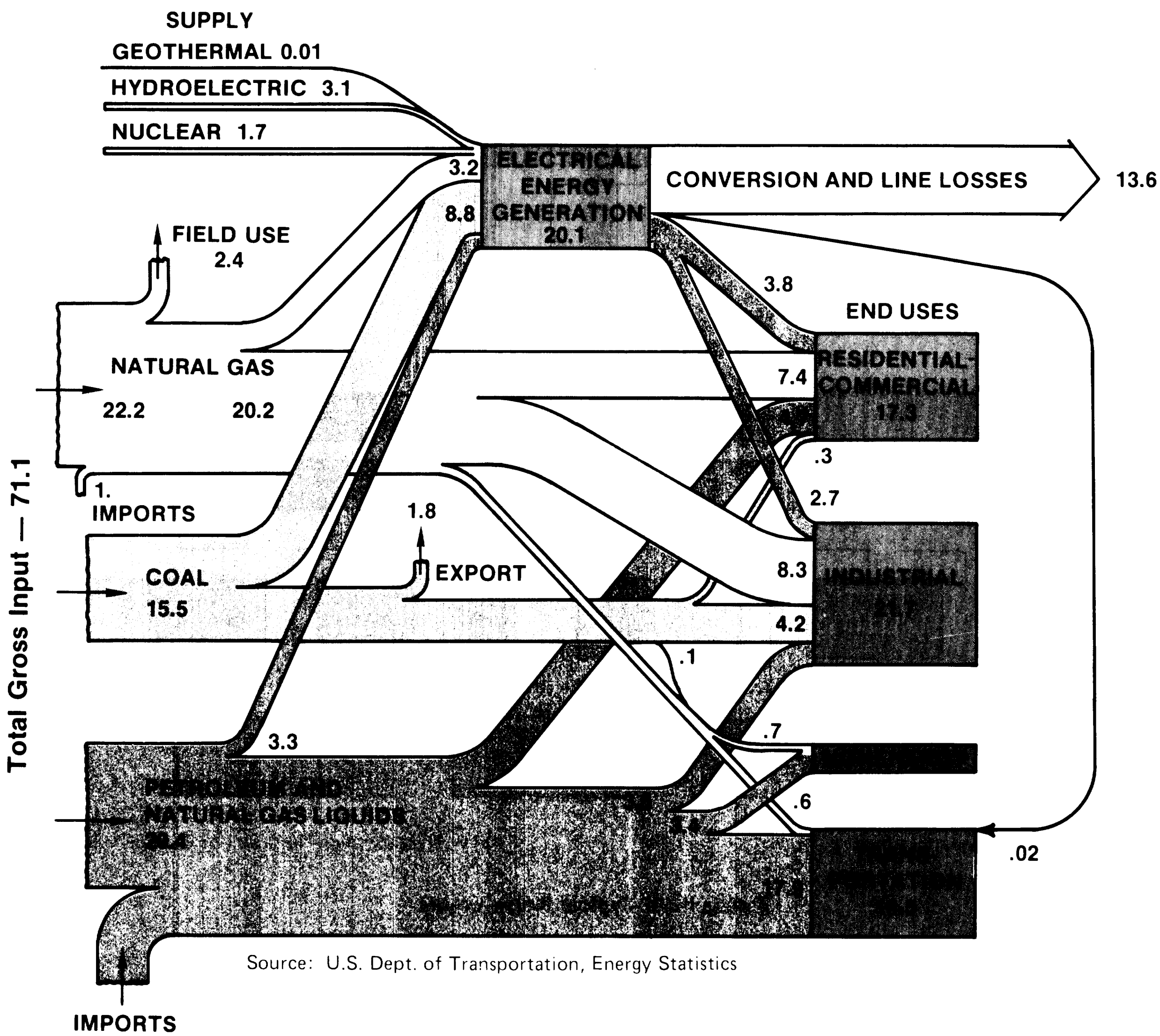


Figure II.14. 1975 U.S. Energy Flow Pattern
(In quadrillions of Btu)

percent per year after 1975 to a market-set price. This provision is expected to result in moderate increases in diesel fuel and gasoline prices through 1990.

Increasing fuel prices are expected to cause shifts in use between competing forms of transportation having different fuel efficiencies and operating cost characteristics. The performance measures in table II.2 assume such shifts.

To compare petroleum with other forms of energy, the figures in table II.2 are given in Btu, a measure of the energy content of the fuels.

Figures II.14 and II.15 show the 1975 fuel input and consumption pattern for the Nation.

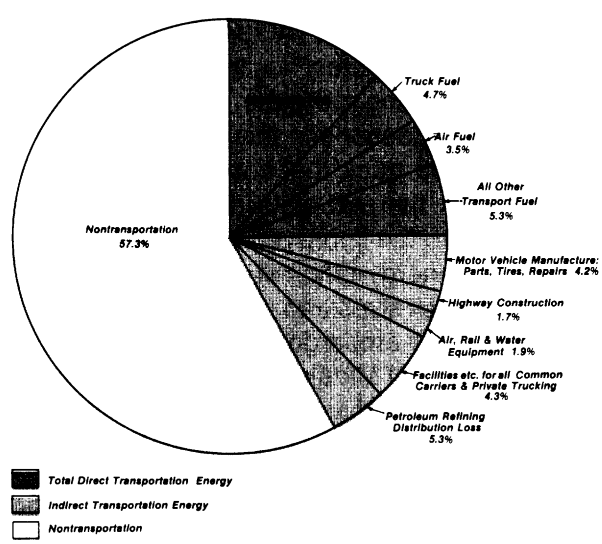
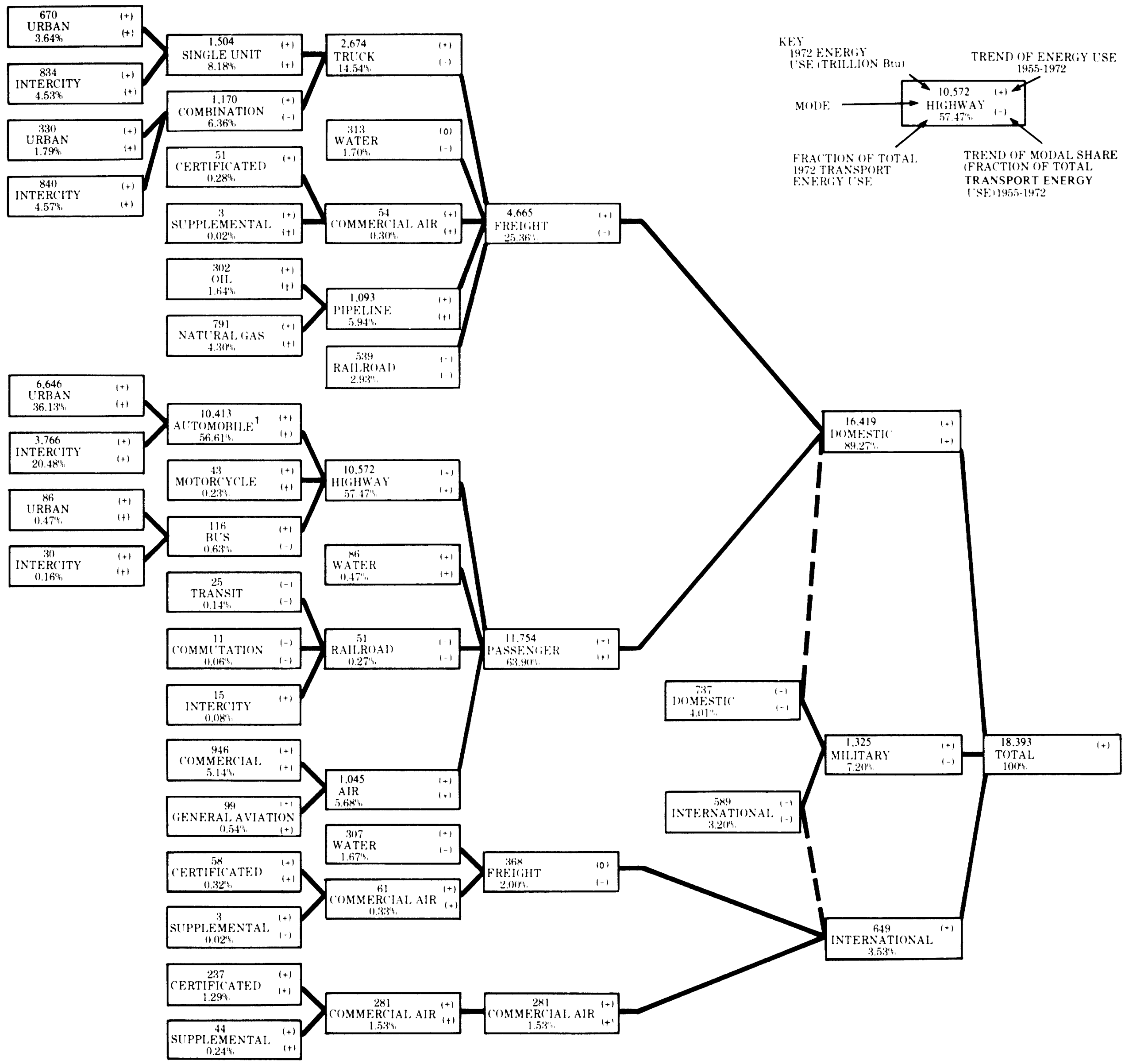


Figure II.15. 1975 Distribution of Total National Energy Consumption.



¹*Including personal use of light trucks.*

Source: U.S. Dept. of Transportation "A Summary of Opportunities to Conserve Transportation Energy" Report No. DOT-TSC-OST-75-22, June 1975.

Figure II.16. 1972 U.S. Transportation System and Its Energy Consumption.

Figure II.16 illustrates the 1972 percentages (by Btu) of petroleum use in the United States and the division among the various modes of transportation. Figure II.17 shows the forecast trends in energy use by mode.

Transportation used over 18.5 quadrillion Btu in 1975, about 24 percent of the gross national energy consumption but more than half of our petroleum consumption. Almost all (96 percent) of our movement of people and goods runs on liquid petroleum fuel. The remaining fuel is primarily natural gas used to power gas pipeline pumps; about 0.1 percent of transportation energy is electricity for oil pipeline, rail, and transit power. Coal, the fuel mainstay in the days of steam trains and ships, has nearly dropped from sight as a transportation energy source, as did wood a century ago.

Automobile use in urban areas accounts for more than one-third of the energy con-

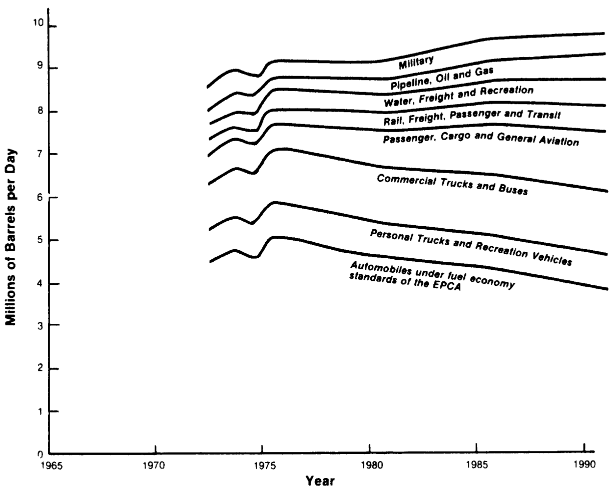


Figure II.17. Future Direct Transportation Energy Consumption Under Planned Conservation Measures.

sumed by transportation; other automobile travel adds another 20 percent. Most cars get much poorer fuel economy in urban traffic. Hence, although the mileage split used by EPA in estimating average gas mileage is tilted only 55/45 in favor of the urban, the fuel consumption split is actually more like 65/35.

It is anticipated that, in the near term, under the impetus of higher energy prices generated by the market system and government actions, operating practices will tighten and technology to reduce energy intensiveness will improve. New designs that will be incorporated into the active transportation fleets over a period of time, should improve overall transportation energy efficiency through the end of the century. Running counter to that trend will be the continued growth of transportation activity sparked by a slowly increasing population and an expanding economy.

Total transportation fuel consumption is the sum of fuel used by all modes. It is likely that the fuel consumption of all modes except the automobile either will remain nearly constant—the opposing trends canceling—or will increase slowly. The earlier energy intensiveness of the automobile was so high and the prospects for improvement are now so great that it is likely that its fuel consumption will decrease through 1990. Beyond that time the growth trend will begin to dominate again, and, by the end of the century, automobile fuel consumption may rise once more.

It is unclear whether the reduction of fuel consumption for the automobile will outweigh fuel growth in other modes. The 1990 total fuel consumption may be slightly below or slightly above the 1975 level as shown in figure II.17. Beyond 1990, however, total consumption appears likely to move upward. But consumption in the last quarter of this century is likely to be well below that expected from a simple projection based on trends of the previous 25 years.

The next century may see a leveling off and perhaps reversal of population growth. If transition to new energy sources is smooth, and if personal affluence and leisure time continue to grow, transportation activity may keep growing even after zero population growth is reached. Transportation energy consumption, based on coal, shale, or possibly electricity or hydrogen, may therefore continue to grow through the first quarter of the 21st century.

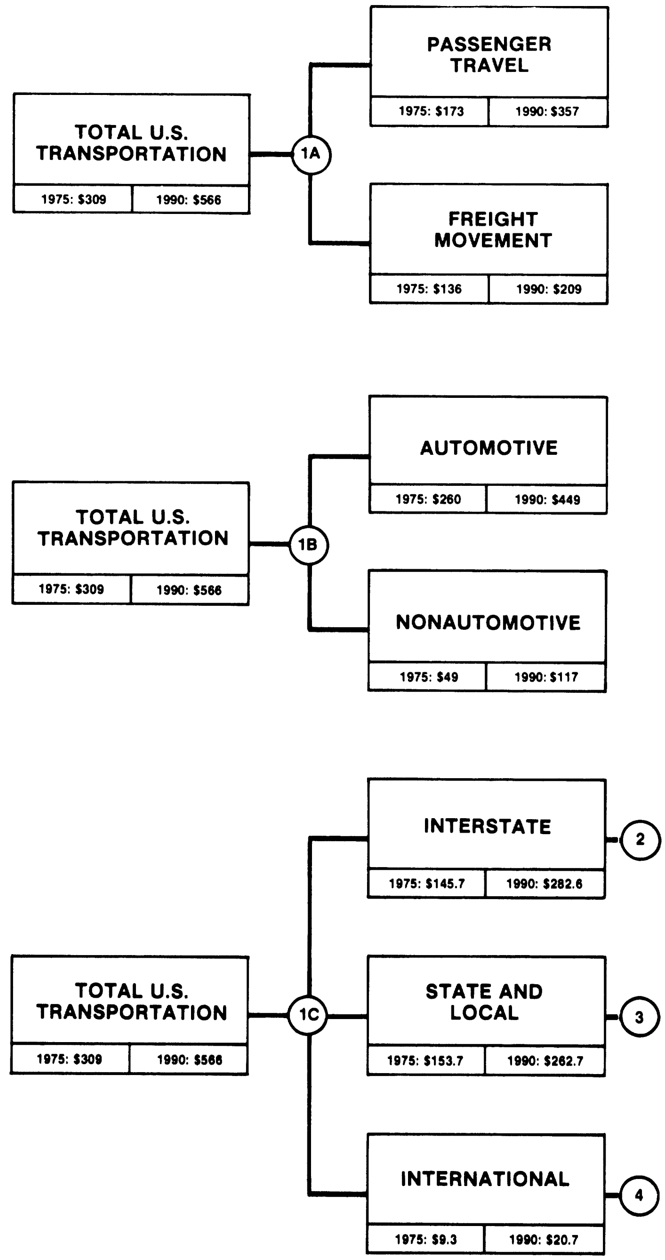
Federal energy conservation policy raises a question concerning an additional "cost" that should be associated with energy use. Both the intense interest in Federal energy programs and the regulated price of oil suggest that some value should be placed on energy in addition to its market cost. Such a value can be estimated by figuring the cost of an acceptable solution to another embargo, for example, stockpiling an amount of oil equal to 1 year's consumption of imported crude oil. Such stockpiling would imply that value associated with one barrel is the value of storing that barrel of oil for 1 year. This cost is estimated to be between $1.25 and $2.70, or about 3 to 6 cents per gallon.

We may then count that for every barrel by which we reduce the Nation's dependence on unreliable foreign sources, we have reduced our need to stockpile by the same amount. The stockpiling cost is thus reduced by $1.25 to $2.70 for each barrel we can conserve. It is important to note, however, that some portion of our fuel consumption is for less essential purposes which we could give up in emergency with little damage to the economy. True conservation consists in reducing the Nation's dependence on imported petroleum for those activities essential to the economy. Improvement in transportation efficiency is such a form of conservation.

TREE STRUCTURE

A branching tree chart is used in the succeeding parts of this document to assist the reader in visualizing the components of U.S. transportation. Figure II.18 shows alternative ways of dividing total U.S. transportation. Tree 1A divides transportation in terms of what is moved—passengers or freight. The succeeding two sections of this report discuss transportation along such lines. Tree 1B divides transportation into automotive and nonautomotive. The next part of this report, part B, "The Automobile," shows why such division is important. Tree 1C divides transportation in terms of geographic scope, that is, interstate, State and local, and international. The succeeding three "parts" address transportation under these headings. The numbers in the small circles correspond to identical circles in subsequent parts.

The numbers for 1975 and 1990 included in each box on the tree indicate the transportation bill in billions of 1975 dollars applicable to each division. The totals correspond to the values shown earlier in table II.2. To the extent that dollars spent reflects the importance of any activity, the values in the boxes reflect the relative importance of those divisions to the National economy. For instance, passenger and freight movement are of roughly equal stature while international transportation is small compared to domestic.



NOTE: The amounts shown are the transportation bills for 1975 and 1990 in billions of 1975 dollars.

Figure II.18. Alternative Transportation Trees.

PASSENGER TRAVEL

Introduction

This section undertakes consideration of the nature and role of personal mobility in the Nation. The present and expected future scale of mobility available to our citizens is treated first. The expenditures for personal mobility, and what those expenditures can be expected to buy are evaluated. The ways personal mobility levels affect our cities, our life styles, and the impact on those who do not fully participate in our high mobility society are then considered. Finally, overall forecasts of future travel activity are presented and briefly described. Man's desire to expand his own mobility has been the prime mover in evolving new modes of travel and developing new transport capability.

Failures and inefficiencies in freight movement are not always apparent to the individual. Typically they are seen in the price or condition of goods, or in the lack of availability of items. These effects are hidden by a host of other factors, which means that the impact of freight movement on our lives is not easily isolated and understood.

On the other hand, weaknesses of the passenger system are more apparent. The effects of congestion, delay, and cost are immediate and direct. Travelers know them because they feel them directly. It is they who wait; they who pay.

Ironically, when the purposes and benefits of transportation are considered the situation in freight is clear and rather straightforward, while passenger transportation is filled with complex factors that cloud the purposes and public benefits. The variety of purposes, goals, and intentions of passengers on a single airplane defies classification and evaluation. Government or private industry cannot and should not judge the reasons for travel, except in emergency situations when public interest overrides "consumer sovereignty."

Government must instead evaluate passenger transport services in the light of national objectives, particularly those for improving economic and social life for the citizens. A better relationship between the costs and benefits of transport services contributes to these objectives by expanding the opportunities available to citizens. When transportation expands a businessman's market area, he may increase his sales and profits. When an individual expands his employment opportunities, he increases his choices of housing, recreation, and public services.

In that context, government and private industry can serve mobility goals by providing service that expands consumer opportunity and choice at prices that afford adequate return on investment (both public and private), and in ways that are economically and environmentally sound.

There is always a risk of emphasizing too strongly the effect of transportation services on other national concerns, such as safety, energy conservation, environmental preservation and the revitalization and preservation of our major cities. These concerns are important, but they must be properly balanced with overall mobility goals. Planning seeks to bring together in one coherent policy the broad and often divergent goals related to transportation. It must provide the means for balanced achievement of all of these goals, so that one is not attained at the expense of others.

Clearly, in pursuing mobility objectives and making specific choices we should identify and take into account all costs—direct and indirect.

Among other concerns are:

- *Economic development* — Business travel, which contributes to economic growth, is certainly pertinent to the national interest. Such travel represents about a quarter of current and future total intercity passenger movement. Increased transport service promotes the economic integration of the country and permits greater geographic specialization leading to economic efficiencies from which the entire Nation benefits.
- *Social goals* — Domestic tourism, recreation travel, and visits to friends and relatives all contribute to the general well-being of society. They enhance the social integration of the Nation and expand opportunities for personal enjoyment.

Local travel, which constitutes about half of passenger activity, is even more directly related to the national interest in that it directly affects the daily social and economic needs of the individual. Local transportation is basic to the provision of services and the access to housing, employment, health, and recreation opportunities, and it may determine the extent to which people live close together or spread widely apart.

All the foregoing concerns are significant to the Nation as a whole. It is difficult, however, and perhaps inappropriate, to measure the effect that expanded travel activity per se has on national interest, or to assume that if transportation is good, more of it is better. In general, it will be left to the private sector and, in some cases, local governments to provide services that might promote increased travel.

One policy set forth by the Secretary of Transportation William T. Coleman, Jr. in his 1975 *Statement of National Transportation Policy* and manifested in this document is that Federal subsidies or other direct financial aid to transportation are warranted only where substantial external benefits can be shown. These benefits include decreases in accidents, fuel consumption, the livability of our cities, the mobility of our rural citizens, the elderly and the handicapped, and environmental damage. The case for such support in interstate travel is sharply limited except there is controversy on this point with respect to rail passenger service.

The dominance of travel in and around metropolitan areas will increase. Major national objectives for urban transportation have been identified after considering locally determined goals. These objectives include preservation of our cities, enhanced economic and social opportunities for all citizens, and protection of our environment, land, and energy resources. A case has been made for selective financial support of mass transit systems by showing their ability to serve all these objectives under certain conditions and to provide major benefits to those who do not use the system, as well as to those who do. No other transport service or sector has shown that it should not become self-supporting.

- *Balance of payments* — The national interest is served if transport services do not impede foreign tourism dollars. Improvements in services to meet this goal would also stimulate Americans to travel within the United States rather than abroad. While the absolute dollar amounts involved are very large (U.S. travel expenditures abroad were approximately $8 billion in 1975 and are expected to increase to $15 billion in 1990), the impact on the entire national transportation system is small in terms of infrastructure or service-level requirements.

The Present Context

Expenditures for passenger travel have risen in step with the Nation's overall economic growth. In fact, transportation spending has accounted for a slightly increasing share of personal consumption expenditures (PCE). This overall growth is a composite of the individual growth trends for various elements of passenger travel (depicted in fig. II.19 and II.20). Automobile and air travel have accounted for most of the increase in PCE in the passenger sector. Intercity rail and bus travel and urban transit have declined relative to the growth of the national economy. All modes except intercity bus have declined in terms of absolute expenditures by the public. A second useful way of looking at these trends is to divide total transport into two sectors. One reflects travel to meet basic, usually recurring needs (work, shopping, medical, and business-related trips). The second is composed of travel for social and recreational purposes. The first sector has grown at a rate approximately equal to total national economic and population growth. The second sector has grown more dramatically, closely following trends in discretionary income and leisure time.

A crucial effect of the foregoing is that transportation-oriented expenditures will increasingly react to changing economic levels. This may lead to industry alignments designed to ride out short-term fluctuations in social and recreational demand; those industry segments that can best adapt to this type of demand are most likely to succeed. Intercity bus and trucking are examples of transport modes well equipped to respond to such an economic environment.

Personal Mobility and Opportunity

The substantial share of the GNP represented by passenger travel expenditures buys Americans a level of personal mobility unparalleled in history. The average American spends approximately 1 hour per day traveling, and goes over 11,000 miles per year.

What does this mobility cost the individual and the society? What are its benefits and impacts? Is this mobility too great or too small? Should we as a nation be seeking to expand it or reduce it? These questions must be examined if we are to make rational decisions about future transportation investment.

The greatest portion of this travel activity is local. About half of our total travel takes place within 30 miles of home. Although historical data are sketchy at best, there is reason to believe that the total amount of time spent in travel each day in urban areas has remained fairly constant. This is more reasonable than it may first appear, for the way individuals have allocated their 24-hour time budget each day has changed very little. The amount of time available for transport is not very flexible. What has changed massively is the miles traveled in that alloted time. More significantly, the number of opportunities or places accessible to the traveler increases with the square of his speed, so that doubling speed provides access to four times as many sites.

Our lifestyles and the configuration of our cities have been modified substantially by increased mobility. This is indicated in part by the rising share of the PCE that goes to user-

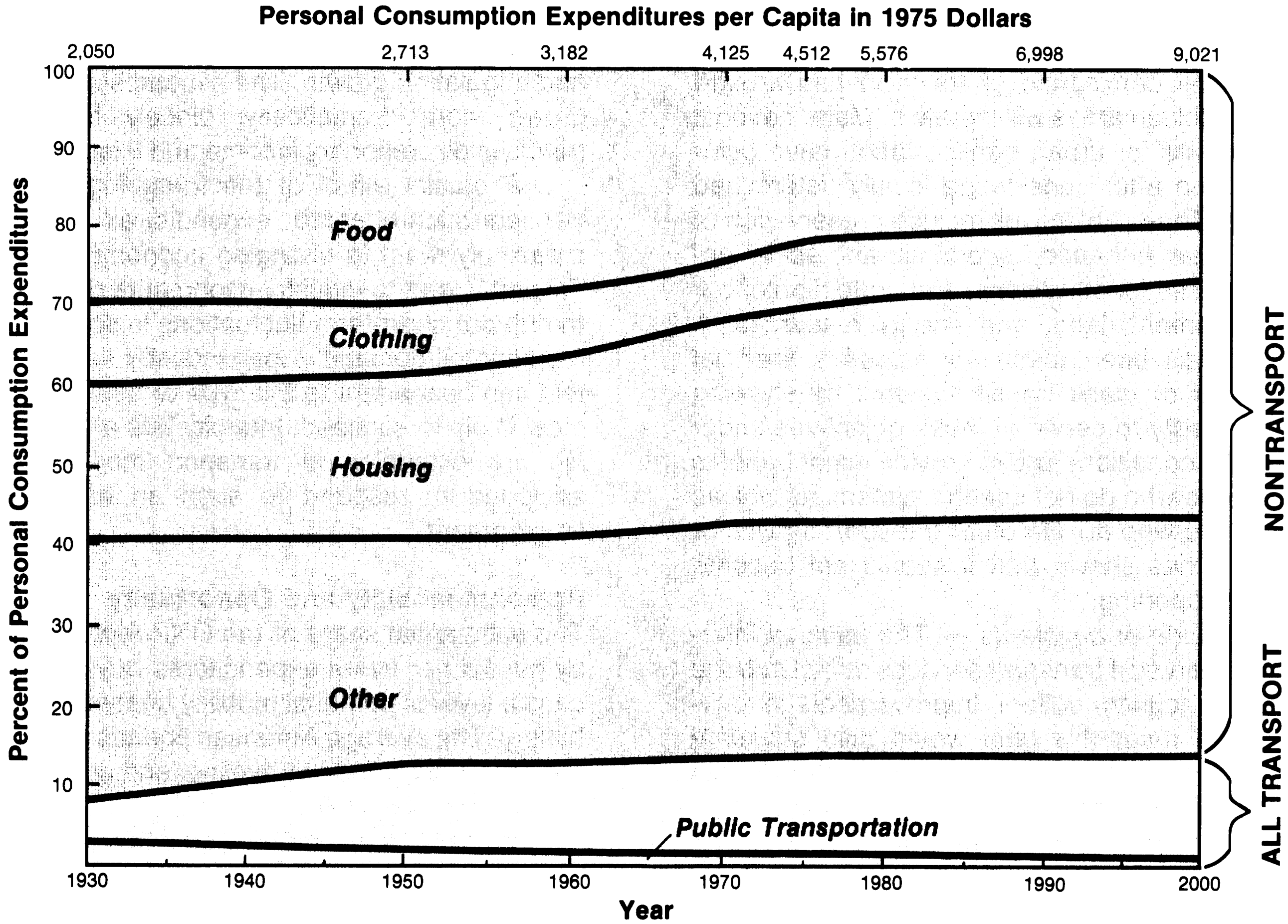


Figure II.19. Personal Consumption Expenditures by Major Category.

operated transportation. More significant is the nature of the changes. These include the multiautomobile suburban household, long-distance commuting, automobile-oriented shopping centers and drive-in services, and simply going for a drive as a major form of family recreation. A frequently overlooked aspect of this mobility explosion has been the vastly improved mobility of most of our rural citizens, whose access to services and opportunities has been considerably improved.

Our cities have been reshaped by transportation. From the early trolley lines out into the countryside, built speculatively to promote land sales, to the present automobile and subway systems, transportation has influenced the way and degree to which we use land. It is an axiom of transportation planning that each transportation system tends to promote that kind of land-use distribution that it can serve best. Automobile-orientation tends to produce the spread city and the drive-in world of the suburbs. The subway system supports the high-density corridor canyons of some of our downtown areas. Transportation systems can have deleterious side effects which are accentuated when their influence on land use is not recognized.

Too often this factor has been overlooked or not given appropriate weight; the result is undesired or unanticipated forms of land development. In many instances transportation improvements have produced land development that was incompatible with other public services (e.g., health, fire and police, and schools). Such development has resulted in extreme inefficiencies and, more important, in rising public costs and neighborhoods that work poorly. In addition, this lack of recognition often has meant that the general public has not recaptured the general taxpayer's dollars used to make the original investment.

In shaping our lifestyles and our urban environment, transportation has already had an

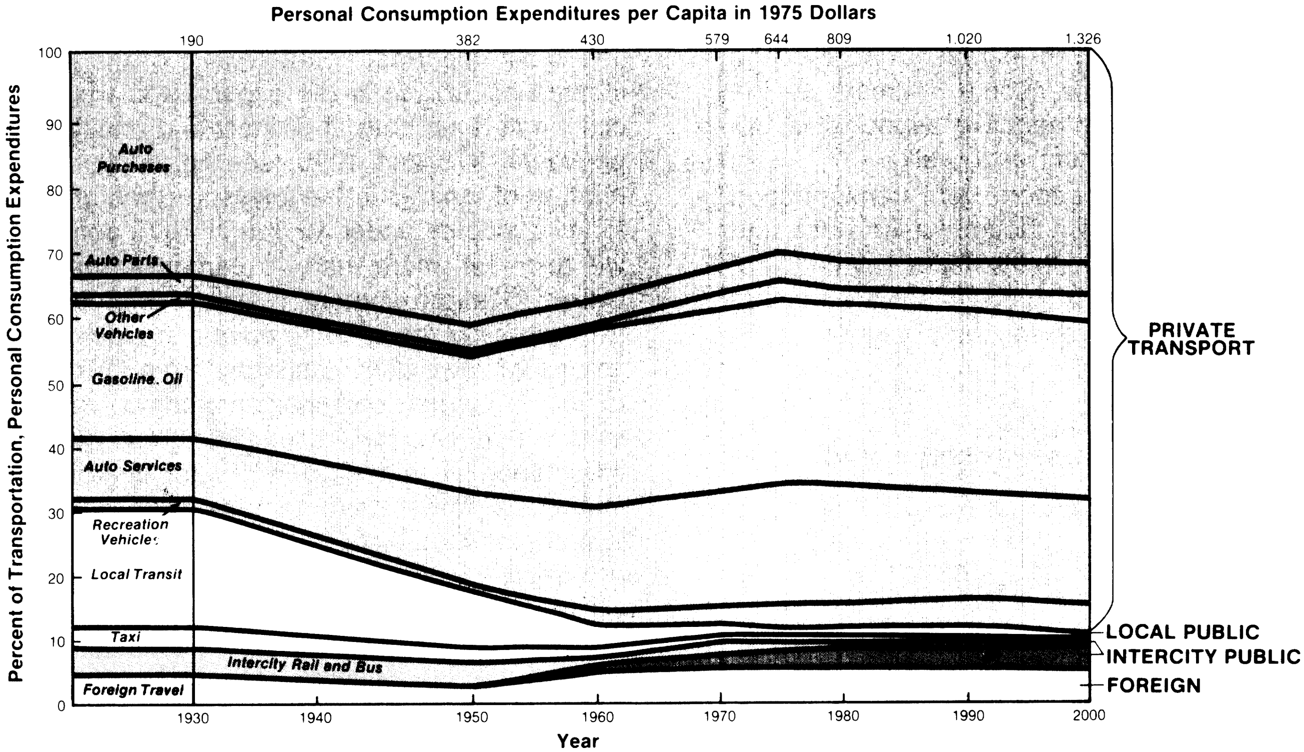


Figure II.20. Personal Consumption Expenditures by Transportation Categories.

influence on our future. Some "futures" have been rendered less possible and others more probable as a result of current mobility patterns. Most structures, facilities, land-use arrangements, jobs, and people that will exist in 1990 are here now. These arrangements and structures will tend to make certain options more economically viable, more "reasonable," in the future. Thus, the auto, assuming problems of liquid energy are solved, is likely to continue to be a "reasonable" solution to mobility needs simply because the present carries over into the future. Behavior patterns and attitudes have similar persistence. Given that 85 percent of the 1990 population is already born, it is not likely that behavioral or attitudinal factors will change dramatically, except in response to extreme external events. Aspects of present mobility, particularly automobile-oriented behavior and air travel, have become embedded in our culture, and cultures do not shift abruptly. On the other hand, the ability of public commitment and changing public policies and priorities to modify attitudes and lifestyles cannot be ignored.

Along with stability factors, there are emerging trends that will move society in new directions. Migration toward rural areas and better climates is an example. Such trends can be abetted by transportation policy if they are considered desirable, or they can be impeded if considered undesirable.

Unless countertrends are supported by transport policy, our dependence on high mobility will persist into the future. The automobile makes possible broad spacing of services and activities in low-density suburbs, which in turn makes the automobile mandatory for even the simplest activity. This not only places one-sixth of the Nation's households without other means of travel at a substantial disadvantage, it leads to a growing disenchantment with the automobile-oriented lifestyle. We have lost our freedom from transportation—that is, freedom from the need to use the automobile or some other vehicle to buy groceries, get to work, or meet other simple needs. As activities are spaced farther and farther apart, walking opportunities decline. Table II.6 illustrates the marked decline in walking to work since 1960.

This is a mixed statistic that probably reflects the positive aspect of increased income and mobility for the low-income segment of the population and the negative aspect of a decrease in the opportunities to walk.

The loss of freedom from transportation can be overcome by thoughtful land use and transportation planning that takes advantage of existing trends and attitudes in society and that will provide for simple means of mobility, such as walking.

Table II.6
Percent of Workers Walking to Work

Workers	1960	1970	Change (percent)
All workers (thousands)	64,656	76,852	+19
Walk to work (thousands)	6,704	5,690	-15
Walk to work (percent)	10.4	7.4	-29
Four Largest Urbanized Areas			
Walk to work (thousands)	890	985	+11
Walk to work (percent)	9.2	8.2	-11
All Other Urbanized Areas			
Walk to work (thousands)	2,289	2,168	- 5
Walk to work (percent)	8.55	6.25	-27
SMSA Ring of Urbanized Areas			
Walk to work (thousands)	555	500	-10
Walk to work (percent)	8.9	6.3	-29
Non-SMSA Urban			
Walk to work (thousands)	1,526	1,129	-26
Walk to work (percent)	16.7	11.6	-31
Non-SMSA-Rural			
Walk to work (thousands)	1,444	908	-37
Walk to work (percent)	11.0	7.2	-35

Services to Special Populations

As the United States becomes more committed to a lifestyle oriented to and supported by the personal-use vehicle, public policy must address the needs of those whose economic, social, or physical condition substantially excludes them from participating in the major mobility benefits of the system. In particular, the expanded spatial distribution of services promoted by the automobile is as much an external cost imposed on the nonuser as is air pollution. It is a cost that must be borne by those benefiting from the system.

Two groups are notably ill served by the personal-use vehicle: those whose incomes preclude vehicle ownership and those whose physical condition rules it out. This section will consider the characteristics and needs of each of these groups.

Mobility for the Low-Income Population. The most important characteristic of the low-income population is the expected sharp decline in its size, both absolutely and relatively, between 1975 and 1990 (see fig. II.21). The number of families in the lowest income group (annual income under $2,300 in 1975 dollars) will decrease more than 40 percent from 1.7 million to approximately 1 million. Moreover, the number of low-income people in older age groups will also decline sharply, from 700,000 to 300,000. A new composition of the very-low-income population will result. This group will be much younger, made up in greater degree of individuals rather than families, and consequently far better able to respond to its own economic circumstance. Because this group will be relatively smaller (less than 4 percent of the total population compared to over 8 percent in 1975), and because the Nation as a whole will be far more affluent, we will be better equipped to help the low-income population improve its circumstances.

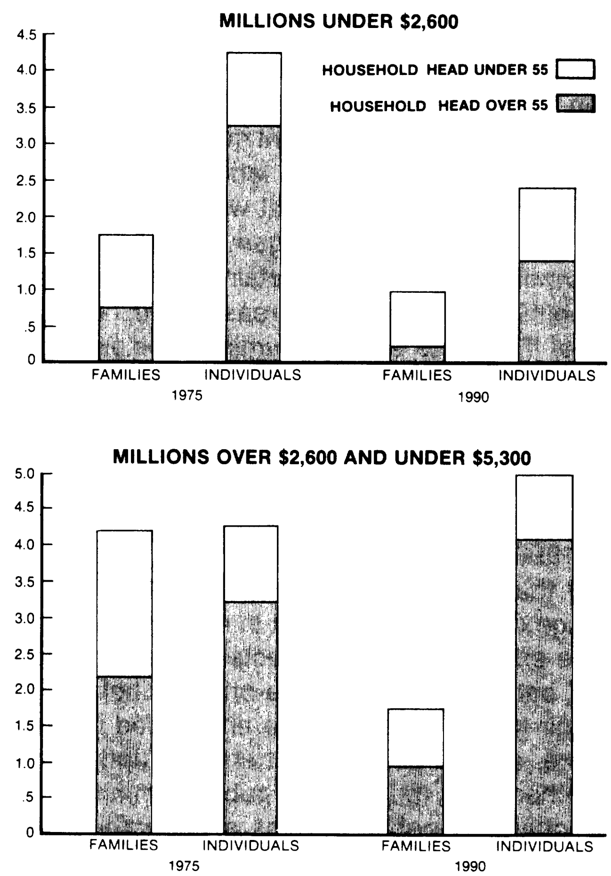


Figure II.21. Projected Size of the Low-Income Population

The changes in the next higher income group will parallel those in the lowest group in important respects. The total number of families with incomes between $2,600 and $5,300 will decline from 4.2 million to 1.8 million between 1975 and 1990, with decreases in all age groups. However, the number of nonfamily individuals in this income group is expected to increase approximately 15 percent, from 4.3 million to 5 million persons. The increase in absolute numbers is explained primarily by persons moving up from the lowest income category and by the increasing proportion of retired persons who will be in the population in 1990.

In summary, there will be substantially fewer persons lacking financial means to participate in the Nation's mobility, they will be more capable of helping themselves, and the Nation will be in a better position to assist them.

Given these factors, there does not appear to be a need for a generalized national transportation assistance program for the poor, because it would provide much assistance when it would not be needed. Instead, more specialized assistance will be required, tailored to the specific mobility needs of the central city and rural poor. This recognition means that general pricing policies do not have to be limited to the ability of the poor to pay. On the other hand, as stated in the chapter on Metropolitan Transportation, there should be no inference that urban transportation service should be priced at a fare which would recover all costs, as there are other social and national interests to induce the general public to ride mass transit.

Transportation's Role in Assisting the Low-Income Population. The foregoing analysis has not included or attempted to anticipate the kinds of assistance programs that might be in operation by 1990 to support the low-income population. Based on existing government assistance programs, it is reasonable to assume that substantial medical, housing, and food assistance will be available. Transportation plays the vital role of providing access to these services. The effectiveness of free health clinics, job-training programs, and so forth, would be severely diminished if their client population could not afford to travel to them. Subsidies for the transportation costs of persons seeking access to public services would be appropriate and cost effective. They would support public goals and effectively meet the needs of the public. Subsidized services might include access to:

- Medical services
- Child support and child care centers
- Job-training services
- Local public service facilities
- Job opportunities

Government at present bears part of the responsibility for assuring public access to such services in terms of how it locates and distributes these facilities. Therefore, directly subsidizing access to public services would be an appropriate choice among a set of alternatives that includes building more facilities and taking the services to the client.

The crucial principle to be recognized is that the needs of the client are better served, the public goals are more effectively met, and the total transportation system is used more effectively if the client and not the transportation system is subsidized. The low-income ridership on a public transit system is rarely large enough, for example, to warrant a reduction of fares on the entire system through subsidized operating costs.

Current transit subsidies in many areas underwrite 50 percent or more of the riders' fares. A goal of providing transportation service to elements of the population at half cost, could be achieved most effectively by reimbursing clients at the public service site, by providing discount tickets similar to food stamps, or by paying the return trip costs to those who arrive by their own means. Where warranted by the physical locations and volume of travel, small pickup and distribution van systems could be employed. The costs of such services would be part of the operating costs of the service system involved and would be appropriately budgeted by the system. Greater budget efficiency would be fostered, in that transport costs would be directly related to caseload level, client population size, and program development. This approach also would clarify cost-effective decisions involving constructing new facilities at remote locations or taking services directly to the client.

Moreover, costly inefficiencies in the transit system would be reduced. These inefficiencies come about from the tenuous relationship between reduced transit fares and the goal of reaching a target population. By focusing support on the low income population in this way, both that group and the public at large would be better served. If the foregoing views are accepted, they should cause a reexamination of pricing or fares for urban mass transportation. The poor would be taken care of by the considerations set forth above. It still leaves open what is the appropriate fare to induce those with the ability to pay to use mass transit facilities rather than the automobile for most of their regular intracity travel.

Mobility for the Elderly and Handicapped. Certain segments of the elderly and physically handicapped populations cannot be served adequately by a national transportation system oriented exclusively to the personal-use vehicle.

The lack of mobility of older people and the handicapped is frequently at the very center of their capacity to maintain themselves independently, or limits their full participation in society. As noted by the May 1970 National Conference on Transportation for the aging:

> "Lack of appropriate transportation constricts the lifespan of any person, limits his capacity for self-maintenance, restricts his activities and his contacts with other people, and may contribute to his disengagement or alienation from society and his experience of anomie. Adequate transportation is not only humane for the older person, it is of economic value to society in that it supports the individual's capacity for independent living and thus assists in postponing or obviating institutional care. Many older people identify transportation as their most serious problem."

Although the remarks were made in reference to the elderly, they also apply to the handicapped.

In many respects, investments to improve the mobility of these groups can make available to the Nation a valuable resource in the skills and knowledge they would be better able to contribute.

The Size and Character of the Population. All estimates of the elderly and handicapped populations are approximate. The following data, therefore, are presented primarily to provide some sense of scale rather than to develop detailed statistical treatment.

Of 20 million elderly Americans, it is estimated that approximately 7 million suffer from handicaps. There are an additional 6.5 million nonelderly handicapped persons. Table II.7 provides some detail on these groups by type of transportation-related handicap.

Economic problems strongly influence the mobility problems of the elderly and handicapped. The reduced incomes of many exacerbate their limitations and make adequate mobility more difficult to assure.

Table II.7
Numbers of Handicapped Persons With Transportation Dysfunctions[1]

Handicap Class	Elderly Handicapped	Nonelderly Handicapped	Total Handicapped
Visually Impaired	1,430,000	540,000	1,970,000
Hearing Impaired	160,000	190,000	350,000
Uses Wheelchair	230,000	200,000	430,000
Uses Walker	350,000	60,000	410,000
Uses Other Special Aids	2,280,000	3,210,000	5,490,000
Other Mobility Limitations	1,510,000	1,800,000	3,310,000
Acute Conditions	100,000	370,000	470,000
Institutionalized	930,000	30,000	960,000
Total	6,990,000	6,400,000	13,390,000

[1] *1970 estimates.*
Source: Department of Health, Education, and Welfare, National Center for Health Statistics, 1960 and 1970 Census of Population.

Future Tripmaking. It is difficult to assess the extent to which present tripmaking needs of the elderly and handicapped are not met and to which future conditions will present mobility barriers. The elderly will be considerably more mobile as a group in 1990 as a result of their improved economic condition and an increase in the number who have drivers' licenses. Since the 1950's, the growth rate of licensed drivers has been most rapid in the over-65 age groups. This has occurred as the population with high license ownership rates has gotten older. Today the age group that will be 65 and over in 1990 has a license ownership rate of more than

90 percent among males and 60 percent among females. While these rates tend to decline with age as licenses are surrendered, the residual will still be large and will provide improved mobility for many of our older citizens. For the elderly, however, the possession of a valid driver's license cannot be equated to full mobility. Even if a person is not technically handicapped, he may have impaired vision, slower reaction time, and reduced strength and endurance. He might, therefore, be limited to short daytime trips in areas of low speed and light traffic. In particular, the elderly may be uncomfortable and sometimes unsafe on high-speed freeways. Thus, although the percentage of elderly persons with licenses increases, the mobility of the 29 million persons over 65 in 1990 may still pose a challenge.

On the other hand, the increased size of the elderly group, both in absolute numbers and as a proportion of the total population, may contribute to improved mobility for its members. Because of their numbers greater recognition will be given to their special needs and interests. The changing demographic character of the population and the consequent changes in travel demand indicate the following:

- Mass transit systems will draw greater proportions of their riders from the elderly in the future, and a lower share from young and low-income groups. This will tend to make transit services more responsive to the travel needs of the elderly, and should influence equipment design, route design, and service scheduling. The lower concentrations of demand and more widespread travel patterns in time and space will support the use of more flexible, demand-responsive transit systems. The trend toward paratransit (public passenger vehicles smaller than traditional buses) services already is apparent in urban and rural transit planning. It is extremely useful in meeting the needs of both the elderly and handicapped.
- These new transit approaches are similar to taxicabs, a mode that overcomes most of the common transit problems faced by the elderly and the handicapped. These problems include the physical and psychological burdens of steps, mechanical doors, crowding, competition for seats, and long waiting times and walking distances at isolated locations. New vehicles such as "handicabs," which permit wheel chair entry and reduce the entry and exit barriers in many cabs, are a further improvement. Flexible route systems are particularly suitable to the low-density areas in which many elderly and handicapped persons live. These systems can also function within city centers where necessary.
- The door-to-door character of such service reduces the need to walk excessive distances and thus cuts down on exposure to pedestrian accidents. It is a tragic fact that our elderly and handicapped, who are the least able to walk, are more dependent on that mode of travel than are all other groups except the very young. Elderly people, who constitute only 10 percent of the population, account for 28 percent of pedestrian deaths.
- The costs of these special systems can be met within the structure of existing operations. That approach would be far less expensive and yet provide better service for the elderly and handicapped, rather than attempting to make over entire transit systems to provide access for an unknown level of ridership.

Architectural Barriers. Flexible, demand-responsive transportation will markedly improve service to the elderly and handicapped, but substantial architectural barriers to mobility will still exist. These can be removed or phased out gradually. Certainly by 1990, many such impediments will have been removed. Table II.8 identifies the major architectural and operative barriers now in the transportation system. Programs are under way to remove such barriers wherever feasible, and thereby to improve accessibility to the national systems, but it must be recognized that they cannot effectively guarantee the specific services required to provide full mobility to the elderly and handicapped.

Table II.9 summarizes the current actions of the Federal Government to remove barriers in the transport system. Any policy, however, must recognize that many of the elderly and handicapped feel that separate treatment is offensive and thus prefer access to usual methods of public transportation, which may require alteration of the vehicle to accommodate them. The competing values and costs require further public debate.

Table II.8
Typical Barriers By Mode

Functional/Mode Disability	Train	Subway	Bus	Airplane
Walk more than one block	Walk from curb through concourse to platform	Walk from entrance to boarding platform	Walk from origin to stop or stop to destination	Walk from curb to gate
Self-propelled level change	Board train via steps	Enter or exit station	Board bus via steps	Board plane via stairs
Sit down, get up	Sit/rise from waiting room or train seats	Sit/rise from seat in car	Sit/rise from seat in bus	Sit/rise from seat in lounge or on plane
Stoop, kneel, crouch	Pick up baggage	Pick up packages	Pick up packages	Pick up baggage
Reach handle	Open terminal door. Enter restroom. Grasp handrail. Open compartment door. Lift suitcase to rack. Buy or turn in ticket.	Buy token. Operate turnstile. Hold overhead grip. Use exit turnstile.	Signal bus. Deposit fare. Grasp overhead grip. Pull signal cord.	Buy ticket. Handle baggage. Fasten seatbelt. Reach overhead switches. Hold oxygen mask. Lower tray table.
Carry 10-pound weight	Carry bággage. Use overhead baggage rack.	Carry packages	Carry packages	Handle own baggage
Move in crowds	Terminals	Platform and vehicle	Terminal vehicle	Ticket counter, boarding area
Identify visual and audio cues	Read direction signs, clocks. Locate gates, restrooms, seats, exits. Hear announcements and warnings.	Read direction signs. See arriving train. Locate platform edge. Hear announcements and warnings.	See approaching bus. Read bus destination. Locate bus stop, curb, stop. Hear announcements, ask directions.	Locate counters, gates. See schedule displays. Hear P.A. system onboard announcements.
Wait standing	Wait on platform	Wait on platform	Wait outdoors	Stand in boarding or ticket line

Source: Travel Barriers; U.S. DOT

Table II.9
Legislation Pertaining to the Disadvantaged

Act	Mode	Effect
Highway Safety Act of 1973 Section 228	Pedestrian	Curbs replaced or constructed after July 1, 1976, to provide adequate and safe access for the handicapped including persons in wheelchairs.
Federal Aid Highway Act of 1973 - Section 165	Bus Transit	FHWA financed mass transit projects be planned and designed for use by the elderly and handicapped.
Section 147	Bus Transit	Rural highway public transportation demonstrations with emphasis on needs of the elderly and handicapped.
National Mass Transportation Assistance Act of 1974 Section 16(a)	Bus/Rail Transit	Planning and design of mass transit to facilitate use by the elderly and handicapped.
Section 16(b)	Bus/Rail Transit Paratransit	Grants for State and local agencies for meeting the special mass transit needs of the elderly and handicapped. Grants to private nonprofit organizations for special transportation systems for the elderly and the handicapped.
Section 5(m)	Bus/Rail Transit	Fares for elderly and handicapped during nonpeak hours equal to or less than half of the general peak hour fares, for DOT funded projects.
Federal Aviation Regulations Part 121.586	Airplane	Carriers prohibited from refusing to carry a passenger solely because he will need assistance during an emergency evacuation.
Part 121.589	Airplane	Crutches and canes must be placed in suitable baggage or cargo storage compartment.
Part 121.311(d)(2)	Airplane	Persons who cannot sit erect for a medical reason exempted from the required seat upright position during takeoff and landing.
Part 121.5/1(a)(3)	Airplane	Briefing of handicapped persons before takeoff regarding routes and appropriate time to exit in an emergency and inquiry into what is most appropriate assistance by flight attendant.
Part 135.27	Airplane	Inclusion of procedures for the emergency evacuation of persons who may need another person's assistance, in the certificate holder's operating manual.
Part 135.139	Airplane	Testing of flight attendants on emergency evacuation assistance and seating of persons who may need assistance.
Interstate Commerce Commission Rules	Intercity Bus and Rail	Removal of physical and architectural barriers to use of restrooms on vehicles and terminal facilities.

The Determinants of Future Travel Demand

Travel is governed by the activities of a society and by the spatial distribution of sites for performing those activities.

A host of factors—economic, social, and spatial—determine the frequency and length of travel. All of these factors are moving in directions that indicate more travel and longer trips by 1990. The major factors identifiable in assessing future demand are discussed below and are summarized in figure II.22.

- *Population increase* — Thirty million (15%) more people by 1990 will undoubtedly increase travel. This increase will comprise about 24 million new births and 6 million immigrants. The new births will, of course, all be under age 15 in 1990—too young to operate a vehicle according to most present rules.
- *Population age distribution* — More significant for transportation demand will be the large increase in age groups with high travel activity, as the "baby boom" children mature (see fig. I.8, "Assumptions"). The age group from 30 to 45 will increase by almost 60 percent in 1990. During the same period the dependent populations—young and old—will decline in size and shift in composition with greater proportions over 65, rather than under 18. This shift will give the labor-force age group greater discretionary opportunities to travel.
- *Labor force* — Two countervailing trends will appear in this period. The number of young people entering the labor force for the first time will decline, particularly from 1980 to 1990. However, the participation of females in the labor force is expected to continue to increase, producing many more multiworker households. On balance, a larger share of the total population will be in the labor force, and thus in the commuter population.

Incomes and Residential Patterns. Increasing per capita and per household incomes will be a major determinant of future travel demand. Incomes are expected to increase by more than 50 percent in real dollar terms between 1975 and 1990. Even this high growth does not tell the whole story. Previously cited demographic trends, too, will combine with these income increases to make for smaller households with large amounts of discretionary income and time. The result will be a highly mobile population. Increased income provides the means to pay for increased travel; it also governs other factors related to tripmaking. Among these are automobile ownership and single-family home ownership. Figure II.23 provides current automobile ownership data by income group. It is significant that the automobile ownership threshold ranges from $3,000 to $4,000 a year. Automobile ownership doubles in that range compared to the next lower income category. Many low-income households, where automobile ownership is lowest, will be moving into this range in the next 15 years. Income curves alone cannot be used to obtain estimates of future automobile ownership. There are other factors involved. But the curves do indicate the tendency to buy a car as income expands. This topic is covered more fully later.

The single-family home also contributes to increased tripmaking and trip lengths. Urban surveys have indicated considerably higher daily trip rates for home owners than for apartment dwellers of the same income group—a product of the spatial separation of activities as much as of lifestyle. Except at very high levels, however, residential density has not been proven a major determinant of trip activity per household. Trip characteristics vary considerably as changes occur in purposes, length in distance, and time and mode of travel chosen. Figures II.24 and II.25 show the importance of trip purposes as percentages of total travel activity for short local trips and for long trips. It also demonstrates that the length range of each purpose is fairly limited. The commuter work trip dominates local travel. However, work travel as a percent of total travel has been declining recently as shopping and personal business travel has increased faster in both frequency and average length of trip. Average trip lengths have been increasing in all categories for both local and intercity travel.

As a choice of mode, the automobile predominates in all purpose and length categories except for the very longest trips (over 2,000 miles round trip).

Activity Patterns and Spatial Relationships. The foregoing has not treated that portion of passenger travel that does not use motorized vehicles. Clearly, vehicle travel represents only a portion of total travel activity.

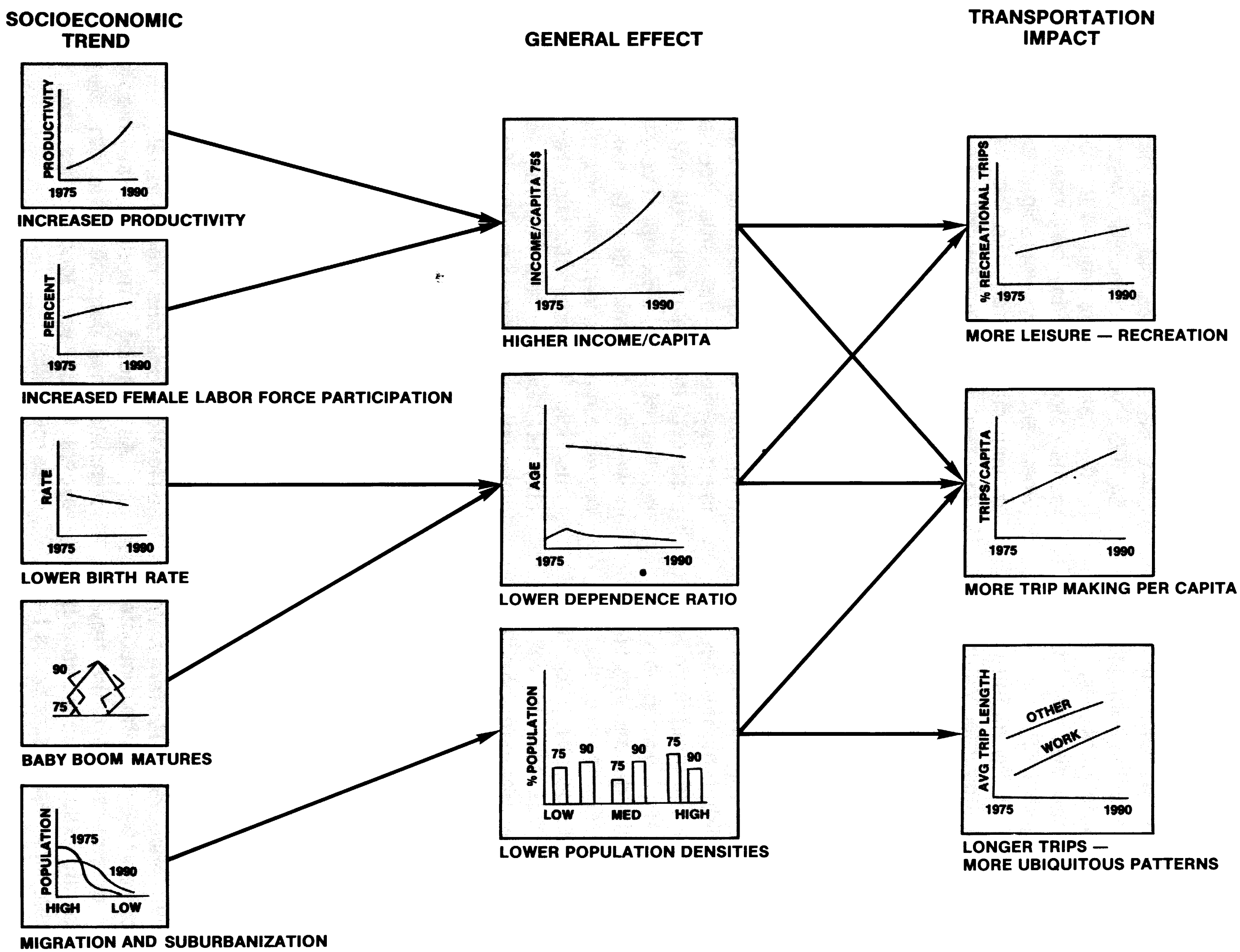
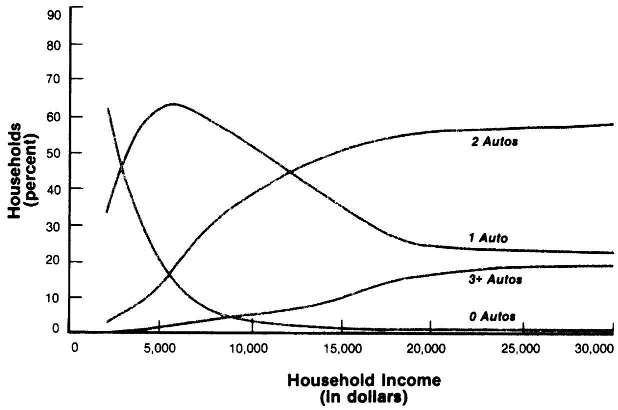


Figure II.22. Socioeconomic Determinants of Future Travel Demand.



Source: Estimated from Nationwide Personal Transportation Study, 1969-1970, *Federal Highway Administration.*

Figure II.23. Household Income and Car Ownership.

Except in work-oriented travel the proportion of trips that do not use a motorized vehicle is not known, yet this factor is important in determining future travel demand.

The decline in walking to work has been noted in table II.6. These data could be cited as an indication that the quality of life is getting better as larger proportions of the population gain access to automobiles or getting worse as opportunities to walk decline. In 1970 over 8 million persons did not use motorized means to get to work. Of these, 5.5 million walked to work and 2.5 million worked at home. These figures represent 11 percent of all workers, more than the percentage using all mass transit modes combined.

There are no comparable statistics for the proportion of nonmotorized trips for other purposes. Because non-work-trips are usually shorter and less specialized than work trips, we can expect higher proportions of them to be nonvehicular trips. It is also reasonable to expect that the proportion is declining, like that of work trips, because of the increasing spatial separation of activities. An increase in the proportion of walking trips would be an inappropriate transportation goal per se, but it is quite appropriate to seek an increase in the opportunity to walk, bicycle, or travel by other nonmotorized vehicle means. This goal would be consistent with broadening the range of consumer choice. Transport plans that increase the dependence of the traveler on vehicles directly, or indirectly through induced changes in land-use patterns, reduce his alternatives and are deficient. More directly, the share of opportunities that can be reached by nonmotorized vehicle

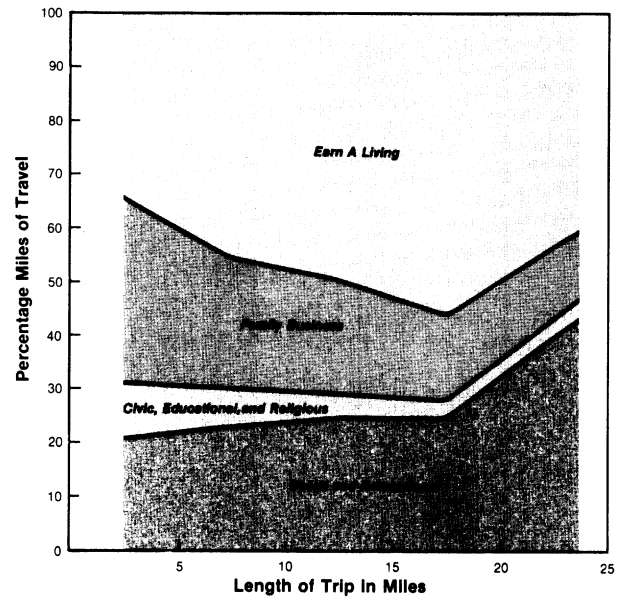


Figure II.24. Purposes of Local Trips.

says more about land-use plans than about transport plans. The "walking potential" of land use arrangements should be receiving consideration increasingly in future local transportation plans. Chapter XII on Metropolitan Transportation describes some elements of current transportation planning that support these goals, including car-free zones, special bicycle paths, and parking controls.

Service Changes. The effect of providing transport services on demand will be treated more fully in subsequent chapters. The more general issue, the travel-generating nature of improved transportation service, is addressed here.

The issue of "induced" demand has not been fully evaluated or resolved. If transport services behave as do most other goods and services, reduced cost will certainly lead to increased demand. Studies of latent demand for transportation services have indicated that the young, the old, and the low-income groups have the largest unfulfilled demand. This demand is manifested when transport services are expanded or costs reduced.

Freeway opponents have often cited the traffic apparently generated by new facilities. Aside from the foregoing cost relationships and the intended diversion as traffic shifts from lower to higher quality facilities, new facilities tend to attract travel and development from less accessible areas. However, various stud-

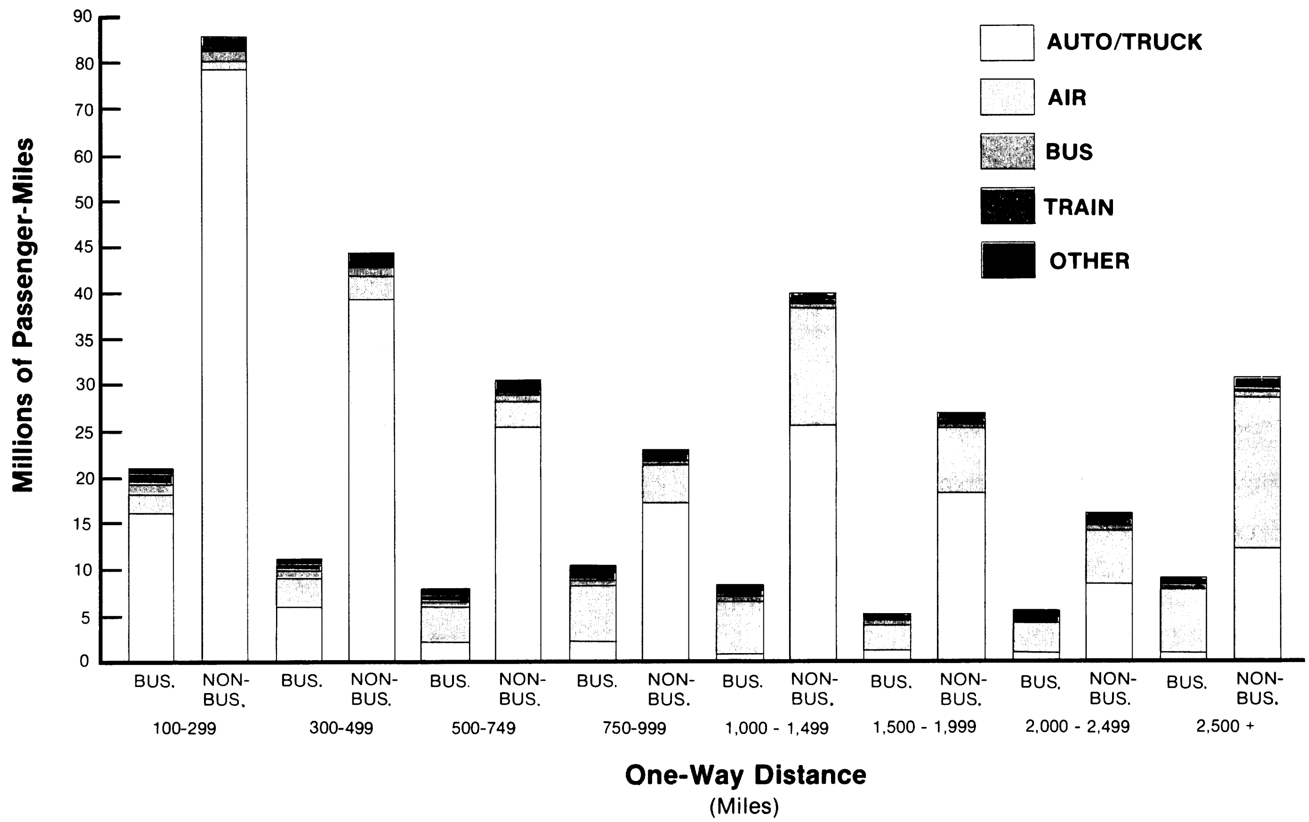


Figure II.25. Purposes of Long-Distance Trips.

ies have not confirmed the generation of significant amounts of true new demand.

It is very important, however, that the character and distribution of facilities can affect the proportion of travel that is mechanized and the length and direction of travel. The relationship between land use and transportation facilities can reinforce or inhibit the combining of many activities into one vehicular trip.

The value of time to an individual and how much he will pay for faster transportation often can be inferred from how he behaves as a traveler. The actual value of time saved varies with the individual and the situation. Nevertheless, the concept of a dollar amount that travelers apparently are willing to pay to save time is useful both in cost-benefit analysis and travel forecasts. Analysis indicates that income level is important in determining the value an individual places on time. Other things being equal, increased income will mean increased demand for time-saving, higher speed travel and for more convenient modes.

The value of time to individuals is expected to increase with the rise in incomes. Traveltime may be more significant in determining future travel demand than fare or other out-of-pocket cost. Few new significant technological line-haul speed increases are expected in the period covered by this document. Traveltime reductions must therefore come from improved access to line-haul modes, more frequent and widespread services, fewer delays, and more efficient transfers between modes of transportation. Growth in demand will permit such improvement. In other sectors new technologies and efficiencies may improve overall traveltimes. In selected areas, particularly in historically congested corridors, congestion delays will be a major determinant of overall trip cost and demand unless substitute facilities are built and are used by those who otherwise would use an alternative mode.

Future Demand

Figure II.26 shows predicted 1990 passenger-miles of travel for each Bureau of Economic Analysis (BEA) area. Figure II.27 identifies areas with the greatest growth in total travel in the 1975–90 period. Table II.10 shows the distribu-

TABLE II.10. PROJECTED PASSENGER TRAVEL.
(Passenger miles in trillions)

Category	1975	1990
Local	1.185	1.665
Intercity	1.348	2.038
International	.047	.145
Total	2.580	3.848

tion of increased demand within major categories.

These forecasts represent 15,600 travel-miles per capita annually. They reflect changes in total population, shifts in population distribution, and the changing socioeconomic character of the population for each BEA area and for the transportation sector as a whole.

In interarea travel, the greatest growth will occur in the middle-volume classes comparable in scale to Detroit-Cleveland or Kansas City-St. Louis, rather than in the highest volume classes such as the Northeast and California corridors (see fig. II.28). When these overall BEA-to-BEA volumes are merged together in actual corridors, some will yield travel flows equivalent to today's Northeast corridor volumes. The merged flows, more significant for transportation planning purposes than the overall growth, are depicted in a spider network[3] in figure II.29 for 1975 and 1990. This technique clearly identifies corridors of substantial growth.

FREIGHT

The transportation of goods and commodities is requisite to all segments of the economy. Such movements permeate all stages of production—from extracting bulky raw materials at the mine to carrying home groceries and purchases in the family automobile (over 15 percent of all automobile trips are shopping trips). In order to properly plan for better transportation, it is necessary to consider our freight system in the context of both its physical features and its commercial functions.

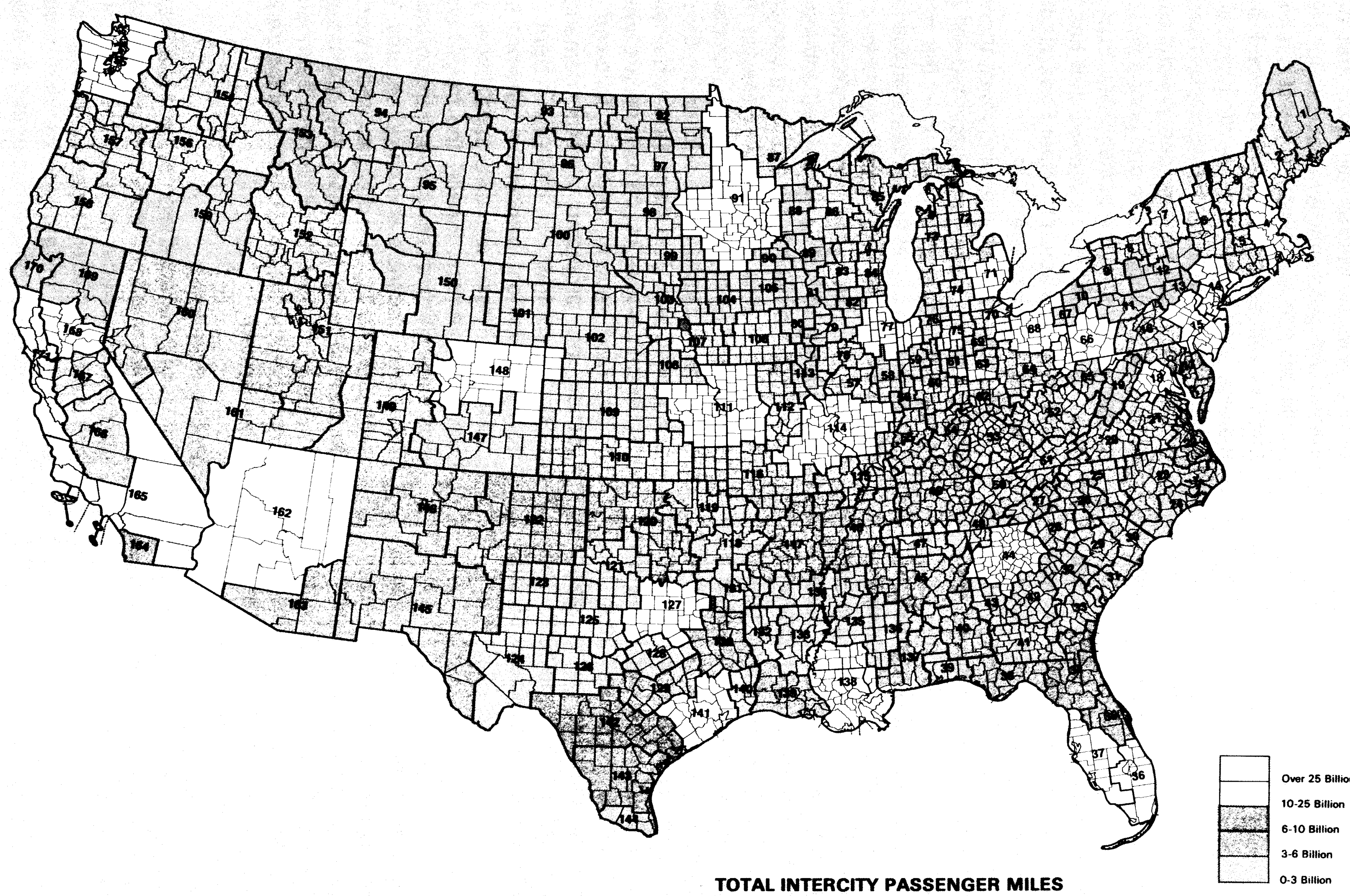
Our national system for freight transportation consists of a vast network of highways, rail, pipelines, airways, and waterways, and a never-ending flow of trucks, rail cars, and barges loaded with goods and even autos. But it is also a market. The changing nature of this market strongly influences and is influenced by the makeup and capabilities of its physical features. It is a market for transportation services in which carriers for hire and private carriers represent the supply side and goods and cargo shippers represent the demand side. In its interstate dimension, it is a market that has been pervasively subjected to either Federal government regulation or oversight.

Comprehensive planning must, therefore, begin with the policy principles that will guide long-range government action in the market. They are taken up in the section that follows on Policy Principles. The major features of the market are examined next, particularly the great variety of highly specialized commodities requiring shipment to be met by a compatible variety in forms of supply. Because future productivity is of major interest, comparative costs are analyzed in the section on Structure of Supply Costs. The magnitude and character of present national freight patterns are taken up in the next section, which is followed by a section on projected system demands in 1990. In contrast to intercity freight, local freight movement presents a different set of problems. These are discussed under Local Freight Movement. Finally, the freight discussion ends with brief reviews of transportation of hazardous materials and cargo security. While each of these topics is complex and is worthy of far more detailed treatment, the discussion will be limited to only those matters bearing most directly on the future evolutions of the transportation system.

Policy Principles

Our freight transportation system is a vital and highly integrated component of our economy, a ubiquitous producer of unwanted side effects, and a market characterized by massive capital investment to initiate service and relatively small marginal costs to increment it. Because of this unique role, government has frequently intervened. In the area of economic regulation, however, many well-intentioned policies are

[3]There are approximately 30,000 pair-to-pair combinations making graphical representation impossible. A spider network forces all travel between two areas through the center points of all intervening areas. It is a summary tool rather than an attempt to depict flows on actual facilities.



NO FIGURES AVAILABLE FOR PASSENGER MILES IN ALASKA AND HAWAII

TOTAL INTERCITY PASSENGER MILES
OF TRAVEL ORIGINATING IN B.E.A. AREAS — 1990

FIGURE II.26. 1990 TOTAL INTERCITY PASSENGER-MILES OF TRAVEL ORIGINATING IN BEA AREAS.

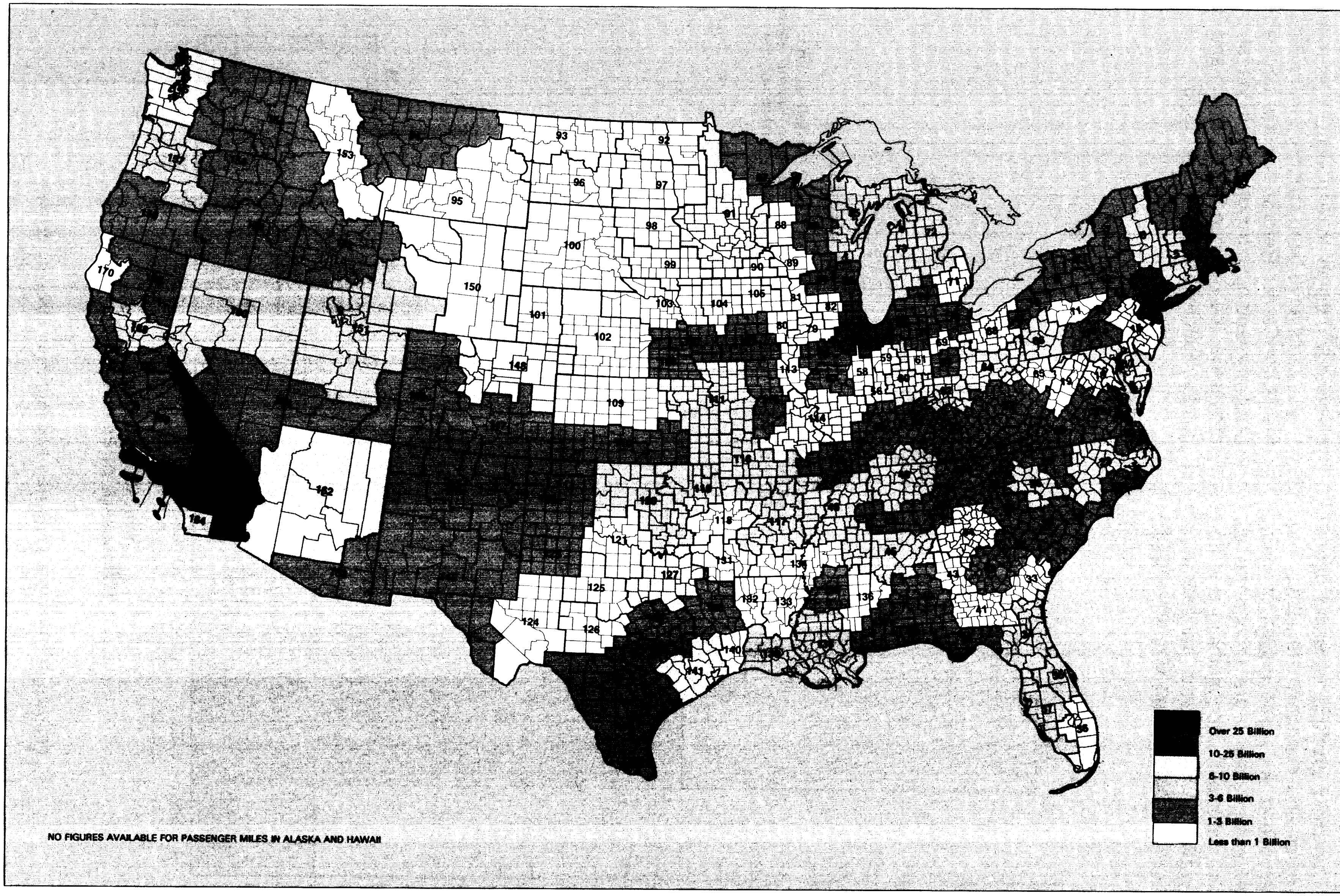


FIGURE II.27. NET INCREASE IN INTERCITY PASSENGER-MILES OF TRAVEL FROM 1975 to 1990 IN BEA AREAS recognized today as having outlived their usefulness. They now produce inhibiting operational rigidities and economic inequities. The unanticipated and undesired results of many past government actions are recognized as inequitable, inefficient, uneconomical, and frequently irrational. For freight transportation alone the costs of outdated government regulatory practices are estimated to range from $3 billion to $10 billion. In response, major regulatory reforms have been proposed in trucking in the Motor Carrier Reform Act now before the Congress, and have become law in the railroad area under the Railroad Revitalization and Regulatory Reform (RRRR) Act of 1976.

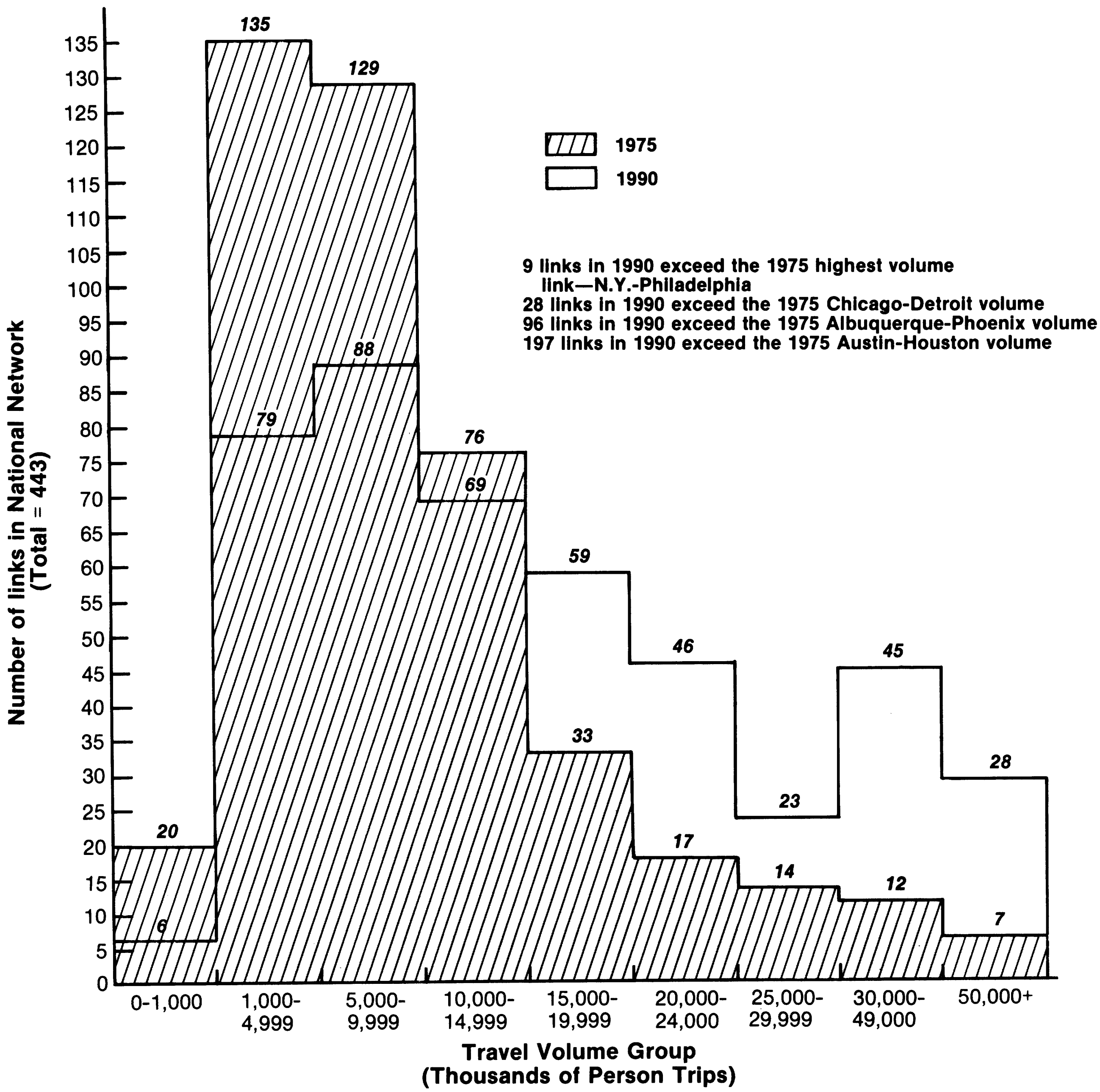


Figure II.28. 1975-1990 Frequency Distribution of Lines By Volume

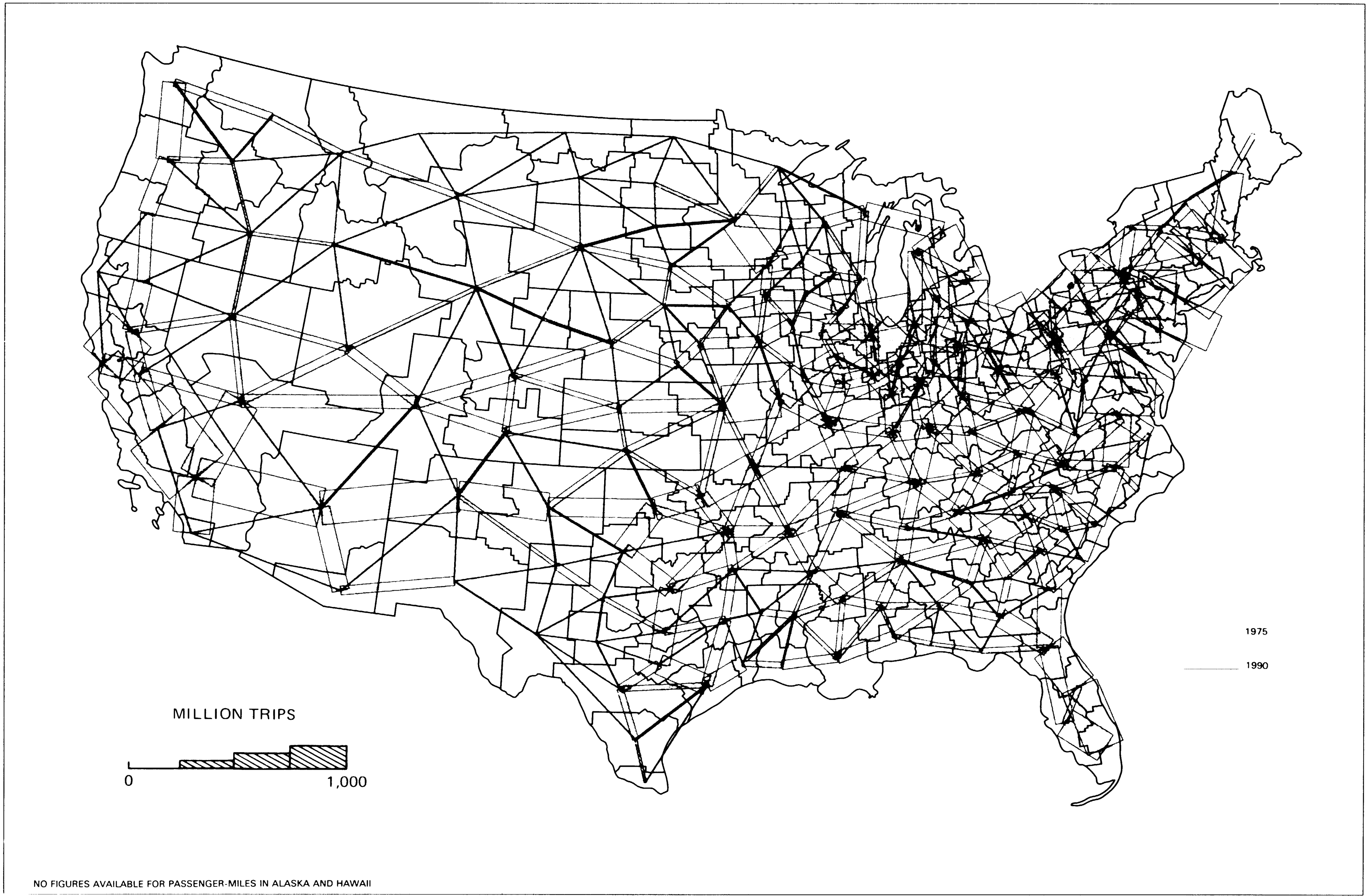


FIGURE II.29. 1975—1990 TOTAL PERSON FLOW BETWEEN BEA AREAS.

When it is recognized that the present deficiencies of past government action are evident, the question of what policies should be adopted as part of a long-range view of the evolving national freight system becomes highly significant. Primarily, the question permits us to re-emphasize the more enduring principles of policy, rather than to attempt further adaptation of those policies presently in effect. In consonance with the policies summarized in figure I.1, three policy principles for freight transportation emerge as particularly useful guides to government action over the 15-to-30-year horizon.

- *The beneficiaries of a service should pay the cost of providing it.* In spite of the immediate logic behind this principle and its seeming compatibility with the Nation's traditional sense of free markets and fair treatment, there have been numerous deviations from it. Many of our industries and shippers pay only part of the overall economic costs of the services they receive. In addition, in many instances, no consideration is given to social costs.
- *Government should do only what the private sector cannot or will not do.* It is necessary for government to intervene in otherwise private sector operations when there is no other way to eliminate side effects of transportation inimical to the public good, or when the market is unable to provide vital services. Such intervention should take place only after it has been demonstrated that appropriate remedies will not be forthcoming through voluntary actions in the private sector. Such failure occurred in the case of safety, the protection of our environment, control over the transportation of hazardous materials, and energy conservation. From the first principle, the burden of providing this protection should be borne by those who benefit from the service. That is to say, the costs of prevention should be internalized.
- *Free competition is to be preserved in transportation markets to the maximum extent possible.* It is necessary to assure continually that essential service is maintained, that adequate safeguards are provided against the abuse of economic power, and that well-managed firms have sufficient earnings to attract capital and to earn a fair return on their capital investment. At the same time we have become more fully aware of the waste and high costs to the Nation of past economic regulatory actions. The key to this balance is to increase reliance on competitive forces—in particular, cost-based rates and freer entry—to eliminate anticompetitive practices where there are competitive alternatives available, to permit abandonment of unprofitable operations, and to eliminate constraints that became archaic in the current context.

In the development of the Nation's transportation system, exceptions to these principles have been necessary for reasons of public policy. Nevertheless, as noted in the Secretary's Policy Statement, many of the conditions that once made such exceptions defensible have long since disappeared. It would be a disservice, therefore, to encourage or promote future transportation systems that perpetuate these exceptions merely because they represent a precedent rather than because they are still needed. In the discussion that follows, the assumptions about future markets and forecast freight activity will emphasize the effects to be anticipated under the foregoing policy principles.

Features of the Freight Market

The demand side of the freight market consists of over 4 million commercial farms and manufacturing, wholesaling, and retailing establishments who daily make independent decisions about how best to move their commodities to the next stage of production, to retail outlets, or to their customers. The supply side of the market consists of over 20,000 freight carriers supplying a great variety of services involving one or more modes. The approximate number of carriers in each mode is: 50 air, 16,000 motor (regulated only), 300 rail, 3,500 water, and 240 pipeline.

To anticipate how these relationships may change in the future, the factors that determine these many shipping decisions must be considered. These are the attributes of the commodity to be moved, the level of service provided by each carrier, the special requirements of those who will receive the shipment, and cost. Their influences will be examined first on the demand side and then on the supply side.

The most significant factors that govern the choice of mode and carrier are the weight and bulk of the shipment and time demands, if any. Within each particular mode, there exist both physical limitations and economies of scale with respect to shipment size. Figure II.30 indicates the present operational ranges for the movement of different size shipments by different modes, and how they become manifest in tariffs charged.

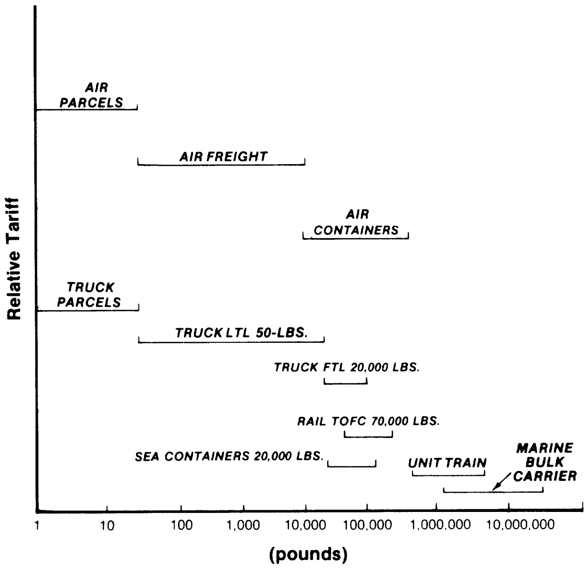


Figure II.30. Typical Effects of Shipment Size On Transport Tariff Rates.

Given these physical constraints, the factors that next determine the choice are the forms of service provided and how well they match certain additional special attributes of the commodity to be shipped. Such considerations as shelf life, value per pound, and special environmental requirements further limit the choice of mode and carrier. Wait times, transit times, reliability, and propensity to damage and shrinkage must match these considerations. The special environmental requirements of some commodities, such as perishable vegetables or animal cargoes, not only place a high premium on reliability and speed of transit, but have led to numerous forms of refrigerated, pressurized, and specially packaged services.

Other factors of the market also influence the choice. The availabilty of suitable facilities, such as docks, rail sidings, or storage facilities, as well as the nature of ownership of the facility (public or private), bear on the decision. Further, it is the aggregate level of demand and the unique characteristics of the traffic that collectively create a viable market and determine the nature of service available, from pipelines to the United Parcel Service.

For many commodity movements, carriers compete vigorously, in terms of both rates and levels of service, to affect the choice. Rates have been subject to extensive manipulation, and the many forms of expense other than that of direct line haul that they must cover—such as collection, distribution, temporary storage, and nonavailability of equipment for other use—have led to a great proliferation of published tariffs.

In addition to the tariff, a number of costs other than the tariff borne by the shipper (or his customer) were noted in the section of this chapter on Transportation and National Development. One is the cost of investment in a commodity that is unavailable for processing because it is in transit. Another is the cost of maintaining higher levels of buffer stocks (including the tied-up capital, storage facilities, insurance, potential for obsolescence, loss, damage, shrinkage, deterioration, and other related factors) to mitigate the effects of uncertainties in arrival times of goods in transit. Encouraged by the availability of highly reliable, "overnight," or otherwise premium service offered by some carriers, many firms have managed in recent years to reduce the size of their stocks carried in inventory, particularly of those items that have high dollar value and are not especially bulky. Alternatively, some firms eliminate the risk by maintaining their own facilities and equipment for hauling their own products. Such "private carriage" accounts for approximately 21 percent[4] of all expenditures for freight movement, excluding agricultural movements.

Structure of Supply Costs

Determining the true cost of providing freight service has always been an elusive matter. Many tariffs are based on the value of a service and may be substantially different (higher or lower) from the costs to the carrier of providing it. If the present initiatives toward regulatory reform take effect, however, tariffs will tend to gravitate toward the true costs of supplying the service. The emphasis here will, therefore, be on estimates of present costs and which components will influence future cost changes.

---

[4]Commodity Transportation Survey, 1972.

Analysis of the costs of a freight movement vary greatly, depending on bulk, quantity, distance, and service selected. For example, on the highway the costs will vary depending on whether the truck is a common carrier, a contract carrier, a carrier of exempt commodities, or a private carrier; whether the commodity travels in a trailer 40 feet long or in two 27-foot trailers; whether the size of the shipment is a truckload, or less than a truckload, in which case the shipment must be mixed with other shipments to constitute a load; and whether the shipment will be direct or must go to a trucking terminal at the origin or the destination of the trip. Similarly, the cost by rail will vary depending on whether the service is by a box car in mixed train service, a truck trailer-on-a-flat-car (TOFC) or a comparable container-on-a-flat-car, and whether it is in mixed train service or runthrough train service. For air movements the costs will vary depending on whether the service is by the lower hold of passenger aircraft or by an air freighter, and whether it is a full container load. This great variety precludes a fully comprehensive discussion. A recently completed study that addresses general cargo service by air, truck, and rail,[5] provides some very useful comparisons among these three modes. Engineering economic costs for a representative group of service options are presented in figures II.31 through II.36. The costs reflect each service under current average operating practices and conditions with respect to markets served, load factors, use of equipment, and backhaul, general cargoes and perishables characteristic of each service. The freight services analyzed are listed in figure II.31.

Figure II.32 compares the costs of shipping 1 ton for various quality services, distances ranging from short hauls to transcontinental movements, by rail, truck, and air. Because this analysis is limited to a composite of general cargoes and perishables, a comparable set of figures for water movement and some forms of rail movement could not be included. The figure shows that, under today's practices and technology, an ordinary box car (line j) results in the lowest cost of the three modes considered.

For containerized shipments moving in the lower hold of wide-body passenger jets (line g) it has been impossible to separate the line haul costs from those incurred in transporting the passengers, and these movements appear less costly than direct truckload at distances over 1,500 miles. A more realistic perspective of relative air and surface prices, however, is shown by line a for narrow body freighter, which indicates that these costs are very high relative to the others. Figure II.33 shows the comparable costs for refrigerated services. How rail boxcars compare with bulk water and rail movements may be seen in figure II.30.

The actual costs for these services in specific markets also depend on the average system payload densities. Specifically, the relationship between the average density of the loaded shipments and the density for which the vehicle was designed affects the average costs of the service. Figure II.34 shows how this

General Service

Rail
- Box Car—Average 70-Car Mixed Train
- TOFC/COFC—Average 70-Car Mixed Train
- TOFC/COFC—35-Car Run Through Train

Highway—Truck Load (TL)
- 40′ Single Rig Direct
- 40′ Single Rig Via O/D Terminals
- 27′ Doubles Rig Via O/D Terminals
- 40′ Doubles Rig Via O/D Terminals
- 27′ Triples Rig Via O/D Terminals

Highway—Less Than Truck Load (LTL)
- 40′ Single Rig Via O/D Terminals
- 27′ Doubles Rig Via O/D Terminals
- 40′ Doubles Rig Via O/D Terminals
- 27′ Triples Rig Via O/D Terminals

Air—Container Load (CL)
- 4-Engine Narrow Body Freighter Igloo System
- Wide Body Lower Hold Container System (W.B.L.H.)

Air—Less Than Container Load (LCL)
- 4-Engine Narrow Body Freighter Igloo System
- Wide Body Lower Hold Container System (W.B.L.H.)

Refrigerated Service

Rail
- Refrig. Car—Average 70-Car Mixed Train
- Refrig. Car—70-Car Run Through Train
- TOFC/COFC Refrig.—Average 70-Car Mixed Train
- TOFC/COFC Refrig.—35-Car Run Through Train

Highway—Truck Load
- 40′ Refrig. Single Rig Via O/D Terminals
- 40′ Refrig. Single Rig Direct
- 40′ Refrig. Double Rig Direct

Figure II.31. Freight System Options.

[5]See *U.S. Cargo Transportation Systems Cost and Service Characteristics*, U.S. Department of Transportation Report SS-212-U1-13, April 1976.

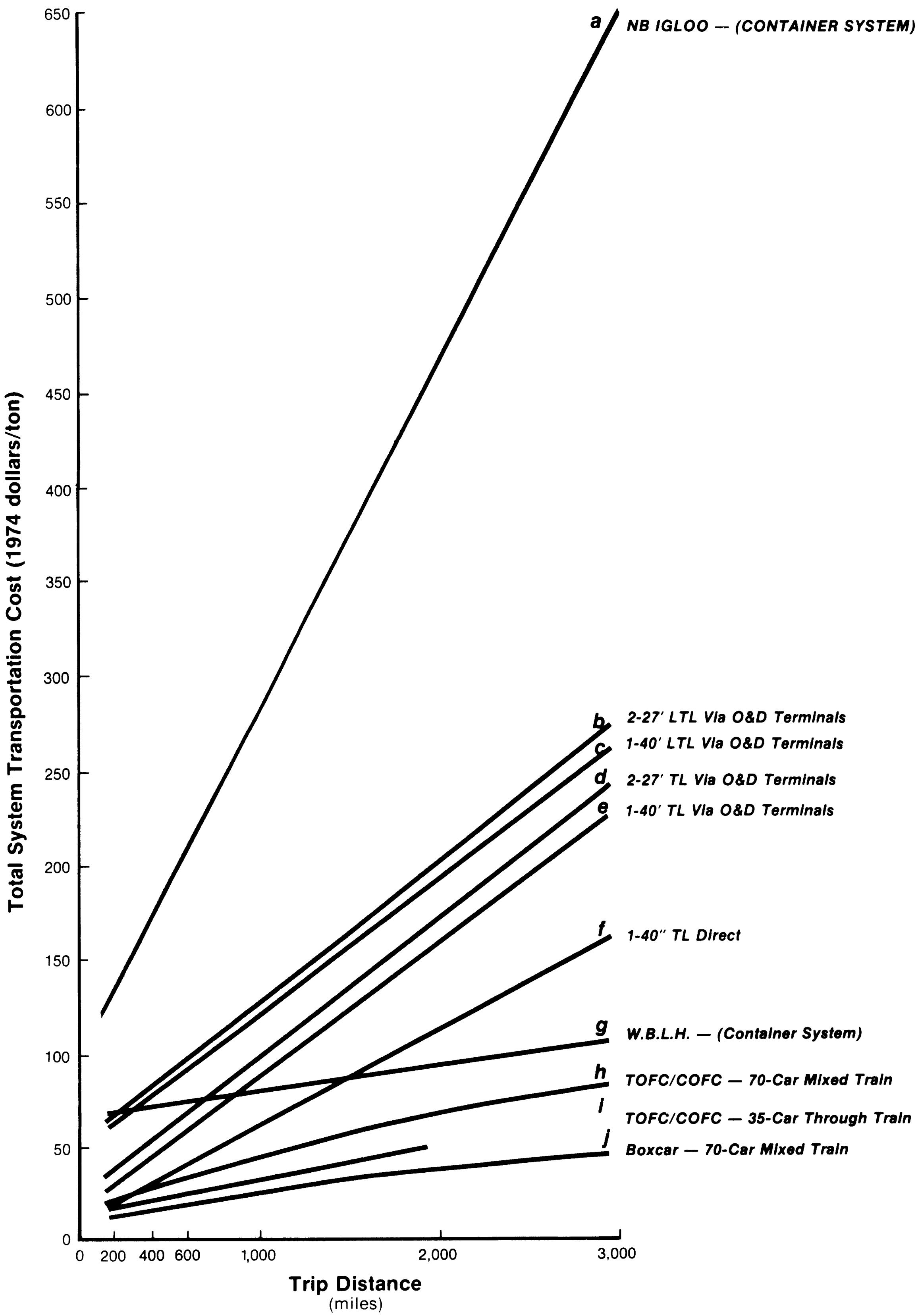
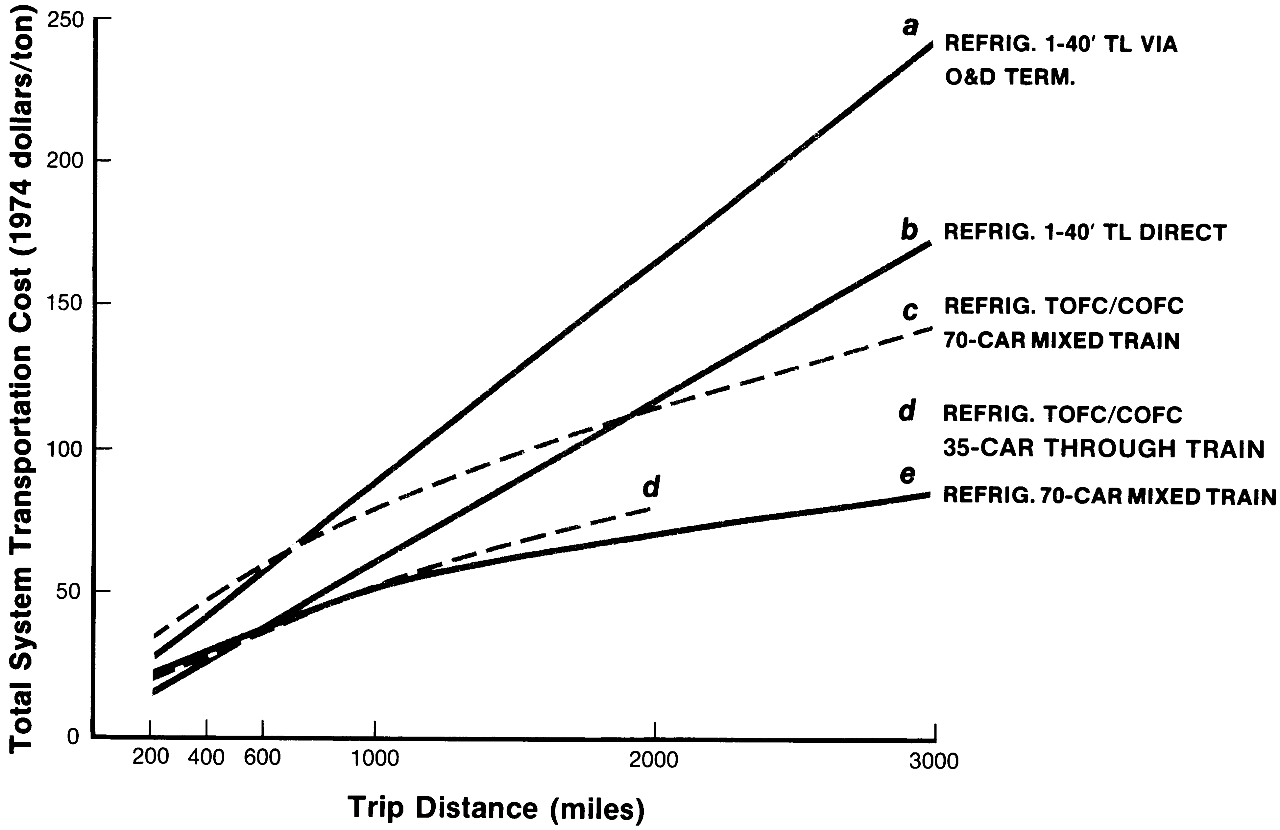


Figure II.32. Door-to-Door System Costs as a Function of Length of Haul — General Service



[1]All costs shown reflect 1974 prices, full capital recovery of investment at an assumed interest rate of 12% for all modes and 1974 replacement and user charges are included in motor carriers costs as a surrogate for highway maintenance expenses. Most other costs are based on the latest available carrier reported data and engineering costs estimates inflated to 1974 when necessary.

Figure II.33. Door-to-Door System Costs as a Function of Length of Haul[1] — Refrigerated Service

relationship changes for different payload densities. An additional discussion on truck capacity appears in chapter VI, the section on sizes and weights.

To determine where the potential lies for improving service or lowering future costs, the comparative costs of each mode must be broken down into the respective input components. Figure II.35 segments the door-to-door system costs for trips of 600 miles by function. In figure II.36, they are segmented by component input within each function, showing the importance of each such input to each mode. These costs have been derived from a composite of all markets and commodities served by the respective modes, as was the case in figure II.32.

The costs of moving freight through 1990 will depend on how labor, energy, and capital costs rise relative to the general economy, and the extent to which they can be offset by gains in productivity. Transportation workers traditionally have been well paid compared to their counterparts in other industries. In 1975, according to the Bureau of Labor Statistics, the average hourly earnings for production or nonsupervisory workers in freight transportation were $6.05 for railroad transportation, $6.19 for trucking and trucking terminals, $6.43 for water transportation, $4.29 for public warehousing, $6.92 for pipeline transportation, and $6.99 for air transportation. These earnings compare with $7.25 for contract construction, $5.90 for mining, $4.81 for the manufacturing sector, $4.13 for finance, insurance, and real estate, and $3.75 for wholesale and retail trade. For the overall economy (i.e., nonsupervisory workers on total private nonagricultural payrolls) the comparable figure was $4.54. There is no reason to believe that this comparatively high

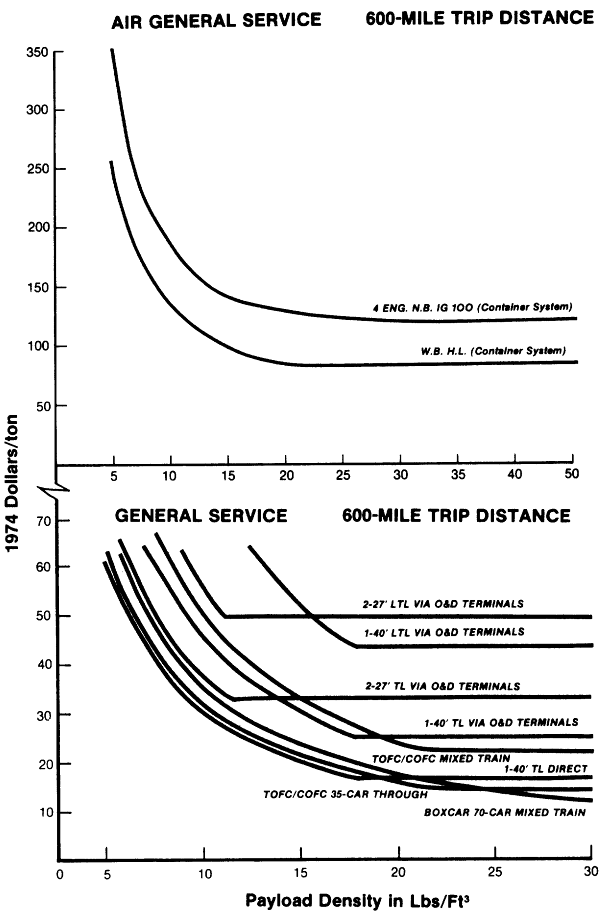


Figure II.34. Door-to-Door System Costs as a Function of Net Payload Density.

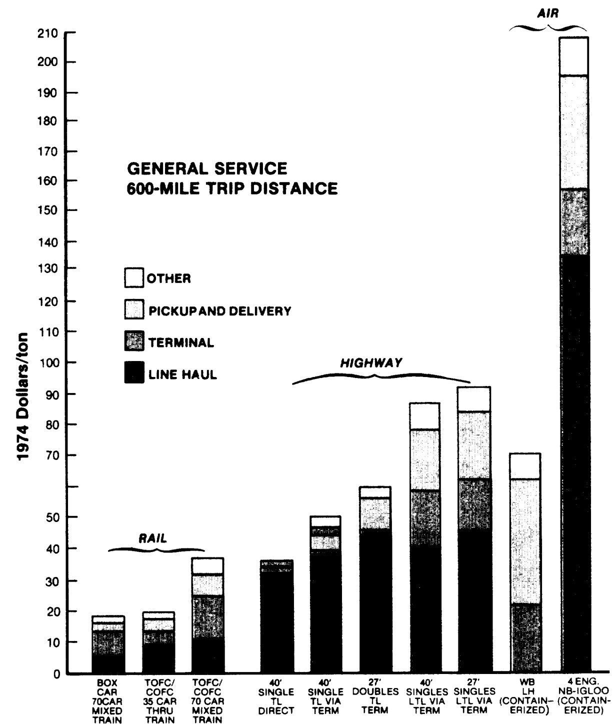


Figure II.35. Distribution of System Costs by Function.

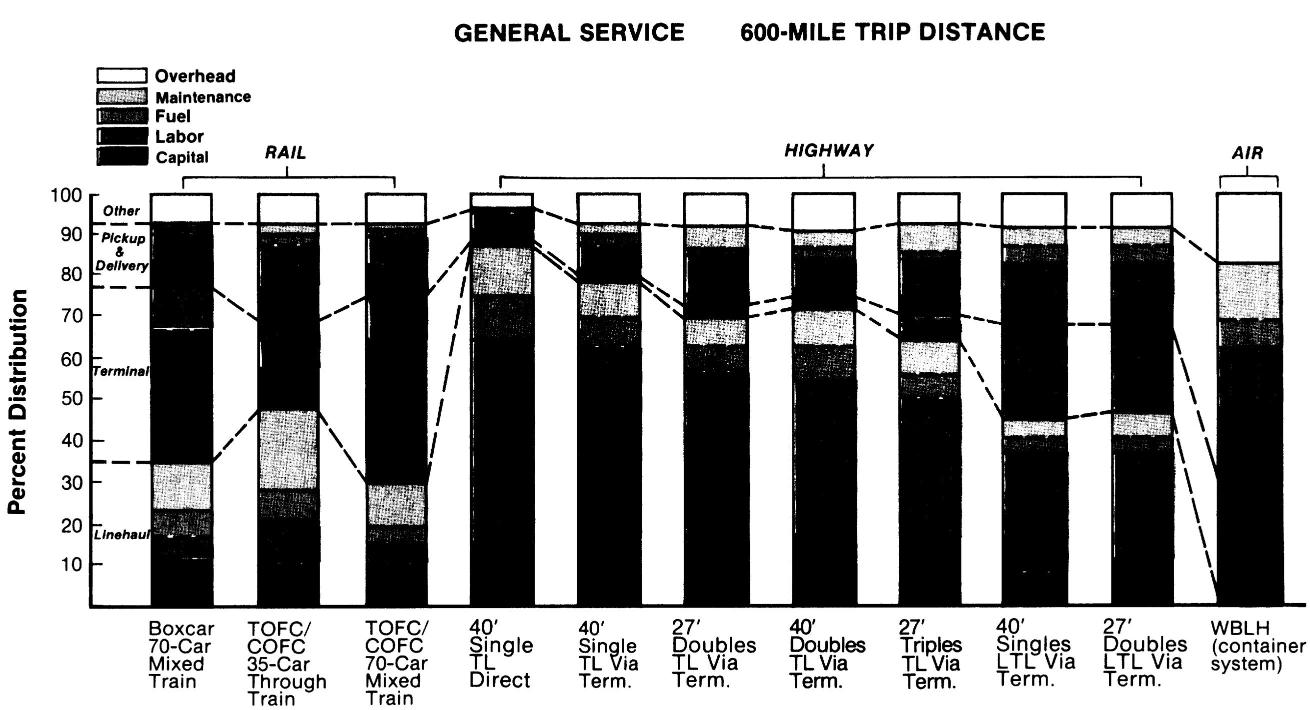


Figure II.36. Distribution of System Costs by Cost Elements.

standing among wage earners in transportation will not continue to prevail.

Many of the near-term opportunities to achieve higher productivity may depend more on institutional change than on technological innovation. In trucking, costs can be decreased through reduced circuitry, reduction of empty bankhauls, and changes in size and weight limits. On the railroads, because of provisions of the RRRR Act of 1976, the abandonment of unprofitable routes, rail network rationalization, increased latitude in pricing, and freedom to seek mergers now offer substantial possibilities for cost reduction.

Patterns of Freight Movement

All demands for freight transportation service are derived from other forms of economic activity. Conversely, the forms and levels of transportation service available influence certain features of economic activity, such as the location of production facilities and, to some extent, the nature of the product. An example of the first may be found in our colonial era, when most cities were located on water because boats, barges, and ships were the principal long-distance freight modes. An example of the second may be found in the western movement across the Appalachians, where very poor freight links were available back to the east coast cities. One result was that farmers who raised grain often chose to convert it to whiskey—a dense, high-value product with good shipping and storage qualities, rather than attempt to transport bulk grain to distant markets.

The character of today's system depends largely on the place and form of today's cargoes and the responsiveness of competing carriers in seeking to satisfy that need; the Nation's future transportation system can be viewed in terms of the expected nature and flows of the 1990 economy and how the competing carriers may respond to them. It is of use, therefore, to link today's flows to today's economy, and then determine how future economic projections may be translated into future transportation flows.

Figure II.37 portrays the estimated volume of freight originating from each BEA region in 1975. It portrays in geographic form the extent to which the economic activity of each area creates demand for transportation services to move commodities from region to region. To demonstrate this most effectively, the ton-miles originating in each region have been chosen as the quantity represented by the shading of that region. The shading reflects interregional but not local movements. The figure shows that there is not a strong correlation between the population of a region and the freight traffic originating there.

Given the relative potential of each region to act as a source of commodities to be moved, the next question of interest is the nature of the geographical patterns of this movement; or, with what levels of intensity do these commodities move among regions in response to the flow of the Nation's economy? This is characterized in figure II.38, which shows an estimate of tonnages moving among the various regions of the country. Such networks are useful for representing general interregional flow patterns, but are not specifically related to any real physical right-of-way or route. In developing the flows through the network, the demand between any two regions is routed over the set of links that yields the shortest path. Over long distances, therefore, the result tends to approximate a straight line, with some circuitry in nearby but nonadjacent regions. Flow volumes on each link are summed, and are shown by the width of the line representing volume. In practice, the traffic flows over existing highway, rail, or water networks. Alternative paths will be used depending on anticipated costs and traveltimes, on route authorities of the carriers involved, or on other factors. These factors are considered in greater detail in later sections dealing with the individual interstate freight modes.

One striking characteristic of the movements indicated in figure II.38 is the heavy density of flows between the Western Gulf and the industrial and populous east coast and Midwest regions. To establish how much of these flows results from energy movement, figure II.39 portrays all freight movements of figure II.38, except for pipeline movements.

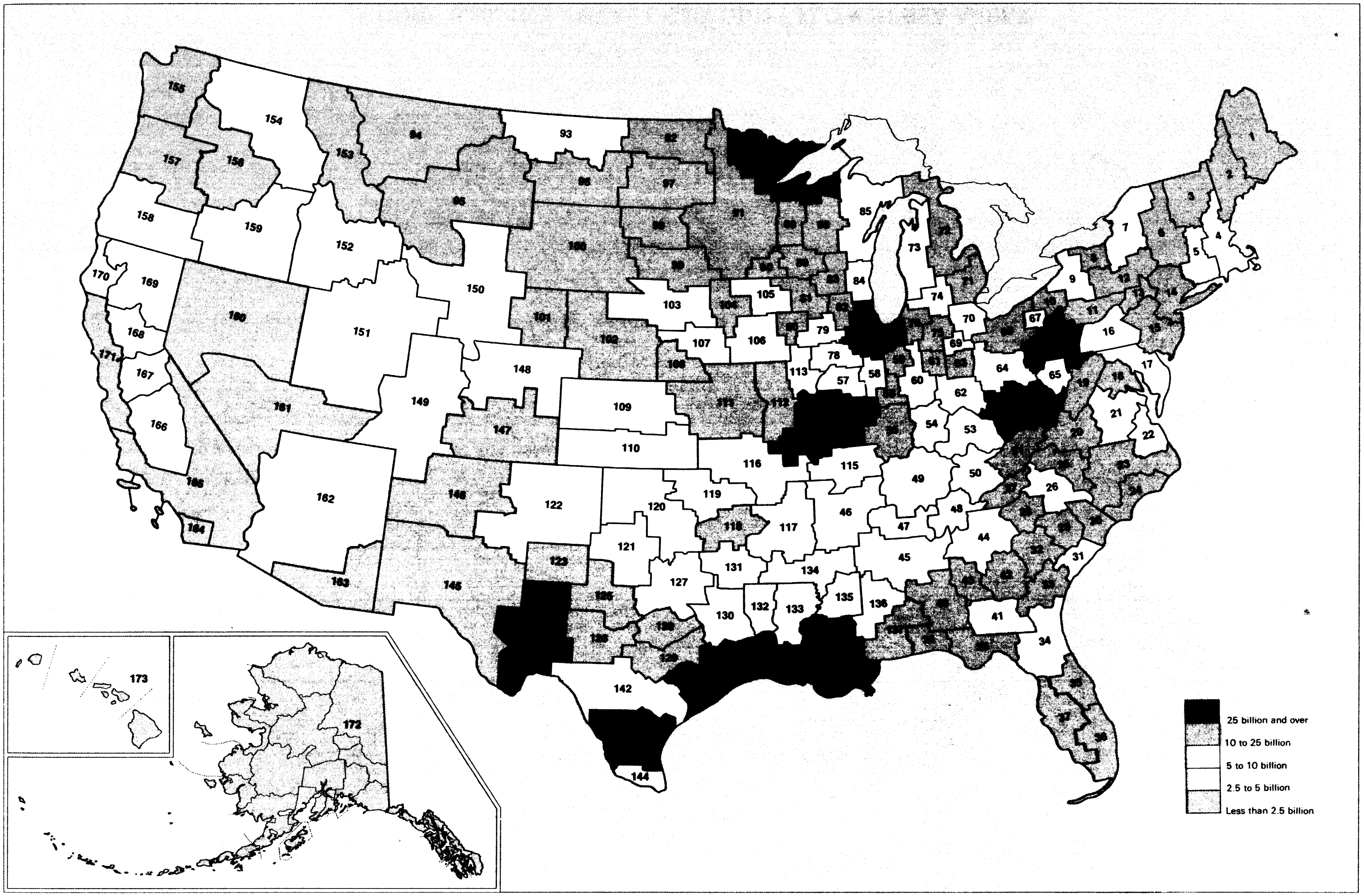


FIGURE II.37. 1975 TON-MILES ORIGINATING IN BEA AREAS.

FIGURE II.38. 1975 TOTAL COMMODITY FLOW IN BEA AREAS.

FIGURE II.39. 1975 TOTAL COMMODITY FLOW BETWEEN BEA AREAS WITHOUT OIL PIPELINE.

The figures pinpoint the corridors of highest density movement throughout our country. This information is of interest to those who see location on a major corridor as particularly advantageous (e.g., because of increased commercial opportunities), as well as to those who view it as particularly disadvantageous (e.g., because of environmental impacts).

The movements in figure II.38 are the aggregate tonnages for the entire 1975 economy. Because the Nation's freight transportation system is relatively mature, in the absence of major technological change it will evolve slowly, so that the system in place today will be in service in 1990 except where reductions are undertaken to eliminate uneconomic duplication. The areas of most interest are those where the greatest changes are to be expected. Therefore refinements of the data presented in the preceding figures would help to determine the nature of the Nation's future transportation system.

For example, if it were possible to separate the movements of raw materials—such as petroleum, grain, and ore—from those of finished commodities such as gasoline, corn flakes, and automobiles—moving toward their final markets, it would be feasible to relate these cargoes to present movements by different modes, and to translate anticipated trends in those segments into changes in future demand by mode. Alternatively, if it were possible to isolate movements within various subsystems of the Nation's economy—such as food production, energy production, and manufacture of finished goods—it would be feasible to apply known trends in each subsystem to compute future shifts in volume and location and deduce where added capacity would be needed.

Figure II.40 provides a preliminary characterization of these subsystems and illustrates the complexities involved. The figure organizes freight movements by commodity class to reflect three basic concerns of the economy: food production, manufacturing, and energy production. These aggregations are imprecise because of data limitations, but they do provide some concept of the flows by geography and commodity that establish the inherent demand for freight transportation.

In figure II.40, the food production system begins with the cultivation of field crops indicated in panel A. The colors indicate, in ton-miles of field crop movements, which BEA regions originate various levels of transportation demand. These commodities are consumed in export markets, in cattle feeding, and the Food and Kindred Products (panel B) sector of the economy. As before, the colors represent the demand for transportation in ton-miles created by the need to transport the output of these industries to other sectors of the economy. This output, however, also represents one measure of the relative demand by BEA region for the products of panel A. In this case, a comparison of panels A and B shows little apparent tendency for firms to locate near their sources of supply. Also, the substantial portion of grain shipped overseas is reflected in panel A, but is not an input to the industries of panel B.

Panels C and D show a similar chain for manufactured goods. The chain begins with our natural resources in panel C. The relative colors indicate the relative ton-miles of transportation originating from those sectors of economic activity designated as Forest and Marine Products, Metallic Ores, Non-Metallic Minerals, and Chemicals and Allied Products. Panel D represents the ton-miles resulting from subsequent stages of intermediate processing and final manufacture. It includes the output of Lumber and Furniture, Paper and Allied Products, Primary Metal Products, Electrical Machinery, Non-Electrical Machinery, Textile Mill Products and Apparel, Transportation Equipment, Fabricated Metal Products, and Other Manufactured Commodities. The shadings in panel D show the broad geographic distribution of that kind of economic activity.

The chain of production of energy is seen in panels E and F. Panel E shows the relative tonnage outputs from Coal and Crude Petroleum. Panel F shows where and to what extent these tonnages are converted into Petroleum and Coal Products. In this case, the tendency for processors to locate near their sources of supply appears stronger. However, the supply-and-demand relationship between the industries represented is especially imprecise. A significant proportion of petroleum products, in the form of petrochemical feedstock, becomes input to the textile manufacture included in panel D, and, in the form of fertilizer, to the cultivation of field crops in panel A. Approximately 15 percent of all the coal consumed in this country is used in steel production. Energy in some form is a required input to all of the industries depicted in the other panels.

Figure II.40 provides a preliminary indication of how activity in the various subsectors of the economy generate transportation demand. The complexities of representing interregional movements of different commodities in our diverse economy at a more detailed level also becomes apparent. Further, the data must be interpreted carefully and treated as approximate, because they are subject to certain limitations, such as the standing confidentiality restrictions imposed on all data of this type by the Bureau of the Census. Input/output analysis provides much more precise information on how the outputs of each industry in our economy provide inputs to the other industries, but geographical portrayal is difficult.

Finally, panel G depicts the geographic pattern of national freight consumption for all commodities and all regions, by aggregating ton-miles of movement at the destination points rather than the origin points. A question immediately arises from studying panel G. Why is the distribution of consumption of ton-miles not more comparable to the national population distribution? One answer is that much freight transportation is consumed in the form of moving bulk commodities from mines, wells, and farms. A second is that only interregional movements have been accounted for. Finally, considerable volumes of freight move to plants where multiple diverse inputs are assembled from many locations, and, in such cases, the producers and manufacturers often find it most profitable to locate facilities where the proximity to each source and market is best balanced to minimize total transportation expense.

Projections of Freight Flows for 1990

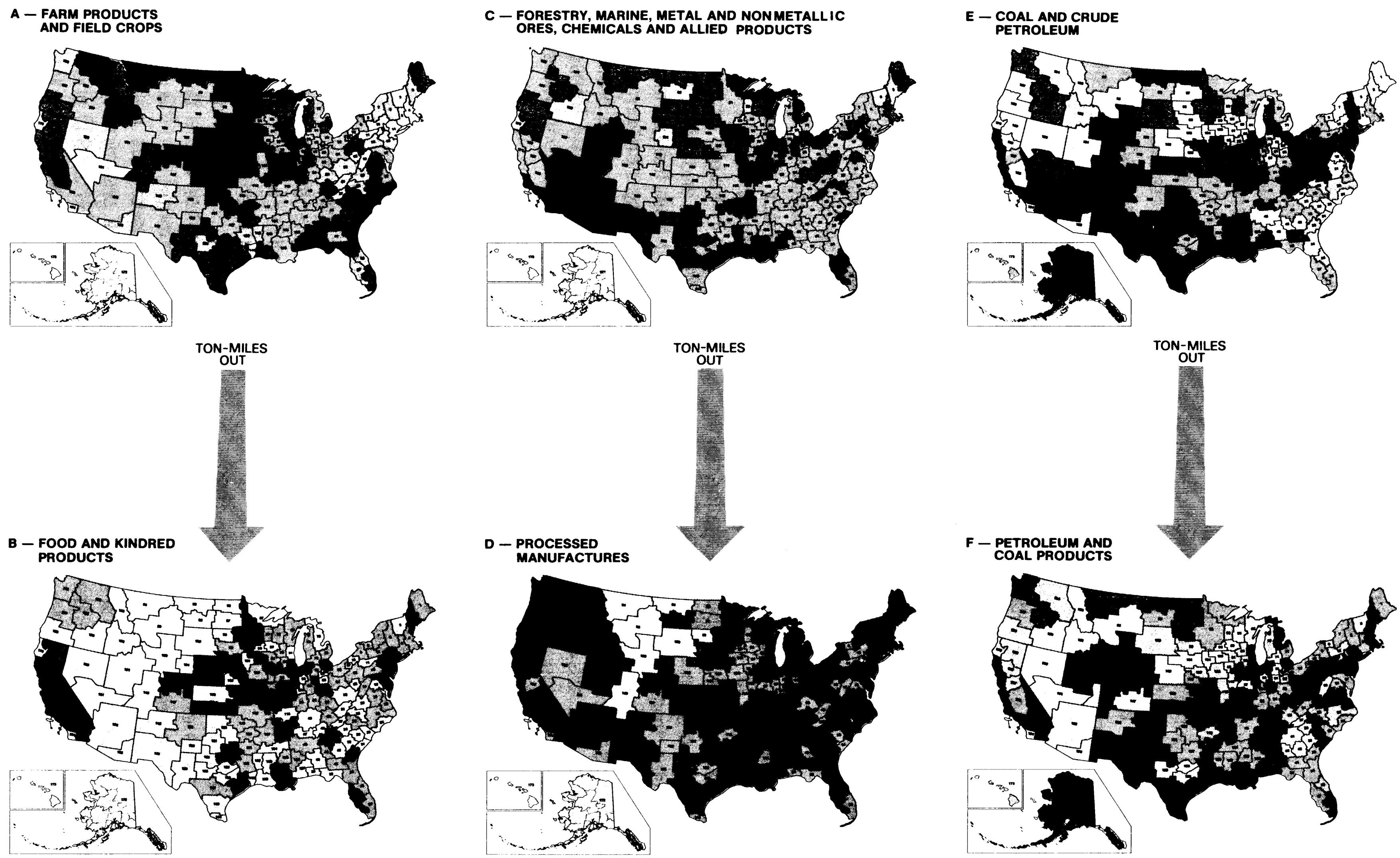
The estimates of the 1975 freight movements provide the setting for examining future freight flows and, in particular, changes that can be anticipated over present patterns. For this purpose, projections have been made of 1990 freight movements (fig. II.41).

Before these projections are analyzed in detail, however, it must be noted that, although they represent our best estimate of future demand patterns, they are subject to all of the necessary qualifiers and cautions that apply to any such projections. In particular, they are based on very limited data. The projections do not represent a refinement of continuous time series; they are interpretations and extrapolations of several partial sets of available data. Each was subject in varying degree to the aforementioned confidentiality restrictions, as well as to the need to aggregate commodity groupings to match the OBERS regional growth projections.

Figure II.41 portrays the expected volume of freight originating from each BEA region, based on the OBERS projections of 1990 economic activity. It is comparable with the 1975 movements shown in figure II.37 measuring freight ton-miles. The increase between 1975 and 1990 may be seen for many regions, an average increase of 69 percent is expected.

A direct comparison of 1975 and 1990 traffic density appears in figure II.42. Marked changes in freight transportation demand between 1975 and 1990, however, are expected to result from the planned new movements of coal from the northern great plains, and from the highly increased production of agricultural products and their transportation to coastal points for shipment overseas. The projected development of low sulfur western coal reserves, as part of the overall Federal Government energy program, is described in chapter V, under Future Energy Movement. The impact of this change may be seen in figure II.43, which augments figure II.42 by including projected coal movements.

It is apparent from figures II.42 and II.43 that substantial capacity problems may be anticipated in certain regions and, in particular, for certain modes. These capacity problems will depend not only on increased demand, but on the proportion of the 1990 traffic that will move on each mode, and the degree to which capacity increases have been provided. Table II.11 portrays a preliminary estimate of modal volumes for 1975. 1980 and 1990. Table II.11 assumed that each mode would capture the same


A — FARM PRODUCTS
AND FIELD CROPS
TON-MILES
OUT
B — FOOD AND KINDRED
PRODUCTS
C — FORESTRY, MARINE, METAL AND NONMETALLIC
ORES, CHEMICALS AND ALLIED PRODUCTS
TON-MILES
OUT
D — PROCESSED
MANUFACTURES
E — COAL AND CRUDE
PETROLEUM
TON-MILES
OUT
F — PETROLEUM AND
COAL PRODUCTS

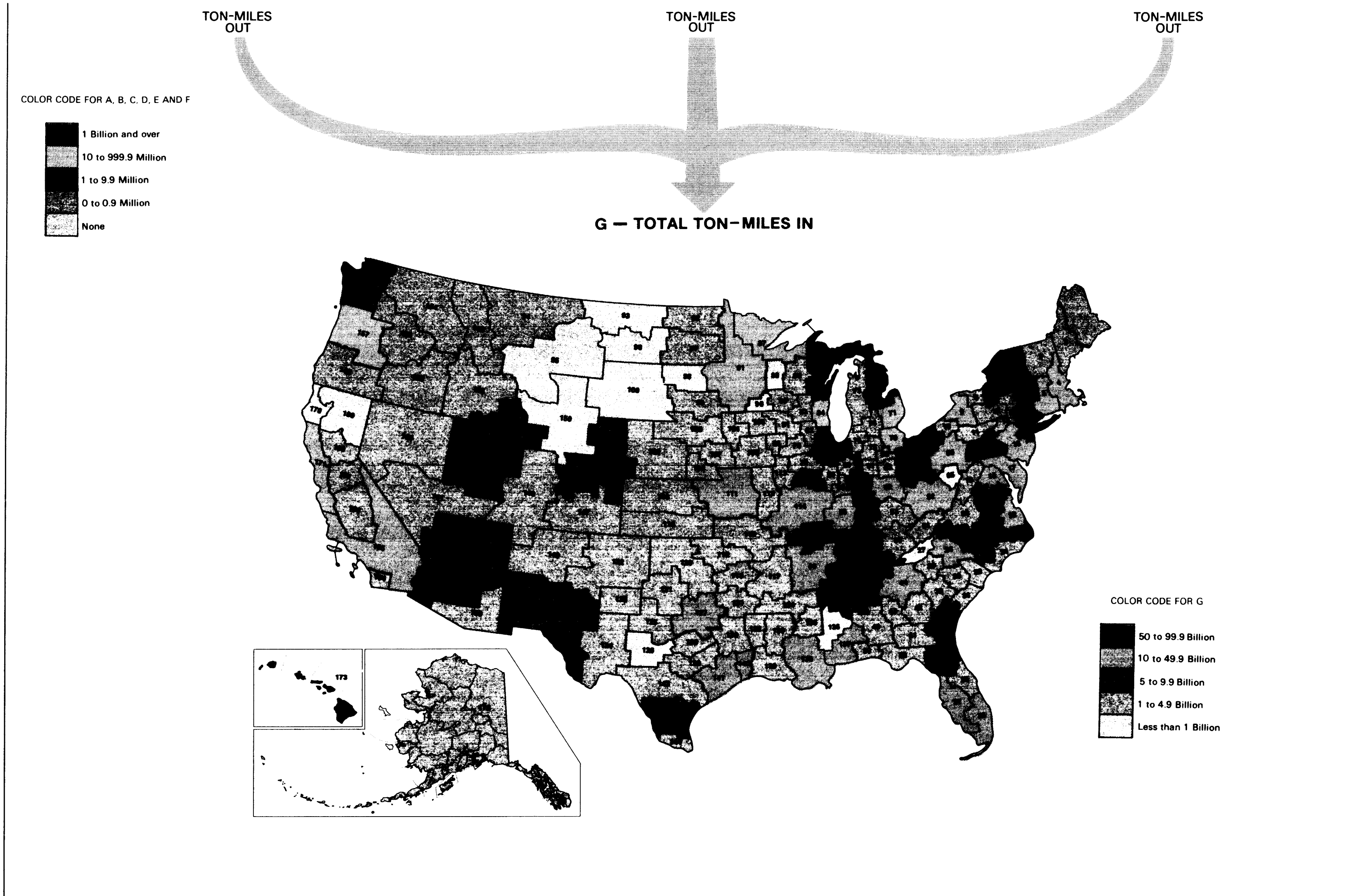


FIGURE II.40. 1975 TON-MILES BY COMMODITY GROUPS.

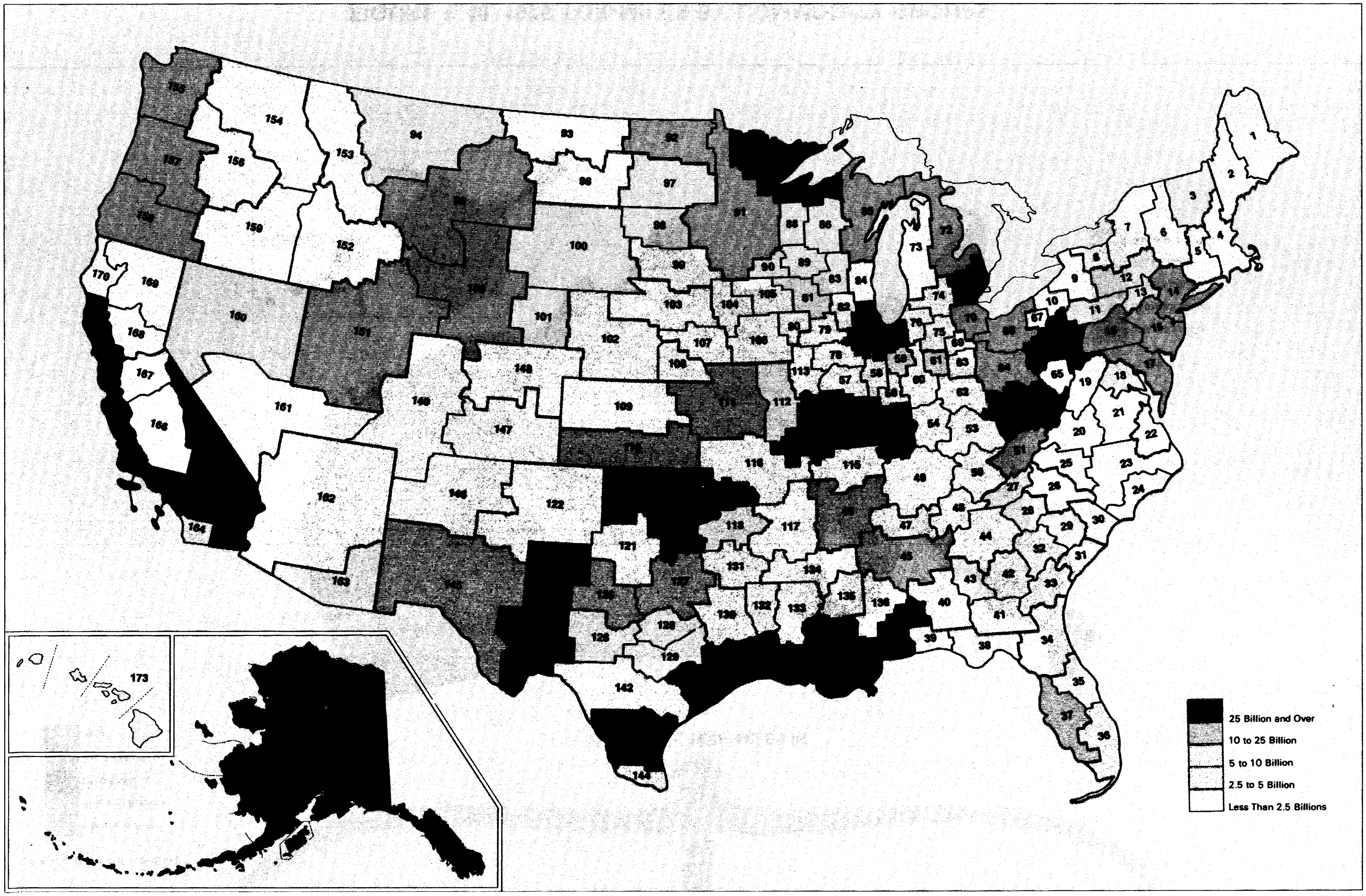


FIGURE II.41. 1990 TON-MILES ORIGINATING IN BEA AREAS.

proportion of traffic of a given commodity class between each pair of OBERS regions that it captured in 1972, and that the distributions of destinations for each origin by commodity is constant. Based on these assumptions, total tonnage carried by all modes is expected to increase by 62 percent between 1975 and 1990. Ton-mileage is projected to increase by 98 percent. While one may object that for one reason or another the relative shares could not possibly be the same as those of 1972, this simplification represents a reasonable base from which to undertake additional analysis.

Table II.11
Projected Percentage of Movement By Modes With Percent Increase 1975 to 1990

Year	Rail	Water	Motor Carrier Tonnage	Private Truck	Air	Pipe-line	Total Volume
Tons:							**(million tons)**
1975	26	17	10	30	1	17	5596
1980	32	16	9	27	1	16	6080
1990	32	16	13	23	1	16	7754
1975-90	66	31	82	5	116	37	
Ton-Miles:							**(billion ton-miles)**
1975	33	25	9	11	2	22	2273
1980	30	23	7	9	2	21	2869
1990	42	20	10	7	2	21	4127
1975-90	130	49	101	11	125	70	

It may be argued that relative shares among the modes will change slowly, because each mode will counter innovations by competing modes with offerings that will keep it as comparatively attractive as before. That is not to say that shifts will not take place, and chapter V presents an analysis of how alternative future resolutions of certain policy issues before the Nation will influence these shares.

For these discussions, however, it will be especially useful to have a baseline projection with which to compare the impacts of the various outcomes. The assumption of comparable shares in 1990 will provide a reasonable point of departure. It also offers compatible results (for queries posed in the context of impacts in 1975), had the policy alternative been in effect then.

Local Freight Movement

Local freight movement primarily includes local pickup and delivery of commercial establishments, as well as local automobile shopping trips. As such, the economic factors that influence such activities are quite different from the line-haul movements discussed earlier. For rail, air, and certain highway modes, local activities account for approximately one-half or more of the total costs for a 600-mile trip distance. The features that differentiate local from interstate freight movement are the limited modal choice, the characteristics of the routes, the multifunction role of drivers, and the sometimes implicit advertisement that transportation is used as an extension of the image cultivated by commercial establishments.

Local transportation is based primarily on use of the ubiquitous street network. Therefore, the options for local freight movement are generally restricted to trucks and automobiles. Estimates indicate that the total annual mileage of automobile shopping trips is about 56.4 billion—or more than twice the 23.4 billion miles for truck pickup and delivery.

The major factors influencing costs and service levels of local commercial truck transportation may be identified by considering the unit of work to which a vehicle and driver are assigned. Usually, a truck and driver are dispatched once a day to make a series of deliveries or pickups at a number of stops. Regardless of whether its purpose is for pickup/delivery for an intercity movement, distribution from warehouse to retail, or delivery from retailer to consumer, every journey has the following components:

- *Terminal activities*. As part of every pickup/delivery journey, the driver (or helper) must perform certain duties at the beginning and the end of the journey while the truck is parked at the terminal. These duties may be as simple as picking up the appropriate paperwork or starting the truck engine and driving away, or as time consuming as loading a truck full of furniture. Typically, terminal activities include loading the truck at the beginning of the journey, unloading at the end, discussion with supervi-

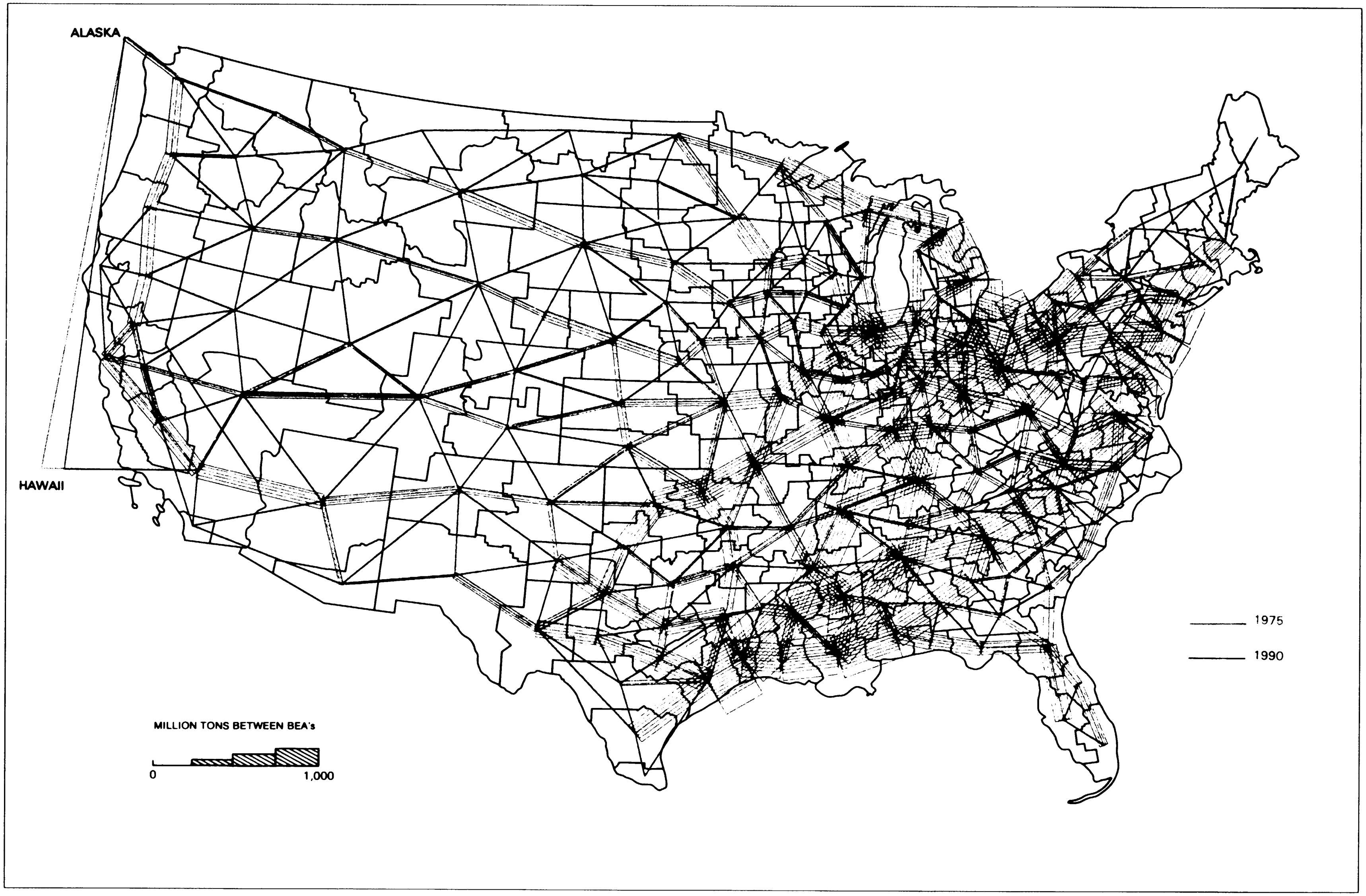


FIGURE II.42. 1975-1990 TOTAL COMMODITY TONNAGE FLOW BETWEEN BEA AREAS WITHOUT WESTERN COAL.

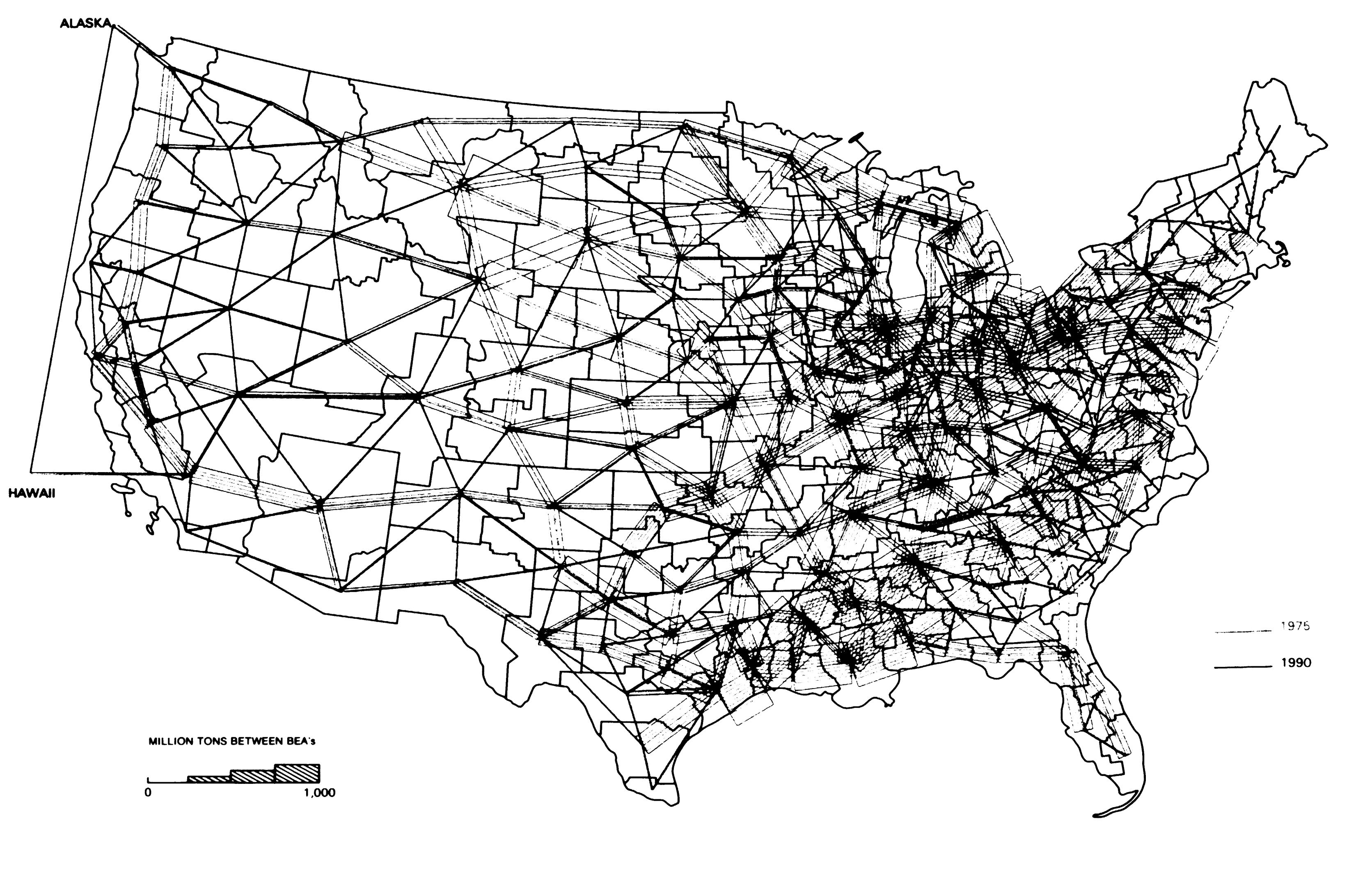


FIGURE II.43. 1975-1990 TOTAL COMMODITY TONNAGE FLOW BETWEEN BEA AREAS WITH WESTERN COAL

sors or managers, vehicle and load checkout, and settlement of cash receipts.

- *Stem driving*. Most fleets used for pickup and delivery contain several trucks. For efficiency, the local area is usually divided into zones, with each truck assigned the pickups or deliveries in a particular zone. These zones may remain the same from day to day, or they may vary depending on demand. The travel of each vehicle between the terminal and the pickup zone for that day is called "stem driving," an analogy to the stem of a flower.
- *Zone driving*. The geographic area between the first and the last stop in a journey is usually relatively concentrated (at least compared to stem driving). If stops are highly concentrated (as with mail, newspaper, or refuse collection), the distance between stops may be as short as one-tenth of a mile or shorter. Other segments (e.g., furniture, electrical appliance, or armored express) may have a very low density of stops, and many driving miles between them. In others (e.g., ready-mix concrete, or bricks and lumber for construction sites) the volume of the product can be made in one journey. In this case, there is no zone driving at all.
- *At-stop activities*. Once a pickup delivery vehicle is parked at an individual stop, the driver (and helper, if any) performs those duties necessary to "serve" that stop. Depending on the type of stop (pickup, delivery, servicing), these duties may include the following:

a. Picking and preparing the order from stock carried on the vehicle or finding a prepackaged order

b. Gaining admittance to the stop

c. Transporting the order into the stop

d. Placing the order in its appropriate location, which may include stocking shelves (as with bakery products, newspapers, or vending)

e. Performing services at the stop (telephone repair, appliance repair, taking an order)

f. Communicating with an authorized person to confirm delivery, handle paperwork, or collect cash, which often involves communication with a manager who is physically removed from the point of delivery

g. Picking up goods to be transported to the truck, which may be a primary function of the stop (e.g., air freight pickup, refuse pickup) or a secondary activity such as the pickup of empty returnable soft drink bottles or soiled laundry (Note that goods are often picked up in a location within the stop different from where goods were delivered.)

h. Returning to the truck (transporting the pickup if one was made)

i. Securing the vehicle and completing necessary paperwork

j. Pulling away to drive to the next stop

Terminal activities, stem driving, and zone driving are all supportive to the prime purpose of the routes—performing duties at stops. Therefore, the greater the reduction of these activities relative to productive duties at stops, the more efficient the goods movement process.

Table II.12 reveals the wide difference in the amount of time devoted to various components of the working day. In most routes, stops require approximately 50 percent of the time allotted to the route. Table II.13 indicates that, although local pickup and delivery of goods and services represents only 2.3 percent of the vehicles and 27.3 percent of the miles, this activity incurs more than three-quarters of all freight movement costs.

The role and responsibilities of the driver are greatly expanded over those of an interstate truck driver. The driver is responsible for all the activities at the stops, including sales, stocking of shelves, and extensive paperwork. Therefore, the delivery of commodities cannot simply be replaced by a new system that does not replace the multifunctions of the driver.

Local freight movement is often constrained by the promptness of and image projected by deliveries from company trucks. Therefore, an advertisement is implicit in many local freight activities. As a result, firms must constantly balance the achievement of exemplary levels of service with minimizing the costs of transportation. This extension of the commercial image frequently inhibits route and delivery collaboration among firms.

Local freight movement may contribute heavily to congestion, energy consumption, air pollution, noise pollution, and inefficient land use. The space in downtown areas necessary for staging deliveries, for unloading at receiving docks, and for proximate storage has been a major problem. More effective use of this space, which would improve the flow of traffic through urban areas, promote energy conserv-

Table II.12
Summary of Vehicle Day Composition by Activity[1]

Product Group	Number of Vehicles	Per Vehicle Day: Terminal Hours/Day	Stem Drive Hours/Day	At-Stop Hours/Day	Zone Drive Hours/Day	Total Hours/Day	Total Annual Hours (thousands)
Services	491,880	.74	1.10	4.70	2.41	8.95	1,102,437
Food	308,095	.71	1.56	3.48	3.08	8.82	679,841
Paper	137,069	.76	1.45	3.67	2.16	8.04	275,463
Energy	116,516	.66	1.86	4.28	1.27	8.06	234,974
Beverages	86,237	.71	.74	6.43	1.10	8.98	193,683
Building Products	79,726	.74	2.53	3.35	0	6.62	131,935
Durable Consumer Products	62,917	.69	1.92	2.88	3.00	8.50	133,660
Consumer Nondurables	51,047	.73	1.77	2.61	3.87	8.97	114,545
Total	1,333,487						2,866,541

[1]*Does not include intercity freight pickup/delivery.*

Table II.13
Summary of Local Goods Movement[1]

Type	Vehicles (thousands)	Percent	Miles of Travel (millions)	Percent	Annual Cost (millions of dollars)	Percent
Local Pickup/ Delivery	1,333	2.3	21,736	27.3	31,842	76.5
Intercity Pickup/ Delivery	163	0.3	1,638	2.0	3,511	8.4
Auto Shopping Trips	56,930	97.4	56,390	70.7	6,259	15.1
Total	58,426	100.0	79,764	100.0	41,612	100.0

[1]*248 urbanized areas only.*

ation, and reduce pollution, holds considerable promise for future planning. Table II.14 compares causes and effects.

Transportation of Hazardous Materials

The movement of hazardous materials as a feature of the Nation's freight transportation, is a cause of concern, but it is vital to public health and to industrial production. This point is exemplified in that for one of every nine hospital patients, treatment by some form of radioactive material is necessary to life maintenance.

The movement of these materials presents several unique transportation problems. Hazardous materials are frequently difficult to identify. There are no universally accepted common definitions of toxicity for different products. Moreover, products not considered hazardous per se may, through interaction, become dangerous when shipped in close proximity to certain other substances. Finally, indication that materials to be transported are hazardous or potentially hazardous essentially depends on proper labeling by the shipper, rather than on action by the carrier.

Hazardous materials regulated for safe transportation include several hundred thousand items. These products are classified and categorized into one or more of several generic classifications: explosives, flammable liquids, flammable solids, oxidizing material, corrosive material, compressed gases, poisons, radioactive materials, and etiologic agents. Approximately 30,000 hazardous items are considered of commercial significance, and the list is growing with development of new materials and with new discoveries of certain harmful effects of previously unregulated materials on people or the environment.

Safety in transporting hazardous materials must begin with the manufacturer of the container. Materials may be transported in bulk, using specially configured vehicles such as tank trucks, or in individual packages, which might be carried as part of general cargo. Many containers used to transport hazardous materials are highly sophisticated. When properly packaged, these materials pose little or no risk, even in transportation accident situations.

American manufacturers are involved yearly in exporting and importing about $8.8 billion worth of hazardous materials ($5.9 billion worth exported and $2.9 billion worth imported). As of 1975, there were more than 250,000 shipments of hazardous materials each day.

Table II.14
Causes and Effects of Urban Goods Movement Problems

Causes	Fundamental Effect on:						Secondary Effect on:					
	Costs	Congestion	Energy Consumption	Air Pollution	Noise Pollution	Land Use	Costs	Congestion	Energy Consumption	Air Pollution	Noise Pollution	Land Use
Number of Stops	X		X	X								
Number of Routes	X											
Number of Helpers	X											
Vehicle Cost (per mile)							X					
Inefficient Terminal Configuration							X					
Institutional Operating Restrictions: Government, Union, and Tradition							X					
Underutilization of Technology: Management, Handling							X					
Stem Driving During Peak Hours		X										
Lane Blockage on Arterials		X										
Improper Matching of Receiving Facilities to Needs		X										
Large Trucks								X		X		
Number of Auto Shopping Trips			X	X								
Excess Vehicle Capacity (relative to load)									X			
Low Speeds, Stop and Start Traffic Conditions									X	X	X	
Inappropriate or Improperly Maintained Engine or Exhaust Systems									X	X	X	
Congestion									X	X		
Use of Trucks with High Noise Emission for Urban Goods Movements					X							
Closeness of Noise Source to Receiver											X	
Suboptimal Land Use Decisions						X						
Gradualism of change												X

Table II.15 indicates the quantity of hazardous materials transported by the various modes, as well as the change in volume of traffic, in millions of tons, between 1967 and 1980. It is estimated that the total traffic will double sometime between 1985 and 1990. However, the simple measure of tons in no way reflects the variety of problems or potential dangers involved.

Radioactive materials transported by air are one of the most important life-saving products being shipped and transported today. These packages are normally small and contain radioisotopes, radiopharmaceuticals, and other materials necessary in the treatment of human beings. Many have a very short half-life that requires high speed air and highway movement. Figures reflecting the transportation of radioactive materials in 1968, and 1973, and projected to 1980, are given in table II.16.

Table II.15
Volume of Traffic of Hazardous Materials[1]
(Millions of tons)

Mode	1967	1973	1980	Increase in Traffic 1967-1980	Increase or Decrease in Percentage of Total Shipped (1967-1980)
Highway	512	656	800	56.3%	Increase 28.7 to 29%
Railroads	149	172	195	30.9%	Decrease 8.4% to 7.1%
Water Carriers	414	437	470	13.5%	Decrease 23.2 to 17.1
Air Carriers	Approximately .2 percent of overall quantity is the air share of traffic with as much as .35 percent at some future date. Based on these figures, air carriers transported approximately 4,53 million tons during 1973.				
Liquid Product Pipelines	709	N.A.[2]	1,290	81.8%	Increase 39.7% to 46.8%

[1]Many products not now regulated may be regulated in the future. This fact may radically affect these figures which relate to regulated products in transportation.
[2]Not available.

The safety record for the transportation of hazardous materials is remarkable in view of the very large volume of such shipments. There were 27 fatalities associated with the 2.3 billion tons of these materials shipped in 1975. However, the shipment of hazardous materials is expected to grow faster than that of other commodities over the next 15 years. While such movements are expected to double their 1967 levels by 1990, total freight ton-miles are expected to increase by about 75 percent over the same period.

To deal effectively with this growth, enforcement of safety regulations must start at the source—the container manufacturer and the shipper. In general, the object is to package the material for shipment so as to protect and contain it, to handle it in a manner to minimize the chance of an incident, and, in the event of an accident, to minimize the resulting damage. This effort should continue through all modes of transportation, starting with the producers of the material and the shipping containers used, through the carriers and intermediate handlers (including possible intermodal transfers), to the final recipient. Law enforcement, fire, rescue, and emergency personnel of localities along the shipment route are an integral part of the system. They may have to deal with material in the event of an incident.

Cargo Security

Another problem primarily related to freight movement is the loss of cargo through theft. Nationally, this loss was estimated at the billion dollar level for calendar year 1974. This estimate must be compared to the transportation industry gross operating revenues, which total some $140 billion.

Trends for federally regulated air and motor carriers of cargo indicate improved control of cargo theft. Air carrier statistics show unmistakable progress in reducing the ratio of theft losses to gross revenues, while those for class I motor carriers show a very slight improvement. There are insufficient statistics from the rail carriers to be conclusive.

As figures II.44 and II.45 show, losses from hijacking and robberies are relatively small, at 2 percent and 1 percent, respectively, of all theft-related losses. Most losses are to employees, customers, and others with legitimate access to the premises. Thus, this problem can be controlled by minimizing opportunities for theft through improved management of goods storage and transfer, tightened accountability procedures, and more stringent hiring practices.

Table II.16
Radioactive Materials Transportation

	Tons of Radioactive Materails Shipped[1]		
Mode	**1968**	**1973**	**1980**
All Modes	17,000	65,000	163,000
	Number of Packages Shipped[2]		
	1971	**1972**	**1973**
Highway[3]	135,000	160,000	180,000
Railroads	1,200 to 2,500	1,500 to 3,000	2,000 to 4,000
Water Carriers	600 to 1,500	800 to 1,600	1,000 to 2,000
Air Carriers[3]	600,000	680,000	780,000

[1] *Transportation shipments are increasing at about 22.8 percent per year.*
[2] *Packages of radioactive materials range from lightweight to packages weighing several thousand tons.*
[3] *Although these figures reflect principal carrier movement, it must be recognized that air shipments are usually intermodal consisting of combined air-highway traffic.*

MODAL COMPLEMENTARITY

Introduction

The preceding sections made clear that each mode possesses unique physical and technological features, which provide inherent cost advantages when supplying certain kinds of transportation service. The automobile, for the most part berthed at home and capable of using our ubiquitous roadway system, offers great convenience at what the user thinks is low cost for many travel purposes. When speed is important, air carriers can transport over great distances. Intercity buses provide public, low-cost, convenient service linking nearly all of the Nation's cities and towns of over 2,500 population.

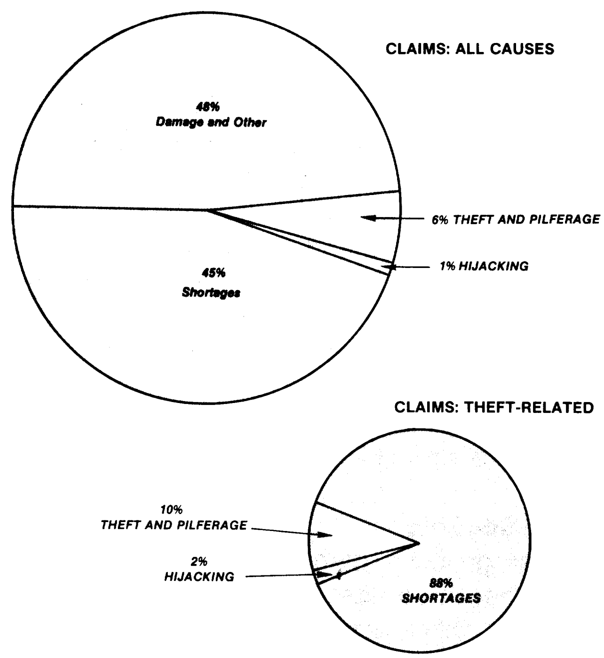
Motor carriers, taking advantage of an extensive highway network, partly paid for by the private automobile user, can provide rapid door-to-door service for a broad range of commodities of varying sizes and quantities, and with great flexibility as to pickup and delivery times and nature of service. Water carriers handle bulk commodities at very low cost, but at less speed, and only between regions having waterways of the proper width and depth. Railroads can transport a broad range of commodities from almost any source of supply to any point of demand. But railroads suffer from underuse in many areas, and must now decide which rights-of-way should be preserved to maintain the overall economic viability of their service. Air carriers and intercity buses can deliver high-value goods overnight. Pipelines transport vast quantities of natural gas, crude oil, petroleum products, chemicals, and even some solids throughout our country at very low cost—but only after massive capital investment, and only from a specific set of origins to a specific set of destinations.

Because of these special advantages, our system has evolved in such a way that the modes both compete with and complement each other. Competition is important because it acts to assure the continual maximum efficiency of each mode. At the same time it provides for a rational allocation of the market demand among modes, based on each making best use of its operational and technological advantages. On the other hand, complementarity is also vital because few of these modes are capable alone of supplying the complete range of services required by the market.

This becomes more apparent when transportation is viewed in terms of its three functions of goods collection, line haul, and distribution. For intercity line-haul service by air, bus, or rail, most people come to the airport or station by automobile or bus. At the end of the trip they reach their ultimate destination by similar means. In freight shipments, many goods are collected by truck and taken to the appropriate terminal for line-haul movement by rail or water. At the other end of the movement, they are again frequently distributed to their ultimate consignees by truck. Approximately 13 million ton-miles of freight are delivered daily to rail or water terminals by truck.

There are also innumerable instances of competition and complementarity within each function. For example, the line-haul movement of ore from Labrador to the steel mills of Pennsylvania may be by either ocean vessel to the ports of Philadelphia or Baltimore and thence by rail inland, or by lake boats down the St. Lawrence River to Lake Erie ports for consumption at lakeside mills or for rail shipment to Pittsburgh and Johnstown. The movement of grain from farm to overseas port may be by truck to railhead, by rail to river port, and by barge to ocean port. Thirty-nine percent of liquified petroleum gas is transported by a combination of highways and pipeline movement.

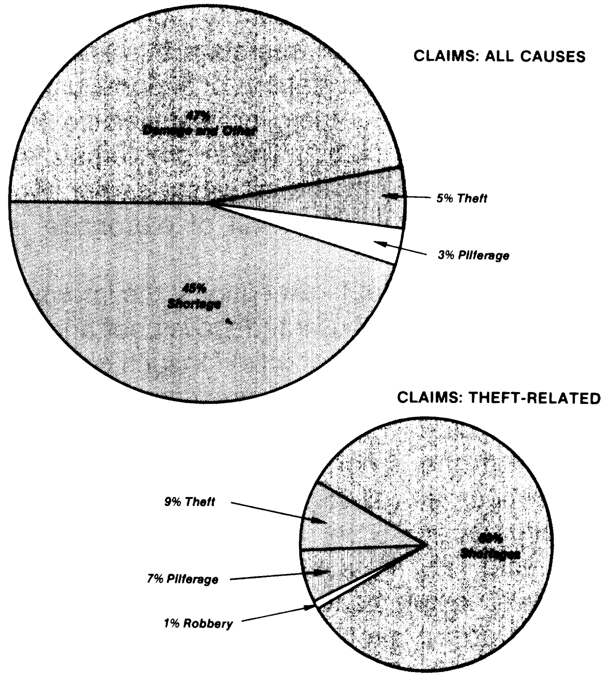
Another form of complementarity appears in the common use of facilities and equipment. Amtrak uses track whose primary function is hauling freight. Air cargo moves in jet planes whose primary function is carrying passengers. Railroad flatcars carry truck trailers full of goods, and car-trains carry both passengers and their cars.



Source: Interstate Commerce Commission, Quarterly Freight Loss and Damage Reports averaged over 3 years.

Figure II.44. Class I Motor Carriers: Distribution by Percent of Claims Paid for All Causes Including Theft.

The potential for intermodal services for the most part remains unrealized, however. The exploitation of the possible efficiencies of modes working in combination has been inhibited by a legacy of fragmented transportation planning, physical, legal, and institutional barriers. The improvement of these intermodal interfaces and common use of facilities represent a potential source of future gains in the efficiency or productivity of the nation's transportation system. These difficulties may be focused in three main areas: the physical interface, the information interface, and, denial of common ownership of different modes.



Source: Civil Aeronautics Board, Quarterly Air Freight Loss and Damage Claims Report averaged over 3 years.

Figure II.45. Certificated Air Carriers: Distribution by Percent of Claims Paid for All Causes Including Theft.

Complementarity in Passenger Movement

Physical Interface. Technological advancement has led to constantly improving line-haul speeds for many kinds of passenger systems. While this potential to reduce trip time is of great importance, it has often tended to deemphasize the consideration of the total portal-to-portal time; substantial time penalties occur in transferring between terminals or from portal to exchange point to terminal. The significance of this loss increases as the overall trip length declines, and while it is less prohibitive cross country, in the journey to work it has diverted many commuters from mass transit systems, although their line-haul speeds may be favorable. Thus, one of the major potentials for attracting additional ridership to mass transit systems lies in improving the efficiency of making transfers at junction points between modes. Often this improvement can be made through physical design. For example, adequate parking lots can be provided at mass transit stops (park-and-ride), service areas can facilitate the auto-to-mass-transit transfer (kiss-and-ride), multimodal terminals can be colocated to minimize the need to walk from one modal portal to the other, route stops can be located at large office buildings or commercial centers. Alternatively, schedules could be better synchronized with connecting lines or demand-responsive paratransit capability provided at terminals to reduce overall trip times.

In intercity travel, it is similarly true that today's intermodal connections often do not maximize convenience. Direct rail-to-air connections are naturally difficult because the best location for rail stations is usually at the central city core, while that for airports is necessarily suburban or farther out. The interface at airports and stations with taxicabs is well developed. The interface between private automobile and bus or rail, in the form of parking facilities, is often poor at downtown terminals. In part, this results from the high land value at these locations and, especially for bus, perhaps from the non-auto-owner status of much of the clientele. In contrast, the air-auto interface is usually of higher quality, with much of the revenue obtained from parking lots and rental cars which are marketed aggressively at most airports. Limousines and taxis also serve most airports profitably, but even in these cases, reservation ticketing could be combined with collection.

Many of today's travelers encounter ill-developed interfaces in the form of bus stops at railroad stations or airports. An examination of these connections indicates the following widespread problems:

- Poor information available — usually no bus agent is present full time at the stop
- Poor physical accommodations — often no waiting room, no seating, no shelter
- No through checked baggage service
- No through ticketing
- Schedule mismatch requiring long layover
- Unidirectional service — often only in-town to the main bus terminal with a second transfer required to continue

Rail, bus, and airport sources agree that an underlying cause of the poor interchange accommodations is the lack of incentive to invest in improvements. The number of passengers now making intermodal transfers is too small to encourage bus companies to invest in shelters or waiting rooms or to pay agents in the terminal. The rail station or airport management also sees little profit incentive from arriving bus passengers. These poor accommodations, in turn, discourage growth of the traffic.

Additional difficulties for bus operators lie in the fact that airports are frequently set well back from the main highway and often involve several terminal buildings. To leave the highway and stop at the several terminal buildings is an often unrewarded expenditure in drivers' and passengers' time. Some airports charge buses for entrance, an added cost. Buses that do make airport stops tend to be "locals"; the fastest service buses run nonstop over the Interstate System highways.

Schedule mismatch between airports and buses is a further problem. Bus service is usually far less freqent than airline arrivals and departures. In many cases, it appears that no attempt has been made to meet any particular flight; a bus normally scheduled to pass the airport simply makes the stop. In a few cases where the bus serves a special location, such as a military base, a college, or a resort, schedules may be matched to the timing.[6]

At bus-rail interfaces, bus schedules may be more frequent than train arrivals and departures. Bus operators complain that train on-time reliability is too poor to attempt to meet the train or to delay bus departures for train arrivals.

Baggage handling is similarly disjointed. Through ticketing and through baggage checking usually require interline agreements, resolution of institutional problems centering around baggage rules and responsibility, and physical facilities. A Greyhound-Amtrak agreement at Boston has resolved the problem and created a bus extension of the rail system. At several other locations, bus lines share rail terminal space but offer no through ticketing, checked baggage, or coordinated schedules. Checked-baggage service is not available at air-bus interchanges, except for special charter or tour service.

[6]An extreme case is once-a-week bus service from the town of State College, Pa., to the Amtrak station at Lewistown, Pa., which makes one trip from the college Friday afternoon and one return run Sunday.

In another area, regulatory problems have been encountered for interstate bus lines attempting to serve rail stations or airports, principally when local carriers protest service between intrastate points. These problems may so restrict the points the interstate carrier may serve that a profitable level of patronage is unlikely.

With few notable exceptions, the intermodal air-bus and rail-bus interface is poor and, at present, most of the potential for such connections is not realized. While present airline, rail, and bus routes would permit interface at 90 percent of the airports and 99 percent of the more important rail stations, only 8 percent of the airports and 5 percent of the railroad stations offer any data about bus connections. Effective complementary service is offered at about a dozen airports and less than half as many rail stations.

Information Interface. If full mobility for any passenger is to be assured, each traveler must be able to move about the country on the combination of modes best suited to his needs and for which he has the means to pay. In practice, however, the traveler rarely has full knowledge of the alternatives available without the services of a travel agent.

In general, the traveler can obtain excellent information on the services offered by any single carrier. For obvious competitive reasons, no carrier is anxious to provide information on competing carrier services. However, most airlines, bus lines, and railroads will provide information on other airline, bus, or rail services to points or at times that they, themselves, do not serve. But the traveler who needs to move between modes finds that airlines can provide little information on continuing bus or rail service, schedules, fares, or even if such service exists. Bus and rail carriers are similarly reticent on intermodal transfer opportunities.

The travel information source most readily available to the average citizen is the highway map, which usually shows airport locations but almost never rail or bus stations. The *Official Airline Guide* is in fairly wide circulation, but its only intermodal information (other than a few bus company ads) is for limousines and rental cars. The (Russell's) *Official Bus Guide* does show airports and rail stations served, but it is not in wide circulation. The *All-American Train*

Fares (edition 5) lists 69 entries for connections, but this guide is also poorly circulated. The average traveler who wishes to make intermodal connections at an unfamiliar city must rely on a travel agent or exert considerable personal effort and persistence to get information.

Investigation indicates further that some of the rail-bus and air-bus "connections" listed are not convenient interchanges (e.g., a bus flag stop at the curb on the highway at the airport boundary; the downtown bus station several blocks from the connecting railroad station). Information on intermodal connections is also scarce inside the connecting terminals themselves. Signs indicating bus interchange locations are almost nonexistent at airports and at train stations, and personnel are frequently ill informed.

Common Ownership of Modes. It is believed that constructive economic regulatory changes that would permit multimodal ownership and operation would encourage improved service (as discussed in the last section of this chapter).

Future Passenger Complementarity. If there is to be a national integrated transportation system in the future, new mechanisms must be found to bring together fragmented service and better use must be made of those already in existence. Funding mechanisms exist that could promote better interfaces but that have hitherto been untapped. These include Federal Highway Administration and Urban Mass Transportation Administration planning funds, funds authorized by the Federal-Aid Highway Act of 1973.

The 1973 Act permitted diversion of funds from highway projects to pay a share of the cost of transit projects. The types of projects authorized include construction of exclusive or preferential bus lanes, passenger loading zones, bus shelters, and fringe-parking facilities. Since fiscal year 1976, access routes to transportation terminals may also receive 70 percent Federal funding. Bus lines would have to coordinate with metropolitan planning organizations and share facilities with local transit in order to benefit from the above options for spending Federal-aid highway funds.

In the regulatory area, the concept of air-bus or rail-bus passenger travel as automatically interstate should be extended to allow Federal regulation to preempt conflicting State and local laws. In addition, expanded entry opportunities should be promoted to permit existing or new bus operators to perform joint intermodal operations when carriers holding rights reject possible participation or provide minimal levels of service.

From the perspective of long-range national planning, intermodal interchange points, airports, and railroad stations would provide:

- Designated and semiprivate loading and unloading areas contiguous to ticketing and baggage claim areas
- Effective guidance for movement through the terminal
- Information and ticketing assistance, primarily adjoining the baggage claim area

Movement by bus should be of the highest quality level obtainable within the context of general scheduled intercity motorbus service. Scheduling should be oriented to intermodal interchange primarily within the limitations of each mode's intramodal requirements.

The average citizen must be able to get accurate, reliable information on his travel alternatives with minimal effort. A single-source compendium of schedules and rates, frequently updated, should be broadly available covering intercity bus operations, the airlines, and Amtrak. This material should be supported by an adequately staffed telephone service. Through-ticketing (multiple in nature physically, if necessary) and through-baggage-checking should be available at the trip origin point—bus depot, airport, or railroad station. Each of these functions should be primarily controlled by the airline or railroad involved, with service at the bus station (to overcome a possible locational problem) by computer terminals.

Finally, it is entirely feasible, under present technology and with the facilities now at hand, that one telephone request could arrange an entire trip. Such service would include carrier line haul, lodging (and perhaps rental car) reservation as well as pickup by paratransit (taxi, van, or limousine) at the front door, through-baggage-checking, and delivery to the destination hundreds or thousands of miles away, all performed as one transaction. It is the institutional barriers rather than technological barriers which inhibit such procedures at this time.

Complementarity in Freight Movement

Physical Interface. Because inefficiencies in freight service are directly translated into costs (unlike passenger service, where they are more often translated into personal inconvenience), there has been considerable impetus to improve the physical interfaces between modes. Privately owned facilities have been highly automated, realizing considerable cost reductions.

The growth of containerization has favorably affected intermodal connectivity and transfer (e.g., TOFC and land-sea operations) and port facility development. Goods haulage in intermodal containers is rapidly coming of age in intercity freight and ocean commerce and is a newly developing trend in air cargo. While piggyback traffic is only a small part of railroad tonnage, it has reportedly contributed about 6 percent of the railroad's revenue in recent years. The railroads and Pacific container ship lines have introduced service for Pacific-to-Atlantic-coast shipments that may be competitive with the more traditional bulk vessel traffic through the Panama Canal.

Nevertheless, there are substantial barriers to complementarity. Because Government regulations apply to specific transportation modes, they tend to inhibit intermodal integration. Intermodal transfers are encumbered by many problems, such as a paucity of joint intermodal rates and through-tariff rules or single-agent loss and damage responsibilities. They are often discouraged or circumvented when carrier management considers intermodal traffic to be less profitable.

A related problem is the separate and distinct legislation for the various modes and inadequate national transportation planning. In the resulting situation, intermodal cooperation is constrained, program gaps occur and redtape restricts the necessary flexibility for effective and efficient transportation systems development. For example, freight rate tariffs prepared for through intermodal service cannot be filed and fully processed by agencies having individually limited jurisdictions.

The historical development of separate terminals by each mode also complicates the problem. Much of the current restraint to intermodal coordination between rail and motor carriers results from inefficient and outmoded terminal operations and technology. Piggyback terminals have been identified by the Task Force on Railroad Productivity as a major deterrent to intermodal development. Many facilities are outmoded or too small. Finally there is the development of modal-oriented industries and labor interests. Intermodal innovations must rely heavily on labor to achieve the anticipated productivity. The operation of multimodal vehicles or containerized intermodal transfer often poses critical labor relation problems.

Information Interface. The informational details of modal schedules and connections are known to most businesses, who usually have found it economical to establish shipping offices to work with carriers from day to day. There is a major area of deficiency in the information interface, however, with regard to bills of lading and other forms of documentation.

The time and expense devoted to preparing supporting documentation for goods in transit appears excessive compared to what the current state of technology could provide. In air freight shipments, in particular, there are instances of freight moving faster than its documentation. In all cases, the associated paperwork is a significant component of total shipment cost.

Computer communications systems have the potential to streamline preparation and transmittal of essential documentation, reducing overall costs. Such systems have been implemented on a small scale where special circumstances have made it feasible, when a single carrier repeatedly moves large quantities of a single commodity between two sites.

No technological breakthroughs are needed to implement such systems more pervasively. The obstacles are primarily procedural or institutional. Joint industry-government efforts, such as the President's Interagency Committee on Export Expansion, are required in many instances, often on an international scale, to coordinate formats of documents, harmonize codes and descriptors, and resolve legal impediments. The current pressures of costs and delays will give impetus to the time-consuming coordination efforts now underway.

Ownership by a single company of what otherwise might be competing modes of interstate transportation traditionally has been restricted or forbidden by public regulation. Thus, transportation in the United States is largely provided by separate modally oriented industries. This separation of ownership has been based, in part, on the fear that one company controlling more than a single mode might dominate and impede the growth of competitive independent modes.

In recent years, interest in intermodal ownership—the notion of a transportation company—has been renewed. For discussion purposes, a transportation company is defined as a for-hire common carrier that owns, controls, or has the right to use more than a single mode of transportation.

Proponents of the transportation company concept argue that it would result in improved service to shippers. A shipper could be served by a single company employing the best mode or combination of modes for each shipment. Such operations likely would encourage synchronization of the modes used and development of modal interfaces and common equipment, such as containers. The same carrier would be responsible for any loss and damage claims. The administrative work associated with shipments would be less. Differences in governmental treatment that now exist between competing modes would be mitigated since competing transportation companies would probably operate similar combinations of modes.

Opponents argue that transportation companies would result in decreased competition and higher costs. One set of arguments centers on differences that presently exist in the ownership of rights-of-way by different modes. For example, opponents contend that it would be anticompetitive to allow railroads or pipelines that own their rights-of-way to operate trucking, airlines, or marine companies that do not own or operate their rights-of-way.

The transportation companies so formed could exercise an unfair advantage. For example, where truck-rail service was most cost effective, the transportation company could provide preferential treatment to intermodal shipments tendered by its own trucking subsidiary. Other truckers, in many cases, would not be able to compete effectively unless they could secure similar service from another railroad. Securing equivalent rail service could be prohibitively expensive or legally impossible, since another rail line between the relevant points may not exist or would not be economically practical. Theoretically, transportation companies involving truckers, airlines, and marine firms need not pose such an anticompetitive threat in the absence of government-imposed entry controls.

Today, the Federal Government exercises differing economic regulations of the various modes. However, the desirable nature and degree of economic regulation appears to be considerably less than is currently exercised over airlines and common carriers by motor. Recent legislation (Railroad Revitalization and Regulatory Reform Act of 1975) has already liberalized regulation of railroads.

Less regulation is likely to be desirable in an environment that permits transportation companies to provide service by air, motor, and water. In particular, the ability of a firm to expand through growth to provide intermodal services to compete with an existing or newly created multimodal transportation company constructed through merger would be essential to assure the protection of adequate competition. Price and service regulations are also in need of modernization, although the precise nature that the modernized regulations should take is still a matter for considerable study.