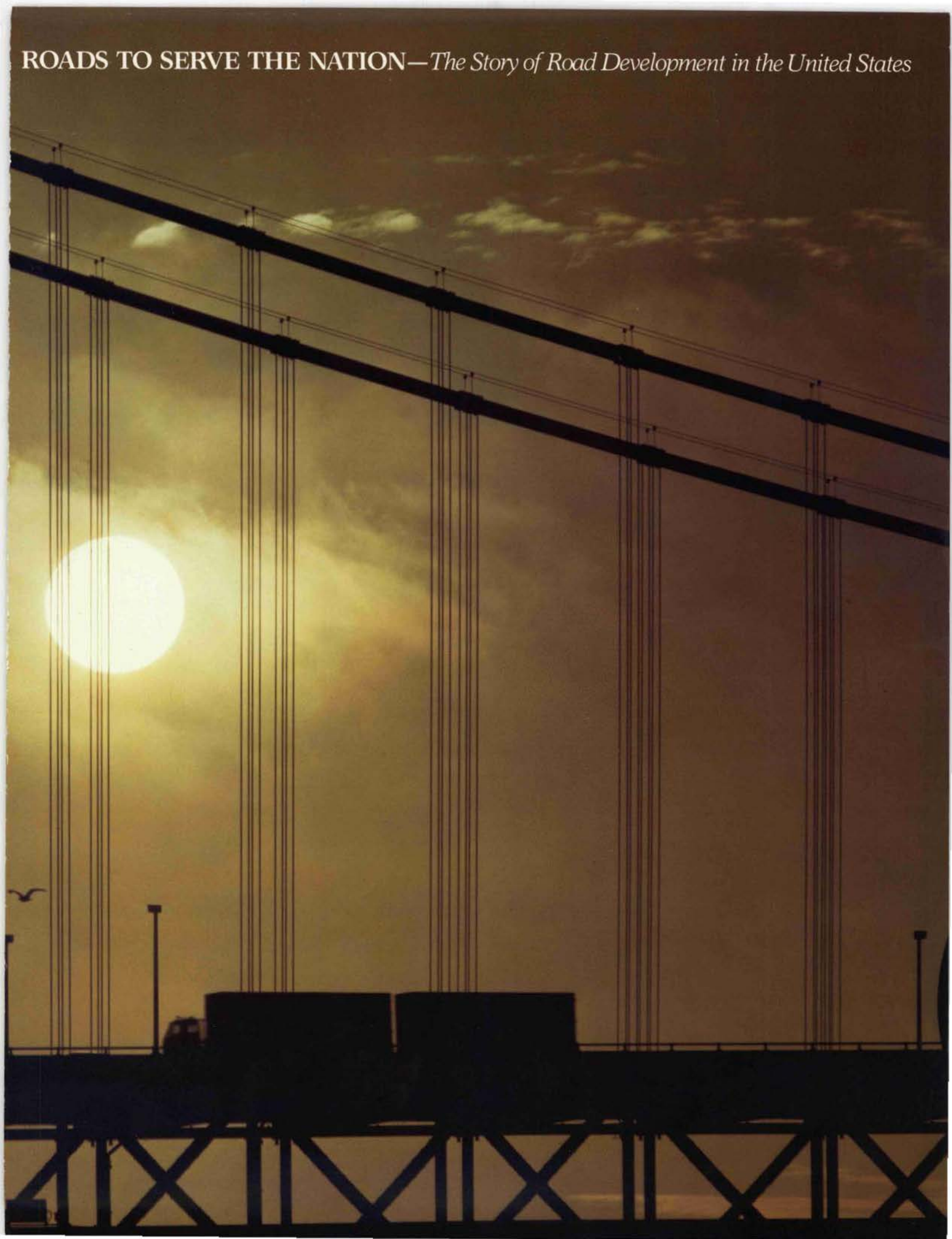
ROADS TO SERVE THE NATION—*The Story of Road Development in the United States*



To the International Road Transportation Community:

Each year many hundreds of road professionals from other countries visit the United States to learn about the successes and problems of the U.S. road system and to locate resources for building and maintaining their own road systems. Their search for information can be difficult because of the size, diversity, and complexity of the U.S. system.

The U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) serves as the principal point of contact for people abroad interested in road technical assistance and technology transfer. The FHWA's International Highway Program Office introduces international visitors to road-related government and private organizations as well as coordinates technical assistance to foreign governments and directs special overseas road projects.

This brochure's intention is to acquaint you, the international reader, with the U.S. road system, the U.S. road transportation community, and the International Highway Programs Office so you can make the most out of your visits and inquiries. The first sections describe the historical development of the road system and its social and economic effects. Later sections discuss current and expected future trends in U.S. road transportation, the organization and structure of the U.S. road community, and the activities of the International Highway Programs Office.

Cover photo

Major bridges, like San Francisco's Oakland Bay Bridge, forged closer links within and between regions, thereby expanding employment, trade, and recreation opportunities. The Bay Bridge, completed in 1936, is 8.4 miles (13.5 kilometers) long and consists of three separate sections: a suspension bridge on the San Francisco side, a tunnel through Yerba Buena Island, and a cantilevered span from there to Oakland. Both bridge sections are double decked. The lower level was originally used for rail traffic; in 1959 it was converted to handle motor traffic with eastbound traffic assigned to it and westbound traffic to the upper level. Traffic engineering improvements have been continually applied to increase the Bay Bridge's capacity. The average daily traffic on this important link now exceeds 250,000 vehicles.

[Cover Photo By Uniphoto]

Contents

U.S. Department of Transportation
Federal Highway Administration

(FPG INTERNATIONAL)

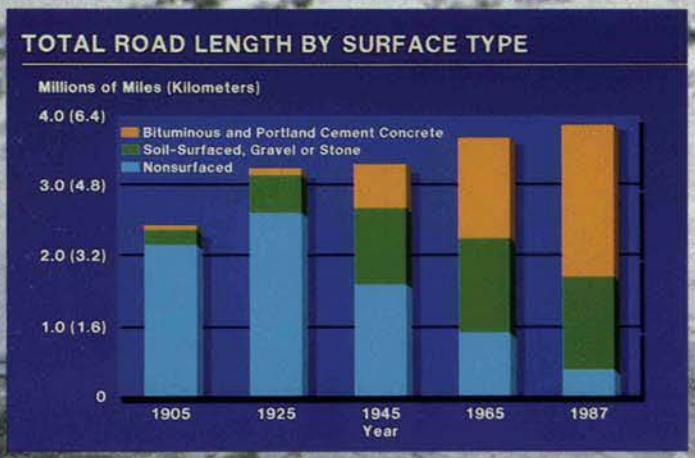
1 History of the U.S. Road System: An Overview

As recently as 100 years ago, most U.S. residents lived in isolated rural communities or in small, widely scattered cities. A network of railroads and inland waterways connected the major cities, but most of the 200,000 miles (320,000 kilometers) of paved roads were in urban areas. People could reach jobs, basic services, and distant friends and relatives often only with difficulty. Farmers, loggers, and other businesses incurred high costs getting their products to market. Large tracts of potentially useful land went undeveloped.

FEDERAL HIGHWAY ADMINISTRATION

Early rural roads were often unsurfaced and poorly drained and were, therefore, impassable after a heavy rain.

In mid-winter, a semi-trailer, with an insulated van that can be heated or refrigerated, brings perishable fruit and vegetables raised in subtropical southern California to cold regions of the country. This cab-over engine, three-axle tractor rig has a sleeping compartment behind the seats.

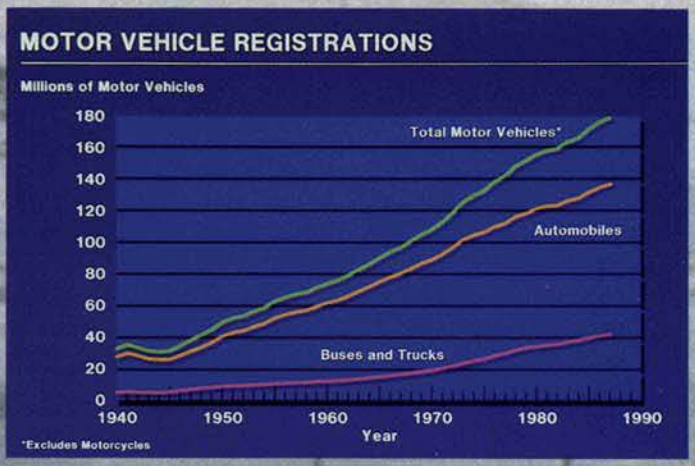


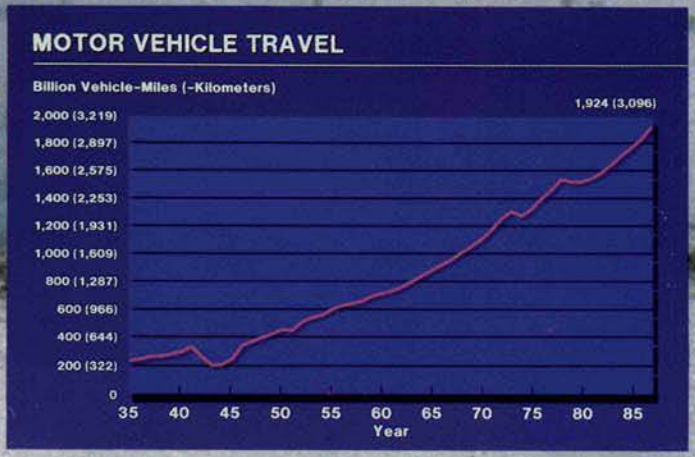
UNIPHOTO

UNIPHOTO

Shoppers may select fresh produce transported directly from the farm or orchard via an integrated network of roads built and maintained by Federal, State, and local jurisdictions.

Changes in the transportation of agricultural products demonstrate how dramatically this situation has changed. At the turn of the century, horse-drawn wagons carried farm products on dirt roads up to 100 miles (160 kilometers) and more to the closest city markets or to connections with railroads and barges that could carry these products to more distant commercial centers. In the last 80 years, however, paved roads have extended into rural America. Trucks now move fruit and vegetables from a farm in southern California to a market in Chicago, a distance of 2,000 miles (3,200 kilometers), in as little as 48 hours. Goods cross the United States, about 3,000 miles (4,800 kilometers), in a few days. Partly because of the highway network, farmers sell their products nationwide as well as internationally, and consumers enjoy the benefits of having a wider selection of goods at reduced prices.





At about 4.0 million miles (6.2 million kilometers), the U.S. road network is the longest in the world. The network's extensiveness is consistent with the demands put upon it by the Nation's large land area (3.6 million square miles—9.4 million square kilometers), big population (247 million) and high degree of motorization (179 million vehicles, excluding motorcycles, were registered in 1987; 87 percent of households have at least one motor vehicle).

In creating its road system, the United States drew on the experiences of other countries and combined these with its own plans, policies, and techniques. The successful development of the road system in the United States is also a story of vision, long-term commitment, cooperative organization, and the search for better technology. These factors are worth examining to gain insight into resolving road transportation problems.

UNIPHOTO

Americans are a mobile people. They spend a good portion of their day in cars enroute to and from their jobs, the marketplace, or recreational activities. Transportation alone takes 21 percent of family expenditures, and the average car odometer registers 9,883 miles (15,813 kilometers) a year.

Vision and the Demand for Roads

Transforming trails and muddy roads into an extensive network of paved roads involved the leadership of far-seeing, dedicated people who understood what they should do and had the will to accomplish it.

In building the U.S. road system, vision was needed to recognize and respond to the public's demand for good roads, to build a political consensus, to plan large-scale construction programs, and to conceive a better future.

UNIPHOTO

Buses are widely used in American cities. Many communities have provided buses-only lanes, which enable bus drivers to operate swiftly in heavy commuting traffic.

CARL RAKEMAN 1878-1965

Albert Gallatin, Secretary of the Treasury Department, on April 4, 1808, presented President Thomas Jefferson with a report "respecting roads and canals," which anticipated twentieth century national transportation policy.

FEDERAL HIGHWAY ADMINISTRATION

By the 1950's, most early unsurfaced rural roads had been paved and widened. Nevertheless, many of these roads were still dangerously narrow, resembling this one photographed in 1953.

Logan W. Page

FEDERAL HIGHWAY ADMINISTRATION

Thomas H. MacDonald

One early visionary was Secretary of the Treasury Albert Gallatin who, in 1808, oversaw the first national transportation study of the United States. The study identified the need for a system of Federally supported roads and canals to promote economic development and national unity. Subsequent pleas from the public resulted in building the first Federally financed highway, called The National Road, which was completed in 1840. The National Road extended from Maryland through the Appalachian Mountains to Illinois.

During most of the nineteenth century, rail and water modes dominated people and goods' transport because the technology of the day made these modes much cheaper and more convenient. In the late 1800's, technological progress in the construction of road vehicles and a populist campaign for good roads (initiated by bicyclists and later taken up by motorists) revived interest in road improvements. New Jersey created the first State-aid highway program in 1891; all other States had established similar programs by 1917.

In 1893, the U.S. Congress established an Office of Road Inquiry within the Department of Agriculture to collect and distribute information on road construction and maintenance, and to help meet farmers' need for better road transportation. The Office later became the Bureau of Public Roads and transferred to the Department of Commerce. Today, the successor agency is called the Federal Highway Administration (FHWA) and has been part of the U.S. Department of Transportation (DOT) since the Department's creation in 1967.

The United States was fortunate in having its Federal roads activities headed by two imaginative and dedicated men, Logan W. Page and Thomas H. MacDonald, whose consecutive terms of office as chief road administrator spanned the years 1905 to 1953. Together, they more than any others, insisted on improving road technology and Federal-State cooperation as the basis of Federal road programs.

Commitment to Construction and a Stable Funding Source

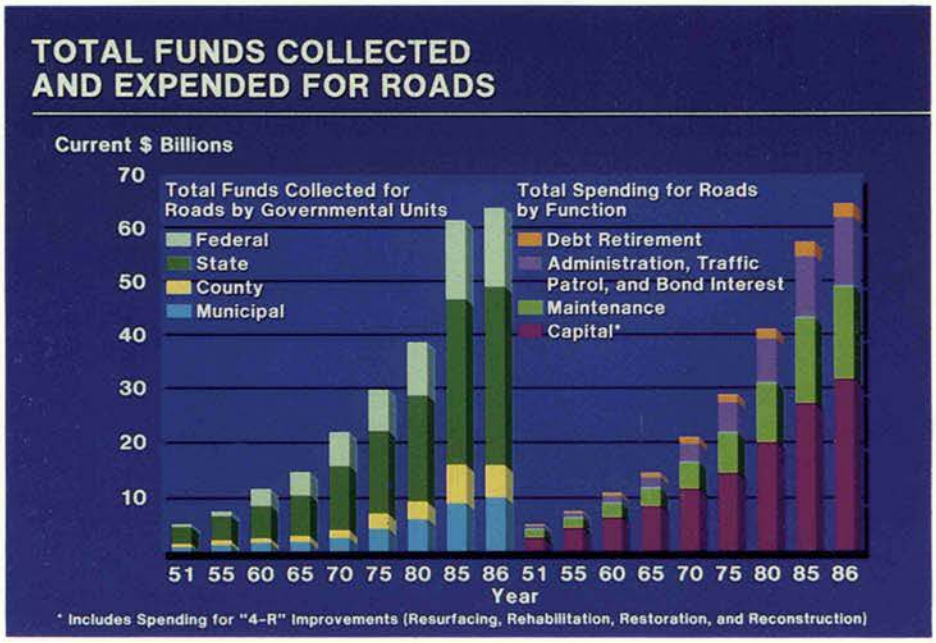
The Interstate Highway System illustrates the need for commitment over the long run. Proposals for a high-standard, inter-regional network of highways existed early in the century, but the first detailed study of the topic by a Federal agency was not completed until 1940. The basic routes of the Interstate Highway System were designated in 1944. Beginning in 1956, the Federal Government made enough money available to the States to begin large-scale construction of the System, and it is just now nearing completion.

During the nineteenth century, the Federal Government confined its road financing and building mainly to military roads and trails in remote or frontier areas. The States concentrated on chartering private toll companies to provide roads and canals; by 1850 hundreds of toll companies operated thousands of miles of roads and canals in the United States. These toll companies contributed to road development, but their profits on road investment were too small for long-term financial viability. State and local governments eventually had to take over nearly all the toll roads.

In the early 1900's, promoters of better roads recognized that an effective construction program needed long-term and stable funding to succeed. The financial problems with toll roads in the nineteenth century helped to turn them toward other financing schemes. As a result, by the 1920's road user taxes were levied at both Federal and State levels. At first, Federal user fees were deposited into the General Fund of the Treasury and were not specifically tied to road improvement projects. The 1956 legislation that substantially raised Federal user fees and established the Highway Trust Fund, however, earmarked revenues from road user fees for road improvements. It also prescribed that fees be imposed on individual classes of users in proportion to either benefits received or costs incurred by them. In recent years a small portion of the Highway Trust Fund revenues—less than 10 percent—has been spent on public transportation projects that, among other effects, reduce peak-hour congestion and thereby indirectly benefit highway users.

As a further effort to provide a stable source of money for road improvements, Congress, beginning in 1921, budgeted road improvement funds for several years in advance and restrained itself from changing these decisions during each annual budget preparation cycle. Since 1966, however, Congress has reinstated annual review and control of Federal spending on roads.

Though the individual States' practices vary considerably with regard to road financing, each has enacted its own road user fees and each has benefited from the stability and equity that this system of finance has conferred.



USER FINANCING AND THE HIGHWAY TRUST FUND

Federal highway legislation in 1956 greatly increased funding for the Interstate System and also substantially increased funding for improving other Federally aided highway systems. To finance this accelerated program of construction, the legislation augmented Federally imposed user fees and established a Highway Trust Fund into which Federal user fees would henceforth be deposited.

Revenues accruing to the Fund were to be used only for financing Federal-aid highway improvements, though in recent years a small percentage has also been earmarked for public transport improvements. Expenditures from the Fund were not to exceed Fund income. Before 1956, the revenue from Federal charges on road users bore little relationship to Federal expenditures on highways. By 1956 and later, legislation also mandated studies of whether groups of users were paying into the Fund in proportion to either the costs they gave rise to or the benefits they received. As a result of such studies and the need for more revenue, user charges have been periodically revised.

Collectively, these institutional innovations have assured a predictable source of income that has enabled the Federal program to work efficiently. This method of highway finance has proven politically popular and stable because it is perceived to be fair.

Present Federal fees paid by users are shown in the accompanying table. Receipts from Federal user fees totalled $13 billion in fiscal year 1987 and were used to finance many kinds of improvements. Some of the most important improvement categories are as follows:

- Interstate System construction;
- Interstate System 4-R (resurfacing, restoration, rehabilitation, and reconstruction);
- Federal-Aid Primary, Secondary, and Urban Systems Highways;
- Federal Lands Highways;
- bridge replacement and rehabilitation;
- hazard elimination;
- rail-highway crossings;
- highway-related safety grants;
- demonstration projects; and
- motor carrier safety assistance.

FEDERAL ROAD USER FEES AND REVENUES FISCAL YEAR 1987

User Fee Type	Rates	Net Revenues ($1000)	Percent Revenues
Gasoline	9¢/gallon	8,395,935	64.4
Gasohol	3¢/gallon	197,001	1.5
Diesel Fuel	15¢/gallon	2,804,294	21.5
Other Special Fuels	9¢/gallon		
Tires	0–40 lbs., no tax Over 40–70 lbs., 15¢/lb. in excess of 40 lbs. Over 70–90 lbs., $4.50 + 30¢/lb. in excess of 70 lbs. Over 90 lbs., $10.50 + 50¢/lb. in excess of 90 lbs.	291,699	2.2
Truck and Trailer Sales	12% of retailer's sales price for trucks over 33,000 lbs. gross vehicle weight (gvw) and trailers over 26,000 lbs. gvw.	723,731	5.6
Heavy Vehicle Use	Annual tax: Trucks 55,000 lbs. gvw to 75,000 lbs. gvw, $100 plus $22 for each 1,000 lbs. (or fraction thereof) in excess of 55,000 lbs. Trucks over 75,000 lbs. gvw, $550	620,191	4.8
(Adjustments)		-470	
		Totals 13,032,356*	100.0

*of which $1,238,858,000 dedicated to public transportation purposes.

Research and Technology

The United States has long benefited from the international exchange of road technology. The United States imported its early construction techniques from Europe. Until the 1820's, many turnpikes were constructed using techniques developed in France during the 18th century by J.P.M. Tresaguet. Later, techniques advocated by John McAdams, a Scotsman, held sway. In more recent times, Germany's autobahns inspired the design of the Interstate System.

Toward the beginning of this century, The Good Roads Movement—a grass roots effort sponsored first by bicyclists then by motor vehicle owners—produced such a demand for better roads that it renewed interest in applying scientific methods to road building. By 1900, Harvard University and the Federal Government had established road research laboratories.

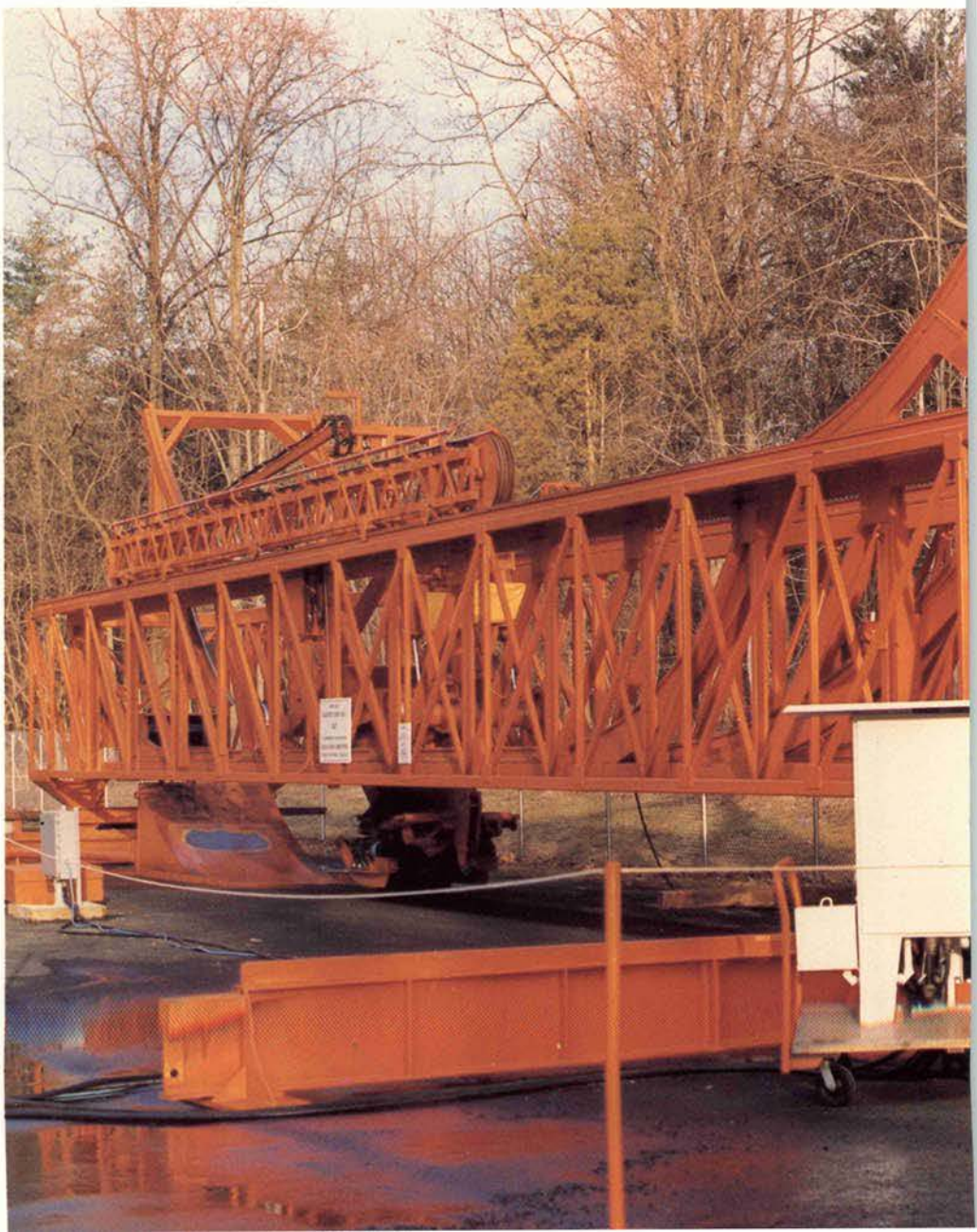
Early work drew on technology brought to the United States by Logan W. Page, who had trained at France's road and bridge laboratory. Page, who became Director of the Federal Office of Public Roads in 1905, launched an ambitious series of technological projects whose subjects and methods are relevant to today's concerns:

- demonstration roads to show local units good road-building practices;
- experimental roads to test new construction techniques and materials (later, they served as the basis for developing technical specifications and standards);
- experimental maintenance programs to demonstrate proper care for roads;
- training programs to ensure a supply of professionally trained engineers; and
- mass media campaigns to keep the public informed.

Section 4 of this brochure, *The Road Transportation Community in the United States,* discusses some major research and technology transfer programs operating under the aegis of the FHWA, the Transportation Research Board (TRB), and the American Association of State Highway and Transportation Officials (AASHTO). These groups attach special importance to making sure that the best technology is disseminated throughout the country. In recent years, they have also become increasingly aware of the need for international cooperation and information exchange in the field of road technologies because now more than ever road technology is produced and consumed on a global scale.

A major portion of today's national road research is focused on problems that promise large payoffs and are, therefore, widely shared. The outstanding example is the $150 million, 5-year Strategic Highway Research Program (SHRP). The SHRP program is concentrating on several national priority topics aimed at improving materials and techniques for building and maintaining pavements and structures. The SHRP has sought and received international cooperation in undertaking its work program.*

* For further information on SHRP activities, please address inquiries directly to:
National Research Council
Strategic Highway Research Program
818 Connecticut Avenue, N.W., Suite 400
Washington, D.C. 20006



The Accelerated Loading Facility (ALF) installed at FHWA's Turner-Fairbank Highway Research Center in McLean, Virginia. The ALF can simulate in 10 to 12 weeks the wear of 20 years' truck traffic on a section of pavement. Its design follows that of a similar device in Australia.

Among the most important concerns of recent road research in the United States are the following:

- improved road safety;
- cost-effectiveness in the design, building, and repair of roads;
- better traffic management techniques to alleviate urban and suburban congestion; and
- the application of micro-computers in all domains to increase the productiveness of individuals and organizations.

Better understanding of institutional aspects of road transportation, such as regulation, pricing, and technology transfer, is also important to realize the full potential of scientific and technical advances.

FEDERAL HIGHWAY ADMINISTRATION

SEGMENTAL CONSTRUCTION OF PRESTRESSED CONCRETE BRIDGES

The need to rebuild the many bridges in Europe destroyed during World War II stimulated the development of segmental construction. This method of construction consists of building up the primary supports of the structure by assembling and post-tensioning individual segments. In France, Eugene Freyssinet was the first to use this method during the 1945-1948 reconstruction of a bridge at Luzancy on the Marne River about 30 miles (48 kilometers) east of Paris. In the United States, the Portland Cement Association (PCA) and the Prestressed Concrete Institute (PCI) conducted a study during 1968 to address the problems associated with the longer spans required on U.S. highway bridges. The concepts developed by Freyssinet and those developed by the PCA-PCI studies laid the foundation for supplying economical and reliable methods of tensioning and, in doing so, advanced the use of segmental construction.

Bridge technology involving either cast-in-place or precast segments has advanced rapidly over the last two decades. Initially, the balanced cantilever method of construction was used. Today, span-by-span, incremental launching, and progressive placement techniques are available. Any of these construction methods can use cast-in-place or precast segments, or a combination of the two. As a result, engineers can use a variety of design concepts and construction methods to economically produce segmental bridges, regardless of site condition.

Starting in 1976, several innovations were introduced in the segmental construction of bridges linking the south Florida mainland to the Florida Keys. These included use of precast segmental, span-by-span construction; dry joints (no epoxy in the match-cast joints); and placement of external tendons encased in polyethylene ducts inside the wall of the box girder.

The Long Key Bridge in the south Florida keys (reef islands) is an example of segmental construction of prestressed concrete bridges. The 12,144-foot (3,702-meters) span cost less than $29 per square foot ($312 per square meter), and saved $2.6 million over a conventional I-beam design.

FEDERAL HIGHWAY ADMINISTRATION

2 Economic and Social Consequences of Developing the Road System

FPG INTERNATIONAL

The common dump truck takes corn from a mechanized harvester in the open field to the mill where it is prepared for processing into many different kinds of foodstuffs, animal feeds, and industrial products.

The linkages among development of the road network, the economy, and personal mobility have been far-reaching in the United States. After residential property, motor vehicles (including cars, vans, trucks, motorcycles, and mopeds) account for the largest portion of assets owned by the typical American family. For example, the number of registered vehicles (excluding motorcycles) in the United States increased from 30 million in 1944 to 179 million in 1987. U.S. motor vehicle sales in 1986 amounted to about 36 percent of world production.

Two of the best and most global gauges of the impact of road transportation on the economy are that it accounts for 15 percent of U.S. Gross National Product (GNP) and 84 percent of all spending on transportation (1986 data).

Harder to measure but of greater significance, roads and road transportation have shaped the development of U.S. communities in this century and affected, in turn, where Americans live and travel, whom they meet, and how they spend their time. Opportunities for most Americans to pursue individual interests have increased as a result but those without ready access to automobiles have often been disadvantaged.

The low-density suburbs made possible by automotive transport offer a pleasant life for millions. Suburbanization, however, was too often accompanied by poor planning for transportation and other amenities in suburbs as well as deterioration in central cities. Events of the last decade point the way towards solutions. Central cities are reviving, and suburban job growth is clustering around satellite cities. These new cities bring urban amenities to the suburbs and permit increased use of public transportation.

Chicken farms and processing plants depend on trucks to transport the finished product to wholesalers or direct to large food chains for distribution to supermarkets and restaurants.

UNIPHOTO

At one time milk had to be transported in 20-gallon cans to railroad depots. Now, one sanitary tank truck takes it in bulk directly to the dairies where it is pasteurized and separated into marketable containers.

MODERN BULK TRANSPORTER

Well-designed roads speed fire-fighting vehicles on their mission.

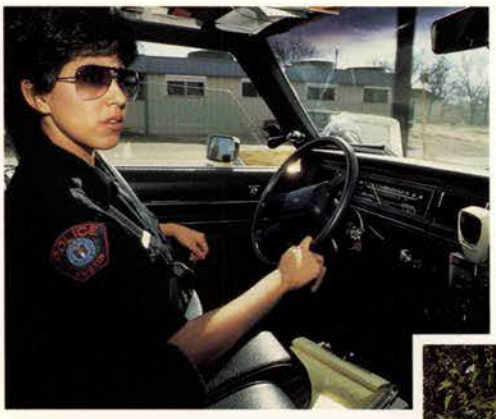
UNIPHOTO

Roads and streets play an important role in the provision of emergency medical services to America's citizens.

UNIPHOTO

FORD MOTOR COMPANY

The U.S. building construction industry relies on trucks such as this one to deliver materials to construction sites.



UNIPHOTO

Because of increased traffic on U.S. roads, more police are needed to assist in traffic control.

The yellow school bus is the prevailing mode of transportation to elementary, junior high, and high schools in communities all across the Nation. Only a small percentage of children live close enough to walk to school.

UNIPHOTO

The pickup truck, work-horse of America's farms, prepares to take grapes from a vineyard to a depot. There the grapes will be combined with other produce and trucked to markets nationwide.

FOLIO

America's top-of-the-line recreation vehicles (R.V.'s) are apartments on wheels that allow travellers to take the comforts of home along with them.

UNIPHOTO

Mobility

Americans prize their ability to travel with comparative ease. In total, and including all forms of passenger transportation, they travel over 3 trillion passenger-miles (5 trillion passenger-kilometers) each year to work, school, recreation, shopping, and other destinations. On average, each household generates 414 work-related trips each year (9 miles or 14 kilometers per trip) and another 1,072 non work-related trips (6 miles or 10 kilometers per trip).

Because of its flexibility and convenience, travel on roads accounts for about 90 percent of total passenger-miles traveled. Air travel accounts for most of the remaining 10 percent. Air travel's share of intercity travel is increasing because of its speed and declining relative cost. By 1987, 18.3 percent of intercity passenger-miles were by air.

Road travel, as measured in vehicle-miles, is dominated by passenger travel with about 72 percent taking place in exclusively passenger vehicles and an additional large amount in the fast growing stock of light trucks* (over 33.3 million in 1986), more than half of which are used for primarily personal travel.

Road travel is also concentrated on main highways and in urban areas. Interstate and other arterial highways, which comprise just 11 percent of the road network's length, carry 71 percent of all traffic. Similarly, urban roads constitute just 18 percent of total network length but carry 59 percent of all traffic.

* Less than 10,000 pounds (4,536 kilograms) gross vehicle weight.

Industry and the Economy

The national road network is the main determinant of accessibility in the country today. Development of the network has spawned new industries and communities and has affected virtually every aspect of the economy.

Over the last 40 years, truck transportation has captured an increasing portion of the freight transportation market. In 1950, motor trucks carried 16 percent of intercity freight ton-miles and railroads 56 percent. By 1987, the corresponding figures were 25 and 37 percent, respectively. (Because of long hauling distances that favor other modes, U.S. trucking accounts for a smaller percentage of ton-miles than trucking in most developed countries.)

Taxicabs are numerous at airport, bus, and train terminals where they are provided special parking lanes for picking up and discharging passengers. Many large cities permit ride-sharing in taxicabs as well as allowing cabs to use the high occupancy vehicle (HOV) lanes on major commuting roads during the rush hours.

UNIPHOTO

UNIPHOTO

UNIPHOTO

An automobile manufacturer's storage lot illustrates the large market for new vehicles. Eighty-six percent of the U.S. driving-age population is licensed to drive. Eighty-seven percent of households has at least one vehicle.

As a share of shippers' total spending on freight transport, trucking is even more significant. By this measure, local and intercity services combined have about 76 percent of the market.

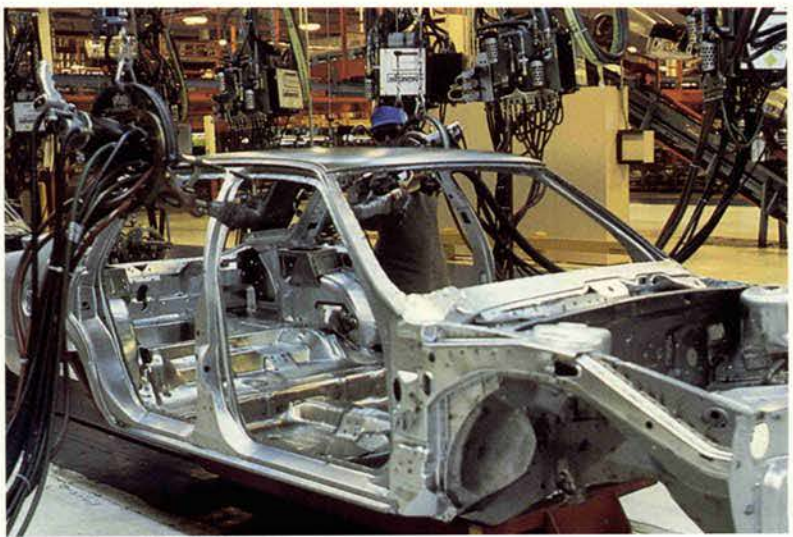
A number of major factors has affected the growth of the trucking industry. Economic activity has shifted away from heavy manufacturing, which is most economically served by rail and water, to light manufacturing and services, which are best suited to truck transport. Suburban and rural locations, with lower taxes and operating costs, have attracted industries away from rail lines near center cities to locations often accessible only by truck. "Just-in-time" manufacturing processes, which reduce inventory costs, depend on the fast, flexible, and reliable service available by truck. As much as anything, however, it was the widespread availability of good roads that enabled the trucking industry to grow.

The industries responsible for building, maintaining, and operating roads, related facilities, and transportation equipment account for 8 million jobs and, as reported above, 16 percent of the Nation's GNP. But road transportation directly affects other parts of the economy as well. For example, many hotels, recreational services, and restaurants depend on good roads for their prosperity.

However valuable, mobility and accessibility have not been achieved without undesirable side effects. Congestion, damage to the environment, the high cost of road maintenance, and especially motor vehicle accidents are persistent accompaniments. Some actions taken to cope with these problems are discussed in the next section.

The pre-World War II automobile assembly line has given way to a completely automated "factory of the future." These computer-programmed robots can turn out fully operational cars at the rate of 71 per hour.

The Interstate Highway System has made bus transportation between distant cities much faster and more economical.



UNIPHOTO

3 Recent and Expected Trends

Completion of the Interstate Highway System has been a principal FHWA goal for the last 30 years. Interstate System construction usually complemented efforts to improve safety, traffic flow in built-up areas, environmental quality, and the overall cost-effectiveness of road investments. Deferred road repairs grew, however, until recent years when system repair was accorded a much higher priority. Now that the Interstate System is in place and in view of changing economic, technological, and demographic conditions, U.S. road programs will have to substantially change. The U.S. road transportation community has underway a thorough assessment of what changes are needed to assure that roads and road programs meet the challenges faced at this turn of the century.

Safety and the Environment

Over the last decade, economic regulation of the transportation industry has been reduced. Safety and environmental protection actions, however, have increased over the past decades because of the damages caused by motor vehicle accidents and pollution. Federal and State governments have established regulations and programs to do the following:

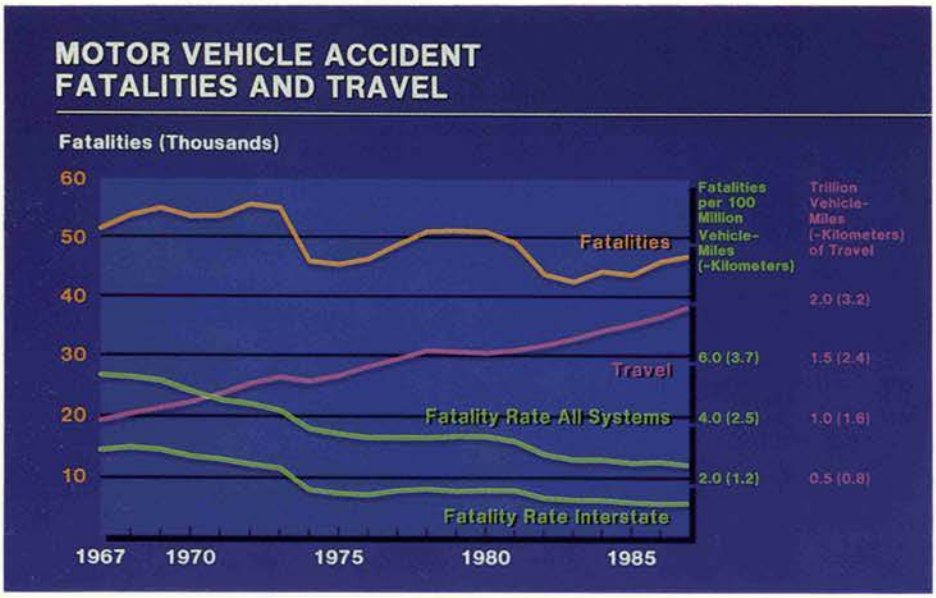
- improve accident data,
- encourage seat belt use,
- curtail driving while intoxicated,
- assure drivers' qualifications,
- reduce accidents attributable to road design,
- ensure the safe haulage of hazardous cargoes, and
- reduce motor vehicles' emissions of air pollutants and noise.

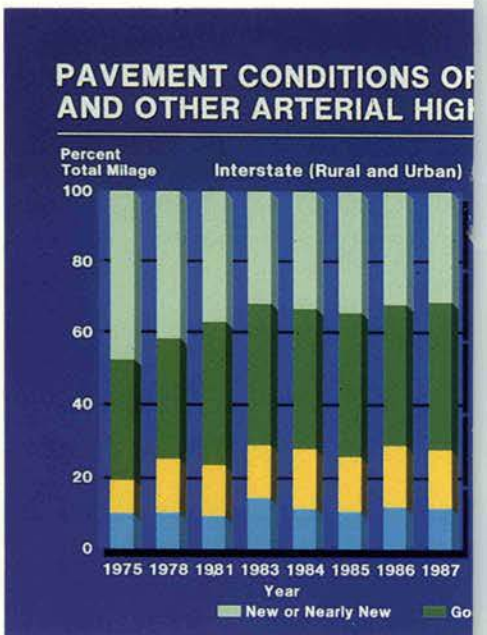
In 1987, 46,385 people died and an estimated 3,495,000 more were injured in motor vehicle traffic accidents on U.S. roads. Measured as fatalities per 100 million vehicle-miles (Figures in parentheses below are per 100 million vehicle-kilometers), the 1987 fatality rate, 2.41 (1.50), was the lowest on record. The Interstate System is the safest system in the U.S. to drive on because of its superior design standards. In 1987, the Interstate System fatality rate was 1.11 (.69) and the non-fatal injury rate, 56.84 (35.32). Comparable average rates for non-Interstate roads were 2.77 (1.72) and 216.27 (136.87), respectively.

As one indicator of the progress made in making U.S. road travel safer, child passenger protection laws are now in effect nationwide.

UNIPHOTO

Much progress has been made in curtailing air pollution caused by motor vehicles, but the problem remains serious in and near many large urban areas. By 1987, 85 percent of passenger cars were equipped with catalytic converters or equivalent control systems that limit exhaust emissions. New automobiles emit 96 percent less carbon monoxide and hydrocarbons and 76 percent less nitrogen oxides than uncontrolled vehicles. Emission rates for light and heavy trucks are also less than before. As of 1986, however motor vehicles were still responsible for 38 percent of lead, 58 percent of carbon monoxide, 34 percent of nitrogen oxide, and 27 percent of hydrocarbon air pollutants.





U.S. Department
of Transportation

**Federal Highway
Administration**

International Highway Programs Office
Federal Highway Administration
400 Seventh Street, S.W. HPI-10
Washington, D.C. 20590
U.S.A.

Phone: (202) 366-0111 or (202) 366-9636
Telex: 710-822-9427 DOT MARAD WSH

Publication No. FHWA-PL-90-024


UNITED STATES
Washington
NORTH ATLANTIC OCEAN
Gulf of Mexico
MEXICO
Mexico City
THE BAHAMAS
Havana
CUBA
DOMINICAN REPUBLIC
PUERTO RICO
HAITI
Belmopan
BELIZE
GUATEMALA
Guatemala
HONDURAS
Tegucigalpa
NICARAGUA
San Salvador
EL SALVADOR
Managua
Caribbean Sea
San José
COSTA RICA
Panama
PANAMA
TRINIDAD AND TOBAGO
Caracas
VENEZUELA
Georgetown
GUYANA
Paramaribo
SURINAME
FRENCH GUIANA
Cayenne
Bogota
COLOMBIA
Quito
ECUADOR
PERU
Lima
BRAZIL
La Paz
BOLIVIA
Brasilia
SOUTH PACIFIC OCEAN
PARAGUAY
Asuncion
URUGUAY
Montevideo
Santiago
CHILE
Buenos Aires
ARGENTINA
SOUTH ATLANTIC OCEAN

THE PAN AMERICAN INSTITUTE OF HIGHWAYS

Transferring road technologies within and between countries is a potentially powerful spur to social and economic development, but traditional means of transfer are not sufficient. Local experts need to be more actively involved to assure that transmitted technology is well received and appropriate. Transfers among developing countries should be further encouraged for the same reasons. The past emphasis on written reports and the physical sciences should be supplemented by more attention to managerial processes, which are decisive in the success of technology transfers and the road improvement programs they support. These considerations are behind the consensus emerging in favor of establishing regional international technology transfer centers.

At the 1987 World Road Congress in Brussels, sponsored by the Permanent International Association of Road Congresses (PIARC), the United States delegation called for the establishment of such centers and informed the Congress of an initiative taken by the Pan American Highway Congress (PAHC) of the Organization of American States to create a center for Latin America. This center will be called the Pan American Institute of Highways.

At the request of the PAHC, and in view of FHWA's experience in creating more than 40 similar centers within the United States, the FHWA has been given the lead in organizing the Institute. The FHWA's International Highway Programs Office in Washington, D.C. will serve as its provisional headquarters. When operational, the center will be managed by representatives of the region's technical community and will be located within the region.

The Institute's operation will begin once the proposed plan for the Institute is accepted by the PAHC. The Congress is expected to decide on the proposed plan at its XVIth Plenary Meeting to be held March 1990 in Montevideo, Uruguay.

Inquiries concerning the Institute should be directed to the FHWA's International Highway Programs Office whose address is shown at the end of *Section 5* of this brochure.

FEDERAL HIGHWAY ADMINISTRATION

The Pan American Highway Congress at its October 1986 meeting in Mexico City resolved to strengthen the technology transfer activities of Latin America by establishing a Pan American Institute of Highways. The FHWA is assisting in the creation of the Institute.

NORTH PACIFIC OCEA

Technical Assistance Projects

The FHWA's experience is that direct technical assistance projects are most effective when the requesting institution has a definite commitment to identify and resolve recurring problems.

Normally, the host country requests assistance and the FHWA provides it under a government-to-government agreement. In some cases, a multi-lateral institution, such as the World Bank, the regional development banks, or the United Nations, requests the FHWA's technical assistance as part of its project development or other missions.

Listed below are examples of recent FHWA direct assistance in the four fields indicated:

■ ***Engineering—***

- Investigated premature asphalt failure.
- Evaluated stress cracking on the deck of a major long-span steel arch bridge.
- Advised a provincial road agency on snow removal methods and equipment.
- Inspected a bridge to determine its structural soundness and potential for additional traffic capacity.

■ ***Computers and their Applications—***

- Reviewed modelling procedures for forecasting urban travel demand.
- Helped to prepare terms of reference for procuring a computer-aided design and drafting system.
- Sponsored a conference for Spanish-speaking officials on the use of microcomputers for road maintenance management.

■ ***Training—***

- Designed a middle-management training program for a public works ministry.
- Provided in-country training for 20 engineers on the principles and practices of value engineering.
- Arranged practical training for two engineers on traffic safety in construction work zones.

■ ***Management—***

- Evaluated the effectiveness of a provincial road agency.
- Advised on the formation of a farm-to-market road maintenance agency.

Financing and Establishing Technical Assistance Projects

Under U.S. law, the FHWA must be reimbursed for expenses associated with its foreign technical assistance projects. The FHWA typically asks recipients to pay for the travel and subsistence expenses associated with projects lasting 30 days or less and for all expenses of longer-term projects. The FHWA also assesses a small administrative fee (currently, 10 percent of costs) on both short- and longer-term projects.

In many cases, funding for these projects derives from earmarked training and technical assistance funds of grants or loans made by multilateral institutions (e.g., the World Bank) or by the U.S. Agency for International Development (AID).

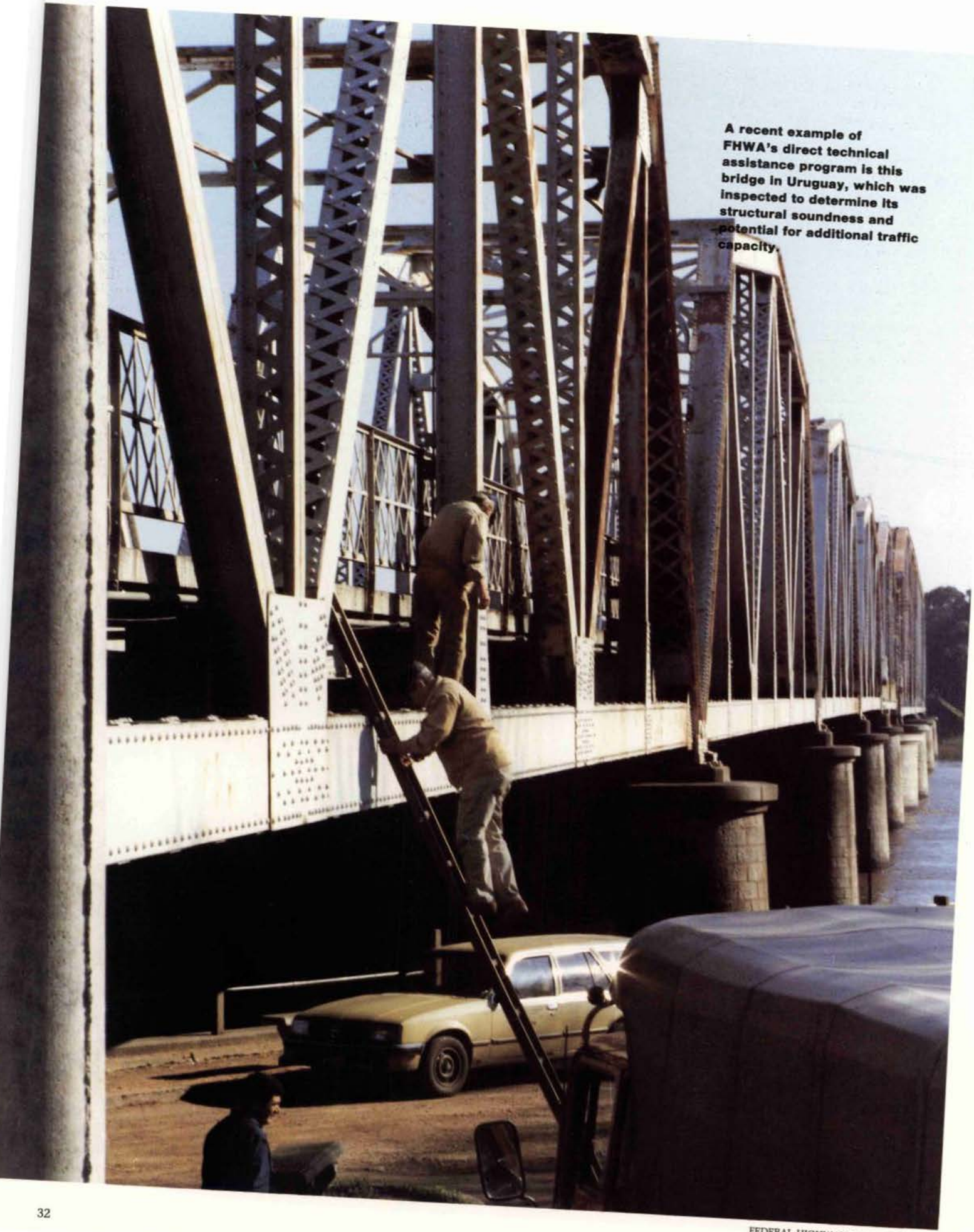
Establishing technical assistance projects follows a simple procedure. First, an approach to solving a problem is developed through discussions between the International Highway Programs Office staff and the foreign country staff. Terms of reference that describe the mutually agreed upon objectives, work program, and budget are then prepared. The recipient country next finds funds from its appropriate domestic or other sources and deposits these funds in advance with the FHWA to cover all (or with large projects, the first phase) of the project's expenses. Once the project is complete, the FHWA makes a detailed accounting of monies spent.

Requesting Technical Assistance

Over the past decades, the FHWA (and its predecessor agency, the Bureau of Public Roads) has worked with more than 70 countries on technical assistance projects. Readers interested in FHWA's assistance or wishing to discuss other subjects raised in this brochure are invited to contact the agency as shown below:

International Highway Programs Office
Federal Highway Administration
400 Seventh Street, S.W. HPI-10
Washington, D.C. 20590
U.S.A.

Phone: (202) 366-0111 or (202) 366-9636
Telex: 710-822-9427 DOT MARAD WSH
Telefax: (202) 366-9626



A recent example of FHWA's direct technical assistance program is this bridge in Uruguay, which was inspected to determine its structural soundness and potential for additional traffic capacity.

FEDERAL HIGHWAY ADMINISTRATION

Scope of Activities

The Office accomplishes its mission in four main ways:

- It facilitates the international exchange of documents and other recorded road information.
- It arranges for international visitors to meet with their U.S. counterparts.
- It arranges for U.S. experts to participate abroad in road technical assistance projects.
- It promotes and coordinates U.S. participation in international organizations, conferences, and exhibits.

The International Highway Programs Office has direct access to the FHWA's in-house expertise which includes the following:

- research,
- planning,
- design,
- construction,
- maintenance,
- safety,
- traffic engineering,
- environmental analysis,
- land acquisition,
- finance, and
- management.

Full-size containers, hauled to a marine terminal by a semitrailer truck or a flatbed railroad freight car, are stacked three high awaiting sea-going shipment. Containerization has made transportation of goods fast and efficient.

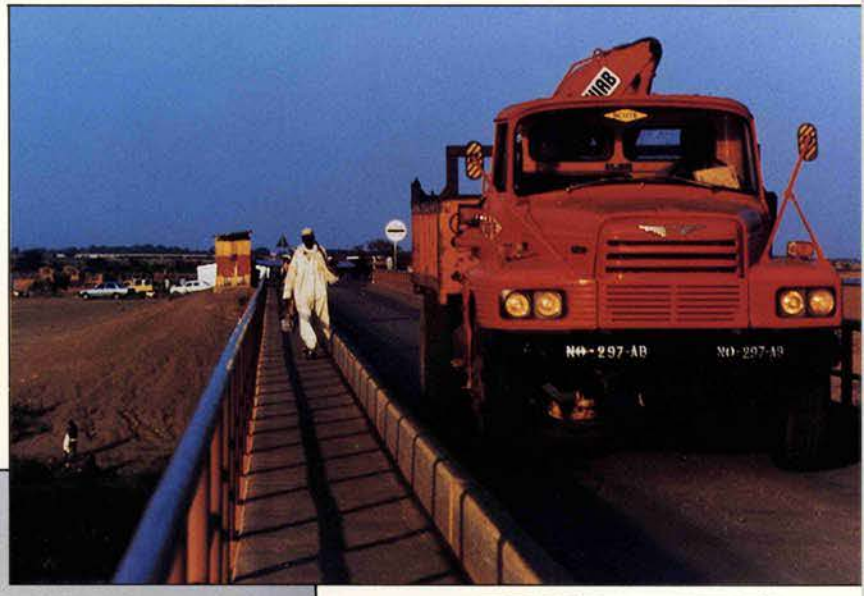
Besides its Headquarters staff in Washington, D.C., the FHWA maintains 9 regional offices as well as offices in each of the 50 States plus the District of Columbia and Puerto Rico. Further, the International Highway Programs Office maintains contact with the U.S. manufacturers of road construction machinery, materials and other road-related products, relevant industry trade associations, and road engineering/construction firms. With these resources, the Office can tailor a program to respond to most technology-sharing needs.

5 International Highway Programs Office

It is hoped that this brochure will give readers a glimpse into how the United States was able to begin this century with an underdeveloped road system and end it with a highly developed system. One key factor in our development has been the exchange of technology and other ideas internationally. Technology sharing between the FHWA and its foreign counterparts takes various forms such as bilateral research agreements, joint sponsorship of conferences and seminars, training courses, and direct technical assistance. The International Highway Programs Office exists to promote this sharing to the mutual benefit of the countries involved.

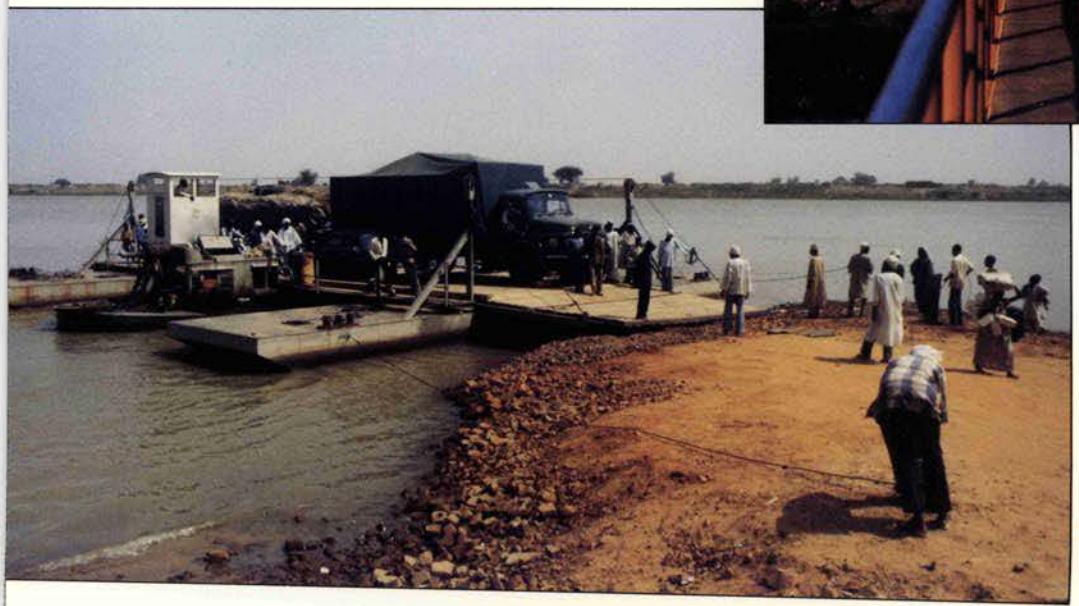
FEDERAL HIGHWAY ADMINISTRATION

Experts from the Federal Highway Administration are participating in the design and construction of more than 224 miles (360 kilometers) of modern controlled-access roads in Kuwait. This project is part of the International Highway Programs Office's direct technical assistance activities.



FEDERAL HIGHWAY ADMINISTRATION

During the 1984 drought in Central Africa, emergency food supplies to the entire population of Chad came into the country on this ferry across the Chari River. A French-speaking FHWA bridge engineer assisted the Chadian government in supervising the construction of the emergency bridge shown, which was needed to prevent the drought-affected river levels from threatening the food supply.



FEDERAL HIGHWAY ADMINISTRATION

retrieval service, containing abstracts of published research and summaries of ongoing research.

The TRB also sponsors nearly 300 committees, task forces, and panels—made up of professionals who serve without pay—that participate in the TRB's research program.

■ ***Other Organizations***— The road community includes many other organizations:

- Professional societies, such as the Institute of Transportation Engineers, promote scientific/technological advancement and establish standards in their fields.
- Industry trade associations, such as the American Road and Transportation Builders Association, advocate the technical, economic, and political interests of their membership.
- Many public and private groups, including those affiliated with universities, sponsor valuable road-related research. Noteworthy, too, are the many citizen groups that have been so influential over the years in lobbying for good roads and opposing projects and programs that they believed ill-advised.

■ ***The Transportation Research Board***— The predecessor organization to the present Transportation Research Board (TRB) was established in 1920 during the early years of the Federal-Aid Highway Program. The TRB is part of the Federally chartered National Academy of Sciences. It is the most important disseminator of road research in the country and a major stimulator and coordinator of research as well.

In cooperation with the FHWA, the TRB and AASHTO jointly administer the National Cooperative Highway Research Program (NCHRP). About $7 million is allocated each year by States for NCHRP using a share of the funds they receive from the Federal Government for highway planning and research. Research projects of interest to the States are selected by AASHTO members and administered by TRB. Thus, States are able to pool research funds for projects selected and managed by them.

The TRB houses the Transportation Research Information Service (TRIS), a computerized on-line information

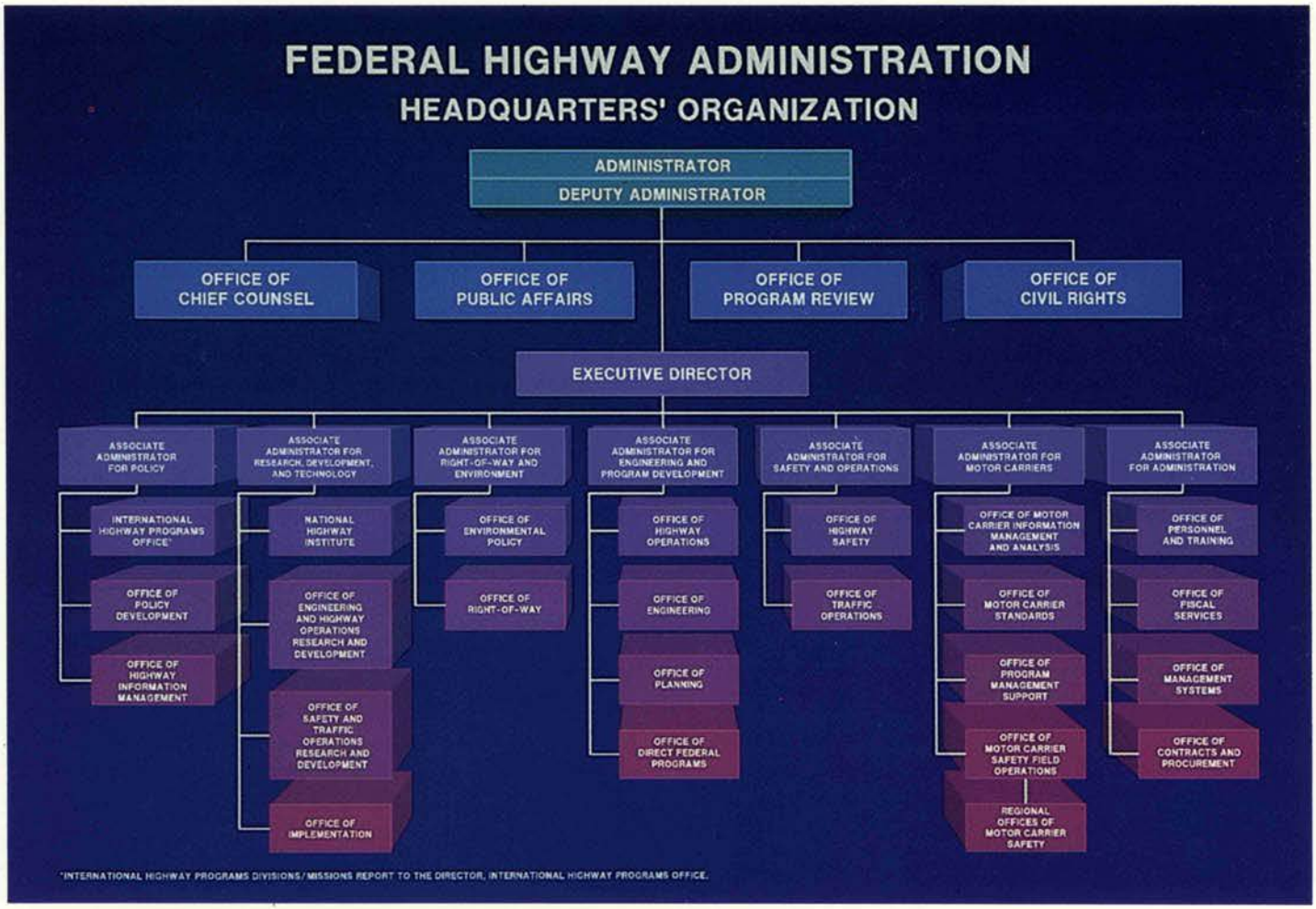
A three-vehicle carrier increases its capacity by towing two trailers. Each trailer is carrying two large pickup trucks.

UNIPHOTO

the technical capabilities of the agency.

■ ***The American Association of State Highway and Transportation Officials***— Long-standing U.S. policy holds that a Federal-State partnership is the best way to assure the development and maintenance of a high quality road network.

Antedating this policy, but in its spirit, the American Association of State Highway Officials (later American Association of State Highway and Transportation Officials—AASHTO) was founded in 1914 to provide a meeting ground for senior highway officials. In 1916, AASHTO helped to frame the Federal-Aid Highway Program. It has since remained the most important forum for the development and dissemination of national standards and for representing States' views on pending Federal regulations and policies.



4 The Road Transportation Community in the United States

Building, operating, and maintaining roads in the United States is a complex business involving, on the public level alone, nearly 40,000 county, township, and city governments in addition to the Federal Government and the States. Private organizations and institutions—such as, engineering and construction firms, equipment manufacturers, materials suppliers, and research organizations, industry trade associations, and citizen groups—are also important participants.

Each of the public and private organizations is a potential resource for those abroad interested in our road transportation system. In view of space limitations, the following describes only the major road organizations and programs through which access to the larger road community is possible.

All Americans depend on hauled-in freight; some 41.1 million registered trucks haul goods in process, perishable produce, and finished products. These trucks criss-cross the Nation on a round-the-clock schedule, while providing direct employment for 2.7 million persons.

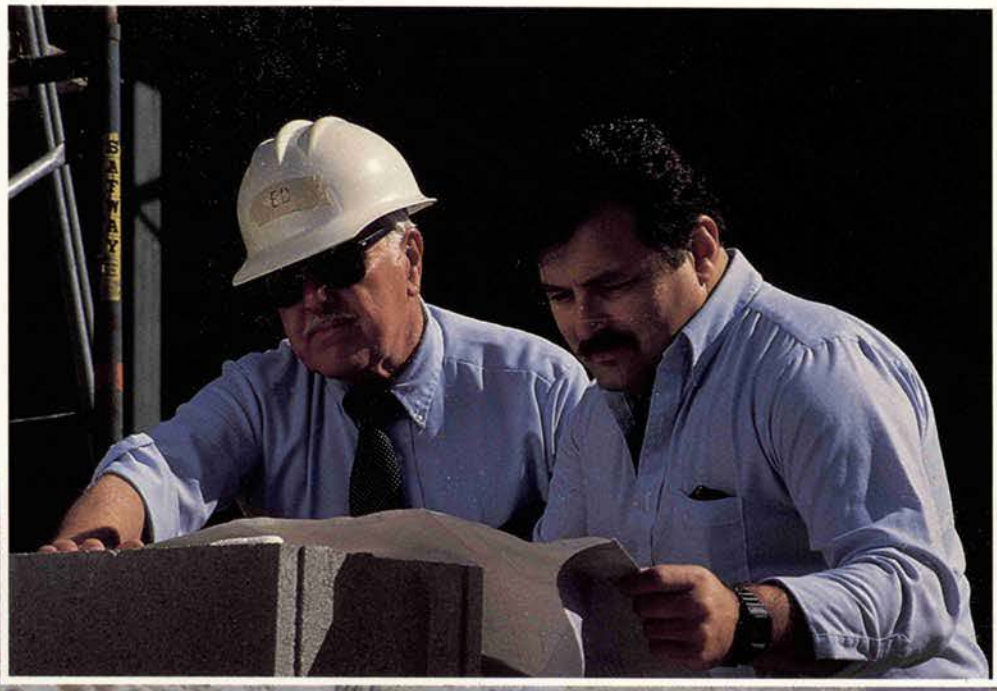
FPG INTERNATIONAL

Organizations

■ ***The Federal Highway Administration***— The Federal Highway Administration is the principal highway agency of the Federal government. As part of the U.S. Department of Transportation, the FHWA, in cooperation with the States, is responsible for financing highway improvements, regulating the safe use of commercial motor vehicles, and undertaking related research and development. The FHWA's expertise includes the following:

- road design, construction, and maintenance;
- policy and planning;
- safety;
- traffic management;
- environmental protection;
- finance;
- land acquisition; and
- research/development and technology transfer.

The FHWA publication, *A World of Technology for Sharing,* further details



UNIPHOTO

A supervisory engineer and a job foreman maintain close contact with each other to meet construction schedules and assure that quality of construction meets specified levels.

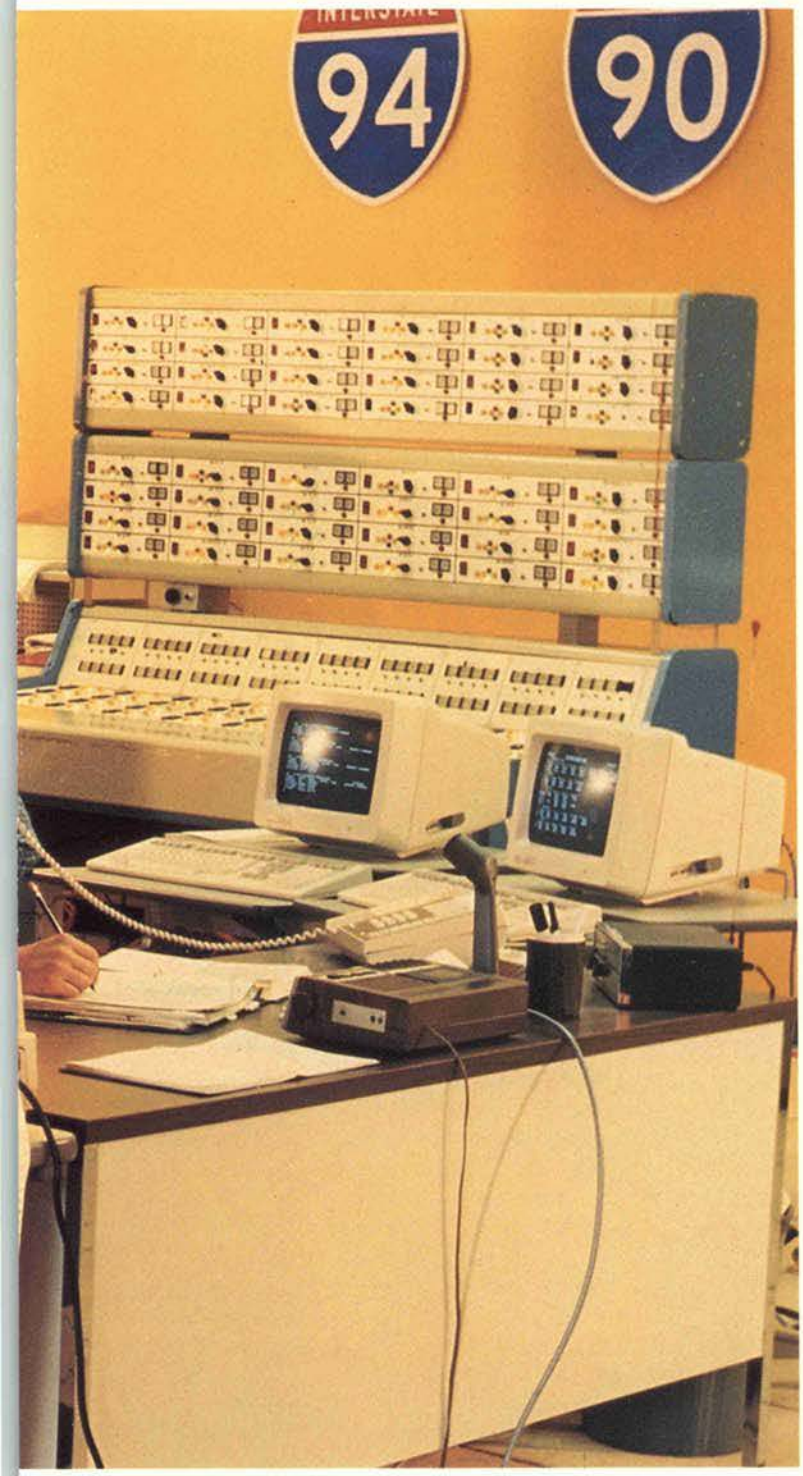
Economic deregulation has significantly improved road transportation productivity in recent years. Deregulation has eased entry into the trucking business, freed up the pricing of trucking services, and permitted railroads and trucking companies to integrate their operations. The benefit to shippers has been improved service and lower costs for most customers.

The 1980's has seen other efforts to better road transportation through institutional change. As mentioned previously, private developers have paid for road improvements to accommodate the traffic generated by their developments and private investors have financed toll roads. These financing arrangements help assure that the right road improvements are built, and built efficiently, and that they are paid for by direct beneficiaries. Future decades are likely to see more recourse to private sector involvement in order to foster efficiency, innovation, and a more equitable division of costs.

The U.S. political structure and the administration of U.S. road programs have always stressed the importance of limiting the Federal government's role. The Nation is, therefore, well prepared to encourage self-reliance, experimentation, and adaptation to local conditions—qualities that recent history has shown are needed to find creative and cost-effective solutions to today's transportation problems.

A new overpass makes its way along a sand and rock hillside in the desert region of the Southwest.

FEDERAL HIGHWAY ADMINISTRATION



Technological and Institutional Strategies

Building more highways is not always the best and certainly not the only solution to the growing problem of urban and suburban road congestion. In many urban centers, no land remains for highway construction. And while a road is being improved, the capacity of the system is diminished. Before new construction is undertaken, existing road space should be used more efficiently by a combination of technological improvements and behavioral or institutional changes. Computerized traffic management and better driver information systems have proved effective at reducing congestion as have encouraging car and van pools, public transportation use during peak hours, and flexible work schedules.

The future of traffic management lies, firstly, in more widespread use of presently available techniques, such as those cited above, and, secondly, in the use of the increasingly sophisticated navigation and communication systems installed both onboard vehicles and along the roadside.

Such systems are under development in the United States, Western Europe, and Japan; they may improve road space utilization and safety by, for example, suggesting less congested routes to motorists or detecting obstacles in the road ahead.

Charging motorists more accurately for the costs of their travel in congested areas would also be helpful, but there is little likelihood of its political acceptance in the near future.

On the infrastructure construction and preservation side, today's best techniques will be more widely used and new techniques featuring better materials, more automation, and less disruption to traffic will be developed.

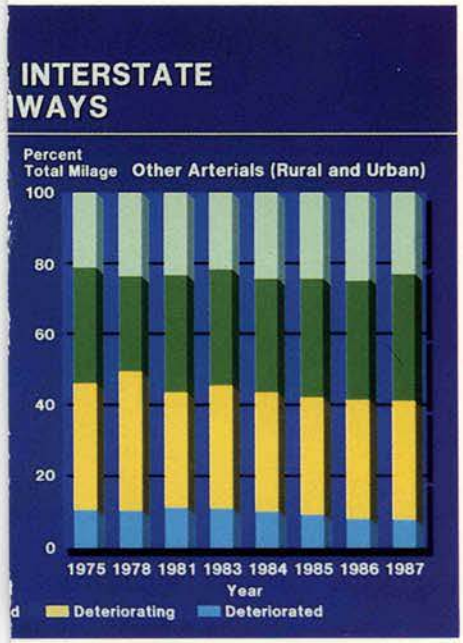
The 4 R's: Resurfacing, Rehabilitation, Restoration, and Reconstruction

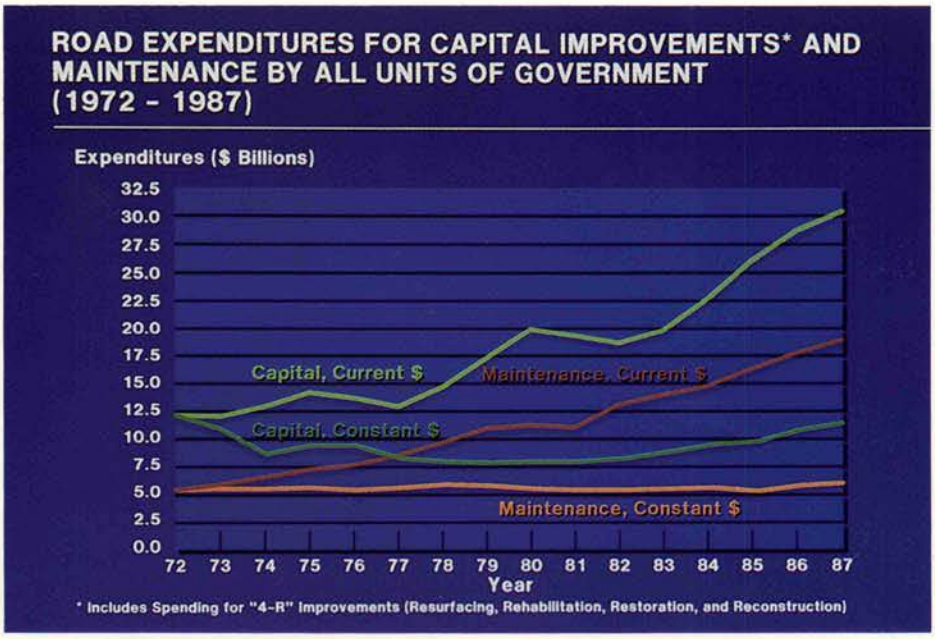
During the 1970's, construction of new highways on a large scale diminished. Transportation policy shifted toward keeping the road system in good condition. During this decade, the oil crisis contributed to inflation that doubled the cost of road construction. Cities, counties, and States, which are responsible for maintaining the roads in the United States, were unable to cope with the growing costs of needed repairs. With the Highway Act of 1976, Congress established a program to **resurface**, **restore**, and **rehabilitate** Interstate System highways—in other words, a program to maintain the Interstate System in good repair. Subsequent legislation added **reconstruction** to this list, so it is called the 4-R Program.

In 1983, new life was breathed into the Highway Trust Fund when Federal user fees were substantially increased for the first time since 1959. Major repair and reconstruction projects for roads and bridges began in earnest. Nonetheless, during the 1980's, Federal, State, and local authorities have still been unable to finance adequately much-needed spending for all types of public works. Governments are being challenged to find new ways to maintain the considerable public investment made in roads. Increased user taxes and tolling, private development of roads and other public works, and government-private partnerships are a few of the financing means being tried.

FEDERAL HIGHWAY ADMINISTRATION

The Edens Expressway (Interstate 94), an urban-suburban freeway in Illinois, was reconstructed to bring it up to modern standards. Every effort was made to minimize traffic congestion during construction, including the problem of moving equipment and materials in and out of the project site. The contractor saved time and money by recycling all of the asphalt and concrete on site. The freeway has been restored to provide motorists with a safe, pleasing drive.





The Illinois Department of Transportation's Traffic System Center handles traffic control and surveillance for the entire Chicago metropolitan area.

FEDERAL HIGHWAY ADMINISTRATION

BRIDGE REHABILITATION

By the 1980's, many U.S. bridges had aged to the point where they showed acute signs of wear. Forty-three percent of the 575,600 bridges inventoried in 1986 were found to be structurally deficient, functionally obsolete, or had already been closed. These bridges needed to be repaired, replaced, or restricted to use by light vehicles only. The highway bridge replacement and rehabilitation program (begun in 1970 and receiving increased funding in subsequent legislation) is addressing the challenge of fixing these deteriorated bridges. Two notable examples are the rehabilitation of the Golden Gate and the Illinois River Bridges.

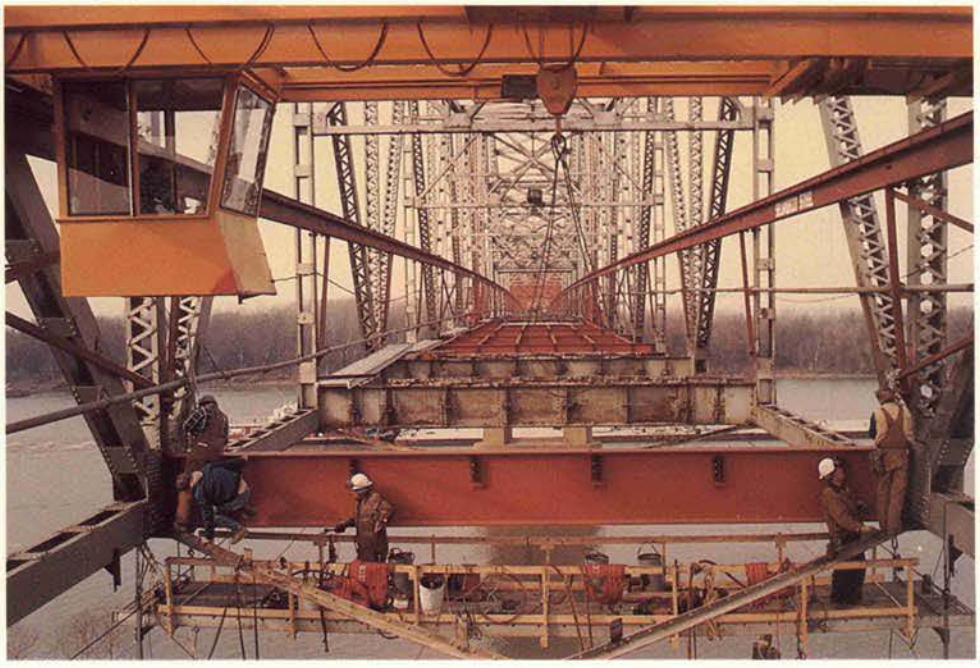
As early as 1969, the deck of the Golden Gate Bridge was corroding, cracking, and spalling due to the deteriorating effects of San Francisco's fog and salt air; the pedestrian sidewalk also needed replacement. A complete replacement project was undertaken in 1983. It cost approximately $65 million of which 80 percent came from Federal-aid funds and 20 percent from State funds. The Golden Gate Bridge rehabilitation project took 27 months to complete and was finished well before the Bridge's 50th anniversary celebration in 1987.

Working between 8:00 p.m. and 5:30 a.m. while keeping two of the four lanes in each direction open, the construction crew was able each night to remove two sections of concrete and steel roadway plus one section of sidewalk, and to replace the sections with new lighter panels. The 15- by 50-foot (4.6 x 15.2 m) steel sections were fabricated nearby and trucked nightly to the bridge. (The change from concrete to steel lightened the span by about 12,700 tons (11,500 metric tons).) After all 747 sections were in place, the contractor applied a 1½ inch (3.8 cm) epoxy asphaltic surface on the entire 9,000 foot (2750 m) deck. In addition, the replacement sections received a thin coating of a skid-resistant substance. The contract to rehabilitate the bridge contained a $100-per minute penalty if all lanes were not open to commuting traffic by 5:30 a.m. each weekday morning. The contractor paid few penalties.

Rehabilitation of the Illinois River Bridge was equally innovative. The contract for the floor system removal and truss span replacement specified a bonus for early completion. This prompted the design and installation on the existing truss framework of two temporary overhead cranes, providing full coverage of the structure. This method of construction enabled the contractor to complete the rehabilitation in nearly half the expected time.

San Francisco's celebrated Golden Gate Bridge was built in 1937 and redecked 50 years later. It is a prime example of how the engineering and construction professions are meeting the challenge to rehabilitate the Nation's bridges.

FEDERAL HIGHWAY ADMINISTRATION



The contractor who removed the floor system and replaced the truss span on the Illinois River Bridge, located on U.S. Route 67, completed the project in nearly half the expected time.

PURCELL TEAM