HIGHWAY RESEARCH RECORD

Number 125

Highway Transportation Research, Education and Technology Abroad

8 Reports

Subject Classification

11 Transportation Administration
12 Personnel Management
55 Traffic Measurements

HIGHWAY RESEARCH BOARD

DIVISION OF ENGINEERING NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

Washington, D. C., 1966 Publication 1368

Special Committee on International Cooperative Activities

(As of December 31, 1965)

HIGHWAY RESEARCH BOARD STAFF
M. Earl Campbell, Engineer, Special Assignments

Wilbur S. Smith, Chairman
Wilbur Smith and Associates
New Haven, Connecticut

M. Earl Campbell, Secretary
Engineer, Special Assignments, Highway Research Board

Robert F. Baker, Director, Office of Research and Development, U.S. Bureau of Public Roads, Washington, D.C.
Donald S. Berry, Chairman, Department of Civil Engineering, Northwestern University, The Technological Institute, Evanston, Illinois
Angelo F. Ghiglione, Deputy Director for Operations, Office of Engineering and Operations, U.S. Bureau of Public Roads, Washington, D.C.
Lucius M. Hale, Agency for International Development, Office of Engineering, Washington, D.C.
Roberto M. Heurtematte, Associate Administrator, Special Fund, United Nations, New York, N.Y.
R. Boyd Ladd, Vice President, Surveys and Research Corporation, Washington, D.C.
Robinson Newcomb, Washington, D.C.
Wilfred Owen, Director, Transport Research Program, The Brookings Institution, Washington, D.C.
C. H. Perry, Office, Transportation Engineering, Director of Transportation, ODCSLOG, Department of the Army, Washington, D.C.
Fletcher N. Platt, Manager, Traffic Safety and Highway Improvement Department, Ford Motor Company, Dearborn, Michigan
Ralph E. Rechel, Consultant in Economics and Organization of Transport, Washington, D.C.
Arthur Roe, Head, Office of International Science Activities, National Science Foundation, Washington, D.C.
Julien R. Steelman, President, Koehring Company, Milwaukee, Wisconsin
Robert O. Swain, President, International Road Federation, Washington, D.C.
George W. Wilson, Professor of Transportation, Indiana University, Bloomington, Indiana
K. B. Woods, Goss Professor of Engineering, School of Civil Engineering, Purdue University, Lafayette, Indiana

Liaison Representative: W. Murray Todd, Executive Secretary, Office of the Foreign Secretary, National Academy of Sciences, Washington, D.C.
Ex Officio: Edward G. Wetzel, Engineer, Transportation Policy, The Port of New York Authority, New York, N.Y.

Foreword

The 1965 Annual Report of the Office of the Foreign Secretary, National Academies of Sciences and Engineering included this paragraph:

> The Highway Research Board (HRB) cooperates with other countries by exchanging publications; by responding to requests for information received from abroad; by authorizing the translation of its publications into foreign languages; by inviting foreign specialists to join HRB Committees; and by encouraging foreign specialists to participate in the HRB Annual Forum. On occasion, members of the Board take part in conferences abroad, sometimes in the capacity of official advisers to U.S. Government delegations.

Since 1925 when the first foreign liaison representative was appointed there has been a continuing growth in cooperative activities abroad, now involving 70 countries. Because of this expanding and recently intensified interest in an identification with the Highway Research Board by highway administrators and engineers in other countries a Special Committee on International Cooperative Activities was established by the Executive Committee in 1965 to provide guidance for this aspect of the Board's operation.

The papers published in this Record stem from the first year's operation of this Committee. Recognizing transportation as a prime force in community development and cohesion, the Committee sought to provide papers which were related to this concept. Education, research and application as related to highway administration and technology are discussed in these papers.

Wilfred Owen points up the problem of transportation for agriculture in the developing country and analyzes the problem through a broad systems approach.

Robert O. Swain and Sir William Glanville address the problem of the exchange of information on current highway researches among countries around the world. The authors tell how the International Road Federation is undertaking a continuing census of current worldwide research projects and will make the census available through the Highway Research Information Service.

M. Earl Campbell and Robinson Newcomb report on a survey of needs in highway administration and technology made for the Agency for International Development in five Asiatic countries and extended into Africa and South America. An action program in research-education-application is suggested.

Wilbur S. Smith shows a virtual correspondence of urban travel desires the world around by matching the findings of transportation studies made in various cities. Basic desires as revealed in trip characteristics are studied and reported.

Hans F. Winterkorn recites significant personal experiences in thirty years of cooperative activities in research and education in many countries, drawing from these incidents lessons in public relations for the sojourning technologist or teacher.

Inasmuch as technological education is pivotal in transportation for socioeconomic development, the International Road Federation in 1949 instituted a fellowship program for training graduate students in highway and traffic engineering. E. A. Hughill, Jr., reviews the program and its achievements during the 16 years of its operation.

The next two papers are from Brazil where they were awarded top prizes in the First Annual Seminar of the Brazilian Highway Research Institute.

Benjamin B. Fraenkel, in a comprehensive review of problems in highway administration in Brazil suggests ways to improve present practices. Some of the principles enunciated are international in relevancy.

Luiz R. Soares makes a summary comparison of the Brazilian Highway Research Institute and its 20 counterpart organizations around the world. The paper shows two principal types of highway research organizations—those which conduct research and are generally funded by government, and those which correlate research and generally rely on voluntary contributions for support. Detailed explorations of support and research programs are summarized.

The international implications and applications of this group of papers give new force to the words of Thomas H. MacDonald in his address to the Fifth Annual Meeting of the Highway Research Board in 1925:

> Science extends beyond the borders of this country. It extends beyond the officialdom, beyond the universities, and beyond the commerce of this country. It extends beyond the borders of all countries. It is international. Scientific labors are not only of great benefit nationally, they are of the greatest import from the international standpoint.

Contents

Road Transportation and Food Production

WILFRED OWEN, The Brookings Institution

Many signs point to a worsening world food crisis. The gravity of the situation is measured by current deficits, future increases in demand due to population growth, and the presence of high rates of population increase in countries with low rates of agricultural productivity. There is also a growing scarcity of new land, hence a growing dependence on costly techniques for achieving higher yields per acre, including the distribution of commercial fertilizers and other agricultural inputs. In addition, there is a continuing migration from rural areas where surplus food is produced to urban areas where it is consumed. The effect of these conditions is to increase the importance of transportation as a means of increasing food production and of facilitating its distribution.

Transport policy makers in developing economies, however, have generally focused on transport requirements for industry. Industrialization has introduced new transport demands in emerging nations and is characteristically the source of the largest volumes and concentrations of traffic. As a result, attention and resources have been diverted from the more pervasive but less spectacular task of providing transportation for agriculture. The fact remains that this aspect of the transport problem, especially the transporting of food, is proving to be both more difficult and more urgent.

This report analyzes the transportation aspects of the food problem through a broad systems approach that includes both transportation and non-transportation investments. It suggests new planning and organizational arrangements to permit economic tradeoffs between transportation and other ingredients of an agricultural takeoff.

•GETTING ENOUGH to eat is the highest priority problem for most of the world's people today. Transportation policy makers can play a major role in overcoming this problem. This is true of both the facilities and services they provide and of the approach they take to programming needed investments. The task will be magnified by the expansion of world population, by the growth of urbanization, and by the increasing mechanization and modernization of agriculture. These trends mean that additional inputs will have to be delivered to permit intensive cultivation, and that larger surpluses of farm production will have to be moved from farm to city.

THE INCREASING REQUIREMENTS FOR FOOD

Population projections to the year 2000 indicate that the number of people to be fed will be roughly double what it is today (Table 1). The United Nations estimates that as early as 1980 the annual food grain requirements of the developing countries alone will jump from 470 million tons in 1960 to 767 million tons. The added burden on transportation facilities will be disproportionately heavy. The reason for this is the in-

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

TABLE 1
ESTIMATES OF POPULATION GROWTH, WORLD AND DEVELOPING CONTINENTS, 1960-2000
(in millions)

Item	World	Africa	Latin America	Asia
1960	2,910	237	206	1,620
2000	6,267	517	592	3,870
Increase 1960-2000:				
Numbers	3,357	280	386	2,250
Percent over 1960	115	118	187	139
Increase 1960-80:				
Numbers	1,310	96	142	850
Percent over 1960	45	41	69	53

Source: U.S. Department of Agriculture. World Food Forum, Proc., Washington, 1962.

creasing rate of urbanization, and particularly the concentration of growth in the larger cities, which will require more food to move from farm to city.

In most of the less-developed countries, a relatively small percentage of the population still lives in urban areas: 9 percent in Sierra Leone, Kenya, and Sudan, 10 percent in Burma and Afghanistan, 18 percent in India. But the trends are upward, and can be expected to continue in that direction as improvements in agriculture reduce farm employment and accelerate migration from the countryside. Between 1950 and 1960, for example, urban population in India increased 49 percent, and in Pakistan 79 percent. Comparable trends were recorded in the Philippines, Korea, Turkey, China, Peru, Venezuela, Colombia, and Kenya (Table 2).

Along with urbanization and industrialization, efforts to raise living standards throughout the world will hopefully result in substantial increases in incomes. In countries with minimum diets, such increases will mean added outlays for food as well as changes in the kinds of food consumed. Family budget data for 16 urban communities in tropical Africa, for example, indicate that well over half of all consumer expenditure goes for food (1). Furthermore, as incomes rise, food purchases shift from corn, wheat, rice and other staples to a more varied diet that includes dairy products, meat, fresh fruits and vegetables. The result in a disproportionate demand for the high-quality transportation services that perishable products demand.

INPUTS NEEDED FOR HIGHER YIELDS

It is no longer possible to produce more food simply by expanding the area under cultivation. The supply of virgin land is disappearing, and major increases in output can be accomplished only from high yields per acre. India, China, and Pakistan, which account for 60 percent of the total population of the underdeveloped world, are now almost entirely dependent on increasing yields per acre for additional food output (2).

To accomplish more production per acre presupposes improved systems of transportation, because adequate inputs of fertilizer, seed, machinery, and other ingredients of intensive agriculture are required. When food output is raised by expanding the cultivated area, the inputs used are generally small. But efforts to achieve higher yields per acre require heavy inputs, especially fertilizer. This also creates surplus output that farmers must move to market.

TABLE 2
INCREASES IN URBAN POPULATION IN SELECTED COUNTRIES, 1950-60[a]

Country	Millions in 1960	Percentage Increase 1950-60
India	35.0	49
Pakistan	6.9	79
Philippines	2.7	51
Korea	5.2	76
Turkey	3.4	96
China (Taiwan)	2.6	64
Peru	1.5	79
Venezuela	2.1	147
Colombia	4.0	177
Kenya	0.41	416
Congo	0.83	247

Source: Urban Land Institute. World Urbanization: Expanding Population in a Shrinking World. Tech. Bull. 43, pp. 45-46, 1962.

[a]Urban areas of 100,000 or more.

Although in most developing countries only one-fourth to one-half of what is produced is sold, the proportion of farm output that is marketed will increase as intensive agriculture expands and as the improvement of transportation reduces costs and makes marketing possible. The effect of improved transport is illustrated by the construction of all-weather roads to serve Indian villages. These facilities have been a primary factor in increasing farm incomes. Where grain production continued to be the principal activity, improved transport reduced the cost of local haulage by a sufficiently wide margin to greatly increase the inputs and marketable output per acre. In some cases transport improvements resulted in altering the pattern of agriculture from less remunerative food grains to vegetables and dairy products. The higher returns resulting from this shift make it possible to purchase increasing amounts of fertilizer.

The effect of intensive agriculture on transportation demand is measured by increases that have taken place in the use of commercial fertilizers. In 1952-53, the world consumption of fertilizers totaled 17 million metric tons. Less than a decade later, in 1960-61, the total had risen to 29 million metric tons. The largest increases were in Latin America, where consumption rose 163 percent, and in the Far East, where the increase was 115 percent.

While many factors contribute to higher agricultural yields, including improved seed, insect and disease control, irrigation, drainage, and mechanization, the use of commercial fertilizer is probably the factor most responsible (3). Experiments designed to isolate the productivity effects of fertilizer have been conducted in a number of countries, and the results, summarized in Table 3, show the very substantial increases in yield that can be obtained.

Per-acre yields in developing countries have not increased by very much as yet. From the late 1930's to 1960, the increase for Asia and Latin America was only 10 percent, compared to 190 percent for North America. But the move toward greater use of fertilizers is illustrated by Indian agriculture in the Fourth Plan. The level of fertilizer consumption in India is extremely low—one-hundredth of the level achieved in Japan. Yet the goal of 120 million tons of food grain production in 1970-71 is a 30 percent increase over 1965-66. To achieve this goal, the use of nitrogen fertilizer will have to be increased from two-thirds of a million tons per year to 2 million tons, a 24 percent increase.

Other inputs for Indian agriculture will also add to the transport burden. By 1970-71 the area to be treated with plant protection materials is expected to quadruple, requiring a 167 percent increase in the availability of pesticides, weedicides, and rodent control materials. The use of hand and power sprayers and dusters will add further to the distribution of agricultural inputs.

Local industry is also expected to expand the production of small gasoline engines used for plant protection, small irrigation works, and other purposes. During the Fourth Plan period the supply of new power-operated machines plus manually operated equipment will rise by one-third of a million units. Agricultural equipment to be delivered in the entire five-year period will total 1,260,000 units.

Tanganyika provides another illustration of the trends. Between 1945 and 1960 there was a twentyfold increase in the tonnage of fertilizer imported, most of it used by estate agriculture producing sugar, tea, and tobacco. There has also been a massive increase in the use of chemical insecticides and fungicides. The growing demand for food has made it increasingly difficult to apply the old method of increasing fertility by letting the land lie fallow for fifteen or twenty years before cultivation is resumed. Research has now indicated how soil maintenance is possible, but in Africa, as elsewhere, the economic barrier is often transportation: ". . . the high cost of carrying fertilizer from port to farm, and the high cost of carrying crops from farm to market. With improved lower cost transportation we may look for the gradual spread of fertilizer use . . . " (4).

Obviously the effects of fertilizer can be realized only if adequate facilities make it possible that fertilizers reach the cultivator at the right time (5). This means roads, vehicles, and a network of distribution centers in rural areas, within easy reach of the farmer. In developed countries these are taken for granted, but in poor countries the lack of such facilities precludes the general use of fertilizers,

TABLE 3

EFFECT OF FERTILIZER ON YIELDS OF SELECTED CROPS

Country	Crop	Duration of Experiment (years)	Percent Increase in Yield per Fertilized Hectare[a]
India	Tea	10	92
West Germany	Hay	10	146
India	Tapioca	1	197
Tanganyika	Peas	1	217
United States	Wheat	4	247
Puerto Rico	Sugar Cane	5	318

Source: Food and Agriculture Organization of the United Nations. The State of Food and Agriculture, 1963, p. 144.

[a]With most favorable combination of primary nutrients, nitrogen, phosphorus, and potassium.

as well as the adoption of other technological innovations. ". . . it can be stated with confidence that reduction of distribution costs is now the essential condition for bringing many technical innovations effectively into play" (6).

Along with fertilizers, a related factor in the improvement of agriculture has been the increasing reliance on mechanization, which in turn has depended on the availability of roads and other transport facilities. In 1960, for example, there was a total of 11 million tractors in use on farms throughout the world. But 9 million of these were operating in countries with highly developed agriculture—in North America, Europe, and Oceania. All of the Far East had only 70,000 tractors. Tractors are rapidly increasing in number in many low-income countries, however, and the trend is creating new demands for transportation of fuel and lubricants, as well as spare parts. The farm tractor is also used as a transport vehicle, and depends on improved roads for moving produce to market and hauling supplies to the farm.

RELATION OF ROADS TO PRODUCTION

The transport implications of improving agricultural yields can be seen in the relationship throughout the world between the miles of road per square mile of cultivated area and agricultural progress. In agriculturally advanced Western countries, the number of miles of farm-to-market roads per square mile of cultivated land varies between 3 to 1 and 4 to 1. The lower ratio is found mainly in grain-producing areas where fields are large. The ratio rises where farms are smaller and the topography difficult. In Britain, France, Japan, and the United States, the ratio is around 4 to 1. In Taiwan and Denmark it is closer to 3 to 1. In India this ratio is only about two-thirds of a mile of road to a square mile of cultivated land. In Malaya it is about ¾ to 1, and in the Philippines around 1 to 1. The statistics indicate that a certain minimum density of farm-to-market roads is present where rural development has achieved high levels, and that none of the poor countries has nearly enough mileage (7).

In India farmers using modern technology are nearly all within a mile or a mile and a half of some sort of reasonably good road. Very few farmers farther than this are using modern methods. Without discounting the many other factors involved in persuading villagers to use modern technology, there is a definite relationship between proximity to a road and the rate of change. Since three-fourths of the villages of India are more than a mile and a half from a road (Table 4), it appears that under present access conditions, any hope of raising productivity in Indian agriculture may be limited to around one quarter of the total farm population. Without improved roads, it appears that most agricultural development efforts will not succeed.

India depends on imports of 6 to 7 million tons of food grains annually. The production of more food is the number one problem to be resolved. Yet India's rural areas are virtually isolated from the rest of the economy, with the result that neither farm supplies nor new ideas can move to where they are needed. Only 11 percent of India's 500,000 villages are connected with the rest of the country by an all-weather road. Seventeen percent of these villages are more than 10 miles from all-weather roads. One out of every three villages is more than 5 miles from a dependable road connection.

Indian attempts to improve the standards of rural road transport are based on plans determined mainly by political and geographic considerations rather than agricultural requirements. The objective of the program, with a target date of 1981, was to bring every village in a developed agricultural area within 4 miles of hard-surfaced road and 1.5 miles of any road

TABLE 4

PERCENTAGE DISTRIBUTION OF VILLAGES BY DISTANCE FROM THE NEAREST HARD-SURFACE ROAD IN INDIA, 1958-59

Distance	Percentage of Villages
Within village	10.9
Up to 1½ miles	18.2
Between 1½ and 3½ miles	20.7
Between 3½ and 5½ miles	12.3
Between 5½ and 10½ miles	15.9
Between 10½ and 20 miles	9.6
Above 20 miles	7.8
Information not available	4.6
Total	100.0

Source: Ministry of Community Development.

by that year (8). Other villages were to be brought within 8 to 12 miles of a surfaced road, or 3 to 5 miles of an unsurfaced road. This program is unrelated to the use of the roads, or to the objectives of the rural economy. Villages that are simply brought nearer to an all-weather road, rather than connected with it, are hardly in a better position to help increase the production and marketing of food.

INTENSIVE AGRICULTURAL DISTRICT PROGRAM

A solution to India's rural road problem is suggested by the new Intensive Agricultural District Program undertaken to concentrate needed agricultural inputs in certain areas having promising potentials for increased production. This "package program" was designed to provide the means of realizing this potential. The means include help to the farmer in drawing up a farm plan, covering soil preparation, water management, application of fertilizers, seed, pesticides, tools, power sprayers, dusters and other farm machinery. The IADP approach also included a variety of "off-the-farm" activities essential to increased productivity, such as training, credit, cooperatives and storage. But despite the reliance on a greater volume of inputs, plus the marketing of increased output, the program did not include measures designed to improve transportation.

As could be expected, however, the areas where intensive efforts have been a success are those that are more accessible. For example, in the Ludhiana District of the Punjab, the package program has led to marked increases in wheat production per acre where access by road has made the program operable (Ludhiana District has 800,000 acres and 1.2 million people. It is about 40 miles by 20 miles. In each of the ten blocks of the District, there are 80 villages, 1,000 to 2,000 huts, 300 depots for the sale of fertilizer, and 1,000 rural credit societies.) After three years of the Five-Year experiment, the yield per acre had increased 40 percent, the area under cultivation had grown, and total output had expanded 68 percent. The consumption of chemical fertilizers increased from 5,500 tons in 1960 to 24,000 tons in 1963-64. The use of superphosphate had increased from 36 tons to 6,000 (9).

As a result of these efforts, farmers in Ludhiana District in 1962-63 were getting an additional return of 126 rupees per acre compared to extra costs of 54 rupees. And in Orissa, rice yields have averaged 2,574 pounds per acre in the package districts compared to 1,760 pounds elsewhere. The added return was 110 rupees per acre, compared to added costs of 60 rupees (10).

In areas where transportation is poor, however, supply problems have limited the effectiveness of the Intensive Agricultural District Program. Despite the variety of assistance available to the farmer, lack of transport has inhibited the program. In many areas of the Punjab, village access roads are poor, and the clay surface becomes so bad during two to three months of the year that it cannot be walked on, let alone be used by bicycles or animal-drawn carts. In these areas it has not been possible to grow vegetables and other perishables for market, since transport must be quick and reliable to enable growers to move their produce to town daily. On a poor road the trip to market, if it is possible at all, may be too hard on the bullocks. Their task is to get the plowing and cultivating done, so that farmers are reluctant to use them for transport. Milk producers living on a poor road find it uneconomical to market their milk because the milk collector, who travels by bicycle, cannot carry enough on a bad road to make the trip pay. He is able to carry at least twice as much milk on a good road, and therefore avoids collecting from farms with poor access.

The return realized by wheat farmers is also limited by the cost of transport over bad roads from his village to the main highway. Average charges for bullock cart transportation to market were found in one location to be from 10 to 20 cents per 82 pounds for only a few miles. This cuts the farmer's margin and prevents him from purchasing the things he needs to run his farm efficiently.

Farmers are also unable to specialize where transport is poor. Each grower attempts to keep himself and his family supplied with a variety of food, and he retains more than he may actually need since he knows that in the event of a short supply it will be difficult to obtain deliveries from other sources.

Farmers on bad roads have additional problems. They find it difficult to persuade rural electric authorities to extend service to areas where maintenance of lines will be impeded by poor access. Plant protection measures as well as fertilizing are made difficult due to infrequent deliveries and unreliable schedules. A very small percentage of high school age children are able to get to school. Literacy workers shun the village that is poorly served by road, and agricultural extension workers find it either impossible or too time-consuming to visit farmers on muddy roads. Villages far from an all-weather road complain of being unable to get help in constructing a well. Thus it can be said that even where a variety of help is available to the farmer, it will stop short of his farm unless it is adequately served by road.

COMBINING PUBLIC WORKS AND AGRICULTURAL DEVELOPMENT

In East Pakistan, one of the most densely populated areas in the world, access problems have also been a serious obstacle to rural development. Transport is particularly hampered by the combination of low-lying land, intricate river system, and monsoon flooding. Farm-to-market transportation has been accomplished principally by country boat, a method made unreliable during the winter drought and summer rains.

Several years ago an effort was begun to remedy some of the conditions that made agricultural yields in East Pakistan among the lowest in the world. The farming population was idle during the four dry winter months. Half the landowners were in debt. High interest rates discouraged the financing of fertilizer and other inputs. The situation was not the kind that one would expect a roadbuilding program to cure. Yet the rural public works program in East Pakistan, concentrating on roadbuilding in relation to the development of agriculture, has demonstrated how roads plus other necessary measures can create successful agriculture (11).

A key step was the organization of a pilot rural works program financed by the Department of Agriculture. New roads were selected for labor-intensive construction by the villagers. The roads were of low-type design, adequate for marketing crops by rickshaw and bullock carts rather than by headloading. The result was an 80 percent reduction in transport costs that increased the price realized by the farmer by more than 1 rupee (21 cents) per maund (82 pounds) of paddy. In addition, the amount of wages paid to those who worked on the program greatly stimulated purchases in the area and overcame the traditional suspicion of government. The cooperatives expanded very rapidly, and the program helped to uncover significant skills and organizational ability among rural residents.

When the effort was expanded to the whole of East Pakistan, thousands of miles of roads were constructed or repaired, canals and embankments were improved, and bridges and culverts constructed. There was a project every ten miles throughout the province. With great numbers of workers participating, projects were completed quickly at a very low cost. A total of two million man-months of work was provided in one year, and the new purchasing power created an estimated million man-months more. The next year, 1963-64, the rural works program was doubled.

The physical accomplishments from 1961 to 1964 included the improvement or construction of 24,000 miles of village-to-market roads and more than 700 miles of asphalt roads. Work was also done on 5,400 bridges and culverts and on 6,000 miles of drainage canals (12).

TRENDS IN MOTOR TRUCKING

Improved highway transport requires vehicles as well as roads, and this aspect of the problem is often left to chance. In India today the principal vehicles are bullock carts. While animals have the reputation of furnishing low-cost transportation, the facts indicate that for most types of work this is an illusion. The bullock averages 1.5 miles per hour with a load of 1.5 to 3 tons. Costs on a ton-mile basis are 22 to 44 cents per ton-mile.

The attraction of bullock carting has declined with the rising cost of carts, bullocks, and their upkeep, and with the improvement of roads and the use of trucks. In Madras it was once common to carry freight up to fifty miles by bullock. Now twenty-five miles

TABLE 5

GROWTH IN THE NUMBER OF TRUCKS, SELECTED COUNTRIES, 1956-1964[a]

Country	Number of Trucks		Percentage Increase,
	1956	1964	1956-1964
Nicaragua	2,461	4,577	86
Peru	43,616	73,232	68
Mexico	194,491	352,681	81
Argentina	148,505	496,500	234
Brazil	301,449	655,874	118
Chile	41,370	82,548	100
Turkey	35,050	80,695	130
India	94,102	219,591	133
Pakistan	13,100	21,137	61
Thailand	19,300	59,160	207
Burma	9,200	18,400	100
Nigeria	16,625	33,455	101
Algeria	50,663	86,500	71
Sudan	9,495	16,540	74
Japan	687,000	3,324,749	384

Source: Department of Commerce. World Motor Vehicle Registrations, January 1956; and, World Motor Vehicle Production and Registration, 1963-64.

[a]From January 1956 to January 1964.

TABLE 6

GOODS TRANSPORT BY TRUCK IN INDIA[a]

Product	Tons	Ton-Km (thousands)	Average Haul (km)
Delhi to Bombay			
Foodgrains	3,683	1,195	324
Fruit and vegetables	5,951	1,921	323
Fodder	1,919	307	160
Cotton	1,225	829	677
Livestock	1,095	1,421	1,298
Building materials	1,240	335	270
Oil	2,515	1,199	477
Sugar	1,343	717	534
Textiles	3,366	3,271	972
Ghee and vegetable oils	1,540	980	636
Iron and steel	2,202	1,467	666
Machinery	1,837	2,381	1,296
Medicine and chemicals	1,600	1,551	970
Provisions	1,363	1,149	843
Other	11,759	9,883	840
Total	42,638	28,610	671
Madras to Cochin			
Foodgrains	7,212	1,721	239
Fruits and vegetables	3,868	1,474	381
Wood	2,993	658	220
Oil	2,878	701	244
Iron and steel	2,622	1,026	392
Textiles	2,215	773	349
Fertilizer and manure	1,727	392	228
Medicine and chemicals	1,543	432	281
Tea and coffee	1,378	476	346
Cotton	1,324	497	376
Provisions	1,258	372	296
Building materials	1,180	232	197
Machinery	1,138	389	342
Other agricultural products	1,108	324	293
Other commodities	11,369	3,591	316
Total	43,813	13,066	298

[a]Data from a 7-day survey in 1963.

is generally the limit. Thus the number of carts has remained stationary, and from 1950 to 1960 the share of total road traffic moving by bullock cart has fallen from 50 percent to 25 percent (13).

The substitution of farm trucks for bullock carts will be hastened both by better roads and by the increasing mechanization of agriculture. Trucks do not operate on the usual dirt road or track, but both buses and trucks, including three-wheelers, are appearing on many rural roads that have been improved to motorable standards. The introduction of tubewells and mechanical threshers, as well as the small tractor, will likewise encourage the shift to motor transport, since the economic justification of the bullock as a method of transport is tied to other non-transport duties such as water pumping, millet threshing, and plowing.

But equally important to local transportation are adequate long-distance transport facilities from local marketing centers to urban consuming centers. With the development of motor roads, growing volumes of agricultural products and agricultural inputs have been moving by truck. For perishable produce such as apples moving from Pakistan's Northwest Frontier Province to Lahore, the movement is principally by truck. The same is true for the hauling of vegetables from the Punjab, and for milk shipments to Delhi. A successful effort to increase food supplies assumes a growing role for motor trucking, for the time required to transport by rail often precludes the movement altogether or involves heavy losses en route.

Indian agriculture has become increasingly dependent on over-the-road transport for the marketing of perishables. On the route from Delhi to Bombay, for example, the largest single class of freight is fruits and vegetables (Table 6). Approximately 40 percent of total tonnage represents products of agriculture. The most remarkable accomplishment of road transportation to date is the fact that growth has taken place despite every kind of obstacle: poor roads, inadequate terminals, the high price of vehicles, high taxes, restrictive licensing policies, and police harassment of vehicle operations at local tax barriers and other check points. The evidence illustrates how desirable truck transport has become from the standpoint of farm economics, even where service is extremely poor.

In Ghana the process of marketing food has been greatly enhanced in recent years by the advent of trucking and the expanded production of cash crops which the truck has permitted. In a recent survey of truck operations, it was found that 55 percent of food destined for Accra was moving over 50 miles, and that 30 percent came from places 100 miles away or more. With speedy truck transport, a high degree of specialization in food cropping had developed. None of the regions supplying Accra shipped any appreciable volume of more than one commodity (14).

TRANSPORT'S CONTRIBUTION TO RURAL DEVELOPMENT

In addition to improved transport of agricultural inputs and resulting outputs, agriculture also depends on better education, health, and a wide variety of innovations that contribute to rural development. Transportation investments can contribute importantly to achieving these other goals that underlie the transformation of agriculture.

This is illustrated by a recent case history of the economic impacts following construction of the 20-mile Ramnad-Mandapam road in Madras (15). Before the road was built, the towns of Ramnad and Mandapam were joined by rail and by a narrow path, unusable even as a cart track. Mechanized passenger transport was totally absent.

After the new road was opened, things began to happen. Two bus companies with four buses began operations. Regional industries began to grow, such as milling and pottery, with accompanying increases in employment. The fishing industry expanded rapidly, for now the surplus catch could be marketed in regions away from local consuming areas. Many retail shops were opened.

The trend in prices indicates a steady decrease in geographical price differentials between rural areas and the more accessible towns. A network of feeder roads, partly induced by the new highway, has helped bring village prices more in line with those prevailing in the Ramnad market. There has also been an increase in the number of elementary schools and in student enrollment. Six post offices are operating compared with three before the road was built, and a number of dispensaries have been established (16).

The situation is duplicated in many parts of India and Pakistan. In one village in Rajasthan the construction of a 5-mile hard-surfaced link road changed the whole pattern of farm life. There was an increase in tubewell construction, sugar cane was grown and transport provided to the mill. A cooperative society was started and is supplying fertilizer, and there is a hospital, an animal hospital, two new schools, and four bus lines with connections to Delhi. Further benefits from road programs include increased employment and incomes in the villages. Road work can be done in the slack season, and can supplement farm income at a time when needs are greatest.

PLANNING TRANSPORTATION FOR FOOD

A successful strategy to guide rural transport planning might best be found by aiming first at the realization of increased food production and marketing. If the resources available to improve agriculture are to be employed to maximum advantage, it will be necessary to weigh the merits of various combinations of inputs. It will generally be essential to build some type of road to provide the necessary minimum standard of transportation. There will be the further questions whether transport services should be animal-drawn or motorized, whether vehicle capacity can be reduced by minimizing peak transportation demand through storage facilities and processing plants, and what role can be played by cooperative organizations and local governments.

Decision makers cannot afford to overemphasize transportation and neglect fertilizers. They cannot afford, within the transportation sector, to concentrate on roads to the exclusion of vehicles, or to neglect storage and processing solutions that might make for a more successful agricultural program than could be obtained by transport solutions alone. The decision maker has to weigh all of the significant factors and combinations of factors capable of increasing agricultural output. It is obvious that the methods of allocating resources to transport and of conducting rural development programs today are not designed to arrive at anything like an optimal solution.

Yet it is clear that the time for transport planning in isolation has passed; that a systems approach to agricultural development is essential if the problem of feeding the world's people is to be successfully resolved. This will require the closest collaboration of transport and agriculture ministries at the national level and establishment of broadly conceived agricultural development agencies at the local level. The basic requirement will be flexibility in the use of funds in order to achieve the maximum supply of food.

A model of a combined agriculture and transportation plan, including related investments, should include the following:

1. Cooperative establishments providing for (a) the distribution of fertilizer, seed, insecticides and tools, and the rental of tractors and other equipment; (b) loans for the purchase of agricultural inputs, payable through the delivery of produce for marketing; and (c) the sale of consumer goods.
2. A network of storage facilities to minimize loss of crops and to reduce the peak flow of perishables at the harvest.
3. The establishment of processing plants that will provide off-peak employment, reduce spoilage, and maximize local income.
4. A network of roads located on the basis of agricultural production potentials, whose construction and maintenance will provide local employment and foster the development of local government institutions capable of performing other kinds of public services.
5. A truck fleet, operated by cooperatives where desirable, to provide pickup and delivery service.

Systems analysis provides the tool by which transportation can be viewed as one of the essential ingredients of agricultural progress. With the help of the computer, it is now possible to simulate the inward and outward flows of traffic and to test the effectiveness of various transport and non-transport methods of handling these flows. Developing nations can view transportation planning as part of the whole process of assuring enough food for sustained economic growth.

REFERENCES

1. Kaneda, Hiromitsu, and Johnston, Bruce F. Urban Food Expenditure Patterns in Tropical Africa. Food Research Institute Studies, Vol. 2, No. 3, p. 268, Stanford Univ., Nov. 1961.
2. Brown, Lester R. Population Growth, Food Needs and Production Problems. In World Population and Food Supplies, 1980, p. 11, American Society of Agronomy, Feb. 1965.
3. Food and Agriculture Organization of the United Nations. The State of Food and Agriculture, 1963, p. 137.
4. Jones, William O. Food and Agricultural Economies of Tropical Africa. Food Research Institute Studies, Vol. 2, No. 1, p. 10, Stanford Univ., Feb. 1961.
5. FAO, op. cit., p. 162.
6. Jones, William O. Economic Development in Tropical Africa. Food Research Institute Studies, Vol. 5, No. 2, Stanford Univ., 1965.
7. Owens, Edgar L. A Study of Politics and Development. The Brookings Institution Federal Executive Fellowship Program, 1965. In process.
8. Report of Chief Engineers on Road Development Plans for India (1961-81). Ministry of Transport and Communications, Government of India, New Delhi, 1958, p. 32.
9. I. A. D. P. Ludhiana. Story of Wheat, Groundnut and Maize in Ludhiana. 1964.
10. Ford Foundation. India's Intensive Agricultural District Program. India Program Letter 134, New Delhi, July 10, 1964.
11. Pakistan Academy for Rural Development. Fourth Annual Report, June 1962-May 1963. Comilla, East Pakistan, 1963.
12. Gilbert, Richard V. The Works Programme in East Pakistan. In Development Digest, Vol. 3, No. 2, pp. 19-30. National Planning Association, July 1965.

13. National Council of Applied Economic Research. Regional Transport Survey of Madras State and Pondicherry. Nov. 1964.
14. Poleman, Thomas P. Ghana's Urban Food Economy. Food Research Institute Studies, Vol. 2, No. 1, p. 163, Stanford Univ., May 1961.
15. Economic Benefits of the Ramnad-Mandapam Road, 1959-60. Ministry of Transport and Communications, Department of Transport (roads Wing), Government of India, 1961.
16. Wilson, George W., Bergmann, Barbara R., Hirsch, Leon V., and Klein, Martin S. The Impact of Highway Investment on Development. Brookings Institution, 1966.

Inventorying Research and Development on Roads and Road Transport

ROBERT O. SWAIN, President, and SIR WILLIAM GLANVILLE, Consultant,
International Road Federation

•COMMUNICATION between individuals, between communities, between nations and between groups of nations is basic to human progress. This has been said many times, but it takes on a new dimension in the context of today.

Communication advances come at an increasingly rapid pace. In science-based activities, such as radio, television and air and space travel, the speed is breath-taking, so fast indeed, that even the trained scientists and specialists find it hard to keep pace. The field of research continually expands, the number of individuals engaged in it grows, the number of centers multiplies, and larger groups are formed to use advanced and increasingly expensive equipment and techniques. Developments in one mode of communication have an influence, often a very direct influence, on progress in another; thus, to give a simple example, the control of aircraft and the control of road traffic depend upon the advances in communication by radio and television.

The road industry is not science-based as that term is ordinarily understood. But a scientific approach is of such fundamental importance and the potential applications of science are so great that road research is now expanding rapidly throughout the world. The movement of the individual and his goods with safety, speed and economy in all climates brings with it many problems in the building of roads, bridges, tunnels and other structures, and in producing safe and fast vehicles and in the discipline and training of the people who use them.

Against this background, it will become increasingly profitable to insure two things: first, that information is quickly recorded and stored, so that all those engaged in research can find out what has been done and is being done, avoiding unnecessary overlapping and costly repetition; and second, that the fruits of research can be put to use with as little loss of time and effort as possible.

To help satisfy these needs in the field of roads and road transportation, the International Road Federation has been working for the past two years with the support of the U. S. Bureau of Public Roads to prosecute a policy of world research cooperation.

This work began in a modest way in 1964, with pilot studies to test the feasibility of conducting an international survey of current research. The project was briefly reviewed at the Highway Research Board meeting in January 1965; later, it formed the subject of a detailed report, "Methodology of International Highway Research and Development Exchange," submitted by the IRF to the U. S. Bureau of Public Roads in January 1965.

The 1964 study was of an exploratory character. It was based upon the results of personal interviews with research personnel in four Western European countries—Sweden, West Germany, Italy and Denmark. Nearly 280 individual projects were reported. This was, in fact, one of its most important results—disclosure that a great deal of valuable research, unknown in the United States, was in progress in Europe, and that research activity was spreading rapidly. This led to the conclusion that an inventory should be actively developed; when in full operation, it would become an essential tool for advancement of research and development on roads and road transport throughout the world.

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

The Bureau of Public Roads agreed with this view and undertook to help again in an extended effort during 1965 aimed at widening the geographical scope.

The area covered by the new survey was considerably increased above that of 1964. It included 17 countries in three broad geographical areas—Western Europe, the Americas, and the Far East. The countries were Argentina, Australia, Brazil, Canada, France, Germany, Great Britain, Ireland, Italy, Japan, Mexico, New Zealand, Norway, the Philippines, Portugal, Spain, and Venezuela. Note that the inventory was repeated in two countries visited in 1964, Germany and Italy. This repetition was included to produce a comparison between the 1964 and 1965 surveys and to provide information about the desirability and future need for some means of keeping the inventory up to date and for broadening its scope.

The need for cooperation has already been touched upon. Research on roads and road transportation is widely dispersed over the world. It is financed in a variety of ways and is concerned, as already indicated, with a wide variety of subjects. There is at present little attempt at coordination over the whole field in any effective sense; the organizational methods vary widely. To attempt an overall survey, even in the limited area of current research, is by no means straightforward, and depends as much upon the free cooperation of all concerned as upon anything else.

There are advantages to the individual research worker and research organization in such cooperation. They can expect to gain from information obtained from others and, moreover, feel rewarded by the knowledge that their own research is known to others. But whatever the advantages, the key to success must always be cooperation, and the measure of success will depend directly upon the effort expended by each individual, each organization, and each country in giving and in receiving. The greatest rewards can only be achieved and shared if all play their full part.

In Europe, a high degree of cooperation has been obtained, despite language difficulties and differences in the modes of organization for research. The Organization for Economic Cooperation and Development (OECD) has played an important part in fostering this cooperation, and the European Conference of Ministers of Transport, an arm of the OECD has given full support. The OECD has indicated its "pleasure in meeting such a fine spirit of cooperation," its view that "the results achieved are very encouraging" and its wish to cooperate in future programs.

Individual countries, too, have shown a spirit of cooperation which, translated into active assistance for the project, has been greater than anything anticipated.

For example, in England, the Road Research Laboratory has collaborated in collection of information and has contributed generously to the tasks associated with the survey. In Germany, the Forschungsgesellschaft für das Strassenwesen has provided much help, and also furnished a center from which the interviewing and correspondence involved could be conducted. In France, the Laboratoire des Ponts et Chaussées and other organizations have provided useful assistance. The three centers mentioned have become the European—English, German and French—centers linking up with the OECD and the HRB.

The IRF-affiliated national road federation in each country has also given generous support in providing introductions and physical facilities which proved invaluable in launching and conducting the survey in each area.

Some research organizations, however, find difficulty in fully sharing knowledge about current research. This is as might be expected, mainly in commercial undertakings where research is regarded as a business asset and an investment by the firm concerned. Moreover, research workers sometimes dislike giving any information until they are able to announce completed findings.

It is notable that there are few, if any, researchers who really know all that is going on in their own countries. Even where research is nationally coordinated or subsidized, there are many projects being conducted independently, or in areas not directly linked to highways.

It has not been possible, in many cases, to obtain costs of individual programs, particularly where they are subsidized by private grants. Some people fear to excite the interest of the internal revenue authorities. There is, too, the difficulty of finding a common basis for costs because of differing methods of accounting. This has not proved serious, since costs are required only as an indication of comparative activity in different fields—precision is not essential to the success of the survey.

During the course of the work, a growing interest in a usable inventory has been shown everywhere. In the few difficult cases, the desire to cooperate has increased as the work has proceeded. The issue of the HRIS book of abstracts, "Highway Research in Progress," which included information from the 1964 IRF survey, has been particularly helpful in encouraging cooperation.

In conducting a survey covering 17 countries where many different languages are spoken it was expected that special precautions would be needed in translating highly technical and specialized terms. Indeed, difficulties were met, but were largely overcome with the help of technical experts well qualified in both the local tongue and the English language. The network of road associations identified with the IRF and the more than 400 qualified engineers who have participated in the IRF fellowship program, and who hold positions of leadership in some 80 of their own countries, have helped to spread the use of common terms. It is, by the way, most encouraging to see what these and other trained professional engineers have achieved in the last twenty years through superior planning, design, construction, maintenance and administration of highways in both developed and developing countries—and under the usual handicap of insufficient funds.

Even with this sort of help, the language barrier is not easy to surmount, although it concerns the mechanics of the job rather than the basic issue. In many instances interviewers have needed interpreters, always a handicap to free conversation and clear understanding. A project abstract furnished in an unfamiliar tongue is not easily reviewed and edited by the interviewer. In further processing, the report must be translated into at least two other languages—three if the original language was not one of those provided for in the Information Centers of the OECD. And the translation of technical material requires a knowledge of technical meanings that are not always the same for similar or apparently identical terms. Local or national usages differ even in a single language. Sometimes there is a lack of a precise equivalent for a term found in another language. These are, at best, inconveniences; at worst, they can lead to very mistaken or misleading reports of research. The need for technically trained translators is obvious.

Language difficulties might be reduced by having the inventory in each country made by a national of that country. But it is important, in so wide a field as roads and road transportation, that the activity should not be inadvertently restricted by employing a person who is experienced in a strictly limited aspect only and may be unaware of the wide field to be surveyed. Indeed in some cases an expert in his country has begun by being certain that research was far more limited than it ultimately proved to be. For this reason, a highly qualified expert from another country is sometimes more effective, although, for obvious reasons, and to avoid misunderstanding, there must be no suggestion of interference with what is, after all, primarily the business of the country itself.

In its earlier planning the International Road Federation felt that it would be logical and highly desirable to have one comprehensive international storage and retrieval center. Experience with the difficulties of translating technical language—even between "English English" and "American English"—has clearly indicated the need for national or at least regional centers where professionals familiar with local usage can produce technically correct texts. Such regional centers for Europe are being provided, as already mentioned, by the Organization for Economic Cooperation and Development.

One of the important aspects in compiling an inventory is to identify what should and should not be included. There is scarcely a branch of science that is not involved in some way, and in the broadest sense it could be said that there are virtually no barriers. For example, advances in electronic research of the most basic kind may be found to have direct bearing on the control and handling of vehicles. Profound advances in medical science may lead to a better understanding of the human problems in relation to highway usage. There also may well be basic mathematical research which leads to a better appreciation of traffic problems. Studies of principles of soil mechanics, geology, structural characteristics—all of which have broad application to the general field of construction—also should be closely related in any inventory compiled for the use of road designers, especially in those areas where these subjects are investigated primarily in relation to other fields.

It seems inevitable, in view of this, that the first requirement should be a link between the road and road transportation problem and the research conducted, and generally, therefore, that the research be conducted with the aim of improving conditions in roads or road transport.

The application of existing knowledge to highway problems in a routine manner can be expected, in the majority of cases, to be of very limited interest. The design of a conventional bridge, based on known principles applied to a specific location, is equally doubtful. Routine planning in a given situation, even though it requires the compilation of much background data, can hardly qualify as research, unless some new principle or new technique emerges which in itself is worth recording.

In fact, it is clear that the inventory cannot maintain a distinct line of demarcation. Omissions will be found about which opinions differ, but it is hoped that research workers and others will understand the difficulties if they note inconsistencies in the recording of their field of interest. Borderline projects generally have been included where reasonable doubt has existed.

Now a few words about where research is found and who is doing it. Generally speaking, research is found in three types of agencies—governmental, academic and commercial. The organizational arrangements vary widely, and time does not permit my describing them here in any detail. The three categories are by no means distinct. For example, universities often undertake research under contract to a government, or have direct affiliations with highway departments. Some receive funds from commercial agencies. Some engage in strictly independent engineering research. Highway authorities often have their own research laboratories for their own personnel. Some commercial agencies find research a valuable means of finding new applications for their products and of producing new materials and processes. Independent research laboratories may operate on a wholly commercial basis. Foundations are endowed to conduct their own research or to make grants in support of research.

In each country, one of the responsibilities assigned to field representatives in the research inventory was to observe and report on the research agencies in that country, their organization, the extent of their coordination, their sponsorship, and the nature and quality of the forthcoming research. These appraisals are in some degree, of course, a matter of personal judgment. This will be fully covered in the final report.

The national organization or administration of research is of little direct concern insofar as it influences the quality of the work, but it must be understood if the interviewer is to be efficient in tracking down all sources of useful information. It may also have a bearing on the willingness or ability of research personnel to discuss their programs freely, particularly on incomplete or unpublished projects. It is hoped that the program and the publicity given to it will help to overcome habits of secrecy or reticence in highway research by demonstrating the advantages that follow the spreading of knowledge.

Some of the resistance appears to stem from a reluctance of the individual researcher to act without authorization from his supervisor or his sponsors. In such cases, approach at a higher level has frequently overcome the difficulties, particularly when it is realized that highway research is a field where free exchange of knowledge is to the advantage of everyone, and that it will usually advance national or personal prestige. The individuals directly engaged in research are not always those to whom official credit is to be given—there is sometimes a sort of hierarchy in government or academic circles in which the responsibility for and the basic ideas themselves derive from a superior official. It is, therefore, difficult to assign responsibilities, but it would seem preferable to include the names of the actual workers, if for no other reason than they may well be the ones who can best discuss the work in detail in response to subsequent inquiries.

It now appears that one of the significant findings is that valuable research can be discovered in seemingly impossible places, and that only a most searching inventory can bring some of it into the open. And there is always a danger that a systematized inventory of "official" projects can further obscure some independent and sometimes apparently unrelated research. Who can tell where pure research in physics, or in the biological sciences, or even in the exploration of the mind may have impact on our highways? Such fringe projects, even when advanced to the point of application to the highway problem, can easily get lost, particularly if the research inventory is made through a central authority that is circumscribed in its interests. A means of insuring wide coverage is, therefore, necessary. Methods of bringing the research agencies together for discussion on how to accomplish this need further consideration. To some extent this is being attempted in Europe.

Our estimates for current research in the 17 countries inventoried last year indicate a total of some 2400 projects. While all of these are in the process of analysis, we have been able to cite certain activities that may be of general interest—bearing in mind the preliminary status of our work. These are projects which for the most part are new to the U.S. Four hundred and sixty of these come from Germany and 350 with a total valuation of $4 million come from Japan.

Those who have been concerned, directly or indirectly, with the AASHO Road Test will be interested to know that three comparable tests, on a more modest basis, are being conducted in Mexico, under actual traffic, to obtain data for pavement design and performance. Mexico is one of the leading countries in the field of Seismic Engineering. Its "Engineering Institute" is considered one of the best research centers in Latin America.

A major undertaking in Venezuela seeks theories and methods essential for evaluating economic impact and feasibility of highway projects in developing areas. Elsewhere in the nation, the Venezuela Institute of Technological and Industrial Research is overcoming a lack of natural mineral aggregates by the manufacture of clay aggregates and the use of blast furnace slag from steel mills. The Catholic University "Andrés Bello" is engaged in a reciprocal research project with the Massachusetts Institute of Technology on "Load-Settlement-Time Characteristics of Deposits of Saturated Soils."

Brazil is reviewing its construction specifications, with a view to establishing the statistical value of acceptance and rejection of work performed. Electronic non-destructive testing is the main concern of many research agencies in Brazil.

Low cost measurement systems and equipment for industrial use in laboratory testing of portland cement concrete is the objective of the Institute of Applied Mechanics and Structures in Argentina, and in recognition of orographic problems, Argentina is deeply involved in research of soil stabilization and soil mechanics.

There are 42 organizations in France dealing with research and development in the areas of road and road transport.

Spain also has a test road. It is claimed that a unique feature of the test is the use of radio isotopes to measure the inclination of the German type tension meter "Ventilgaber" when placed in concrete pavements. This cell should be vertical in order to measure stresses in a pavement. By seeding its upper and lower edges with radioactivity it is possible to measure the angle it makes with the vertical and thus correct its reading.

The test road has different combinations of pavement and bases resting on subgrades with different Atterberg values. In some localities the subgrade had a liquid limit of 43.7 percent and a plasticity index of 21.9 percent while in other localities it has a liquid limit of 90 percent and a plasticity index of 57 percent. This differs from the AASHO test road which had a uniform subgrade. It will be possible here to study the behavior of the pavement as affected by the quality of the subgrade.

Germany has two notable types of research—one carried out by engineers and the other by learned societies and non-engineers. The problem of road transport and road traffic is so much the question of the day that many German learned and professional societies have working committees on roads and traffic. The Medical Society has a committee on Traffic Medicine; the German Psychological Society has a similar working committee. Their work was published for eight years in the Journal of Traffic-Medicine and Traffic-Psychology until it stopped publication in 1962. Since then, it has appeared in the German Traffic Safety Journal. The Psychological Society has found that a change in type of accidents over the past 10 years caused by drinking may be traced to the general economic advances that have made car ownership more common.

German economic and legal societies also have working committees. The legal staff of the Kuratorium of "Wir und die Strasse" went through all traffic violations in Germany for the last two full years and found that only 10 percent of the violators had more than one brush with the law in this period. This shows, they claim, that troubles on the roads are not caused by a small minority and that strict measures are not the answer.

The German Government Winter Services Station in the Bavarian Alps is experimenting with more than 20 types of equipment for snow removal and deicing. They are fitting a special truck chassis with a 125-HP engine for driving and a 250-HP engine for operating experimental snow-removal equipment (suckers, blowers, etc.).

Another interesting project mentioned in the 1964 IRF report is the work of Dr. Eisenman of the University of Munich on highway capacity. One of his findings is the need to alter the German law that requires for trucks a power-load ratio of 6 HP per ton of total weight. Changing this to an 8:1 ratio will alleviate conditions on the overworked roads of Germany.

An interesting example of research by industry is the one of Nordlabor in Pinneberg, near Hamburg. Recent German government roadbuilding specifications require constant and rigid quality control by accredited laboratories. State and institutional laboratories could not cope with the amount of work entailed, so some six or seven laboratories with first-class equipment were created to provide the service. The one at Pinneberg is doing so well that it can also indulge in research. Among its noteworthy facilities is a climate chamber of about one cubic meter capacity, coupled with computer programming. A program for climatic changes (rain, heat, dampness, freezing, thawing, etc.) can be fed to a computer indicating cycles, time of duration and other data. Recording apparatus checks on the computer program and also records the behavior of the sample or samples under investigation (volume changes, stresses, temperature at various depths of sample). This apparatus is used extensively to study asphaltic concrete, its aging and stripping characteristics.

In Australia, where a large road mileage serves small volumes of traffic, it is essential that roads be built and maintained at the lowest possible cost. Several projects are under way involving analysis of characteristics and best methods of processing of locally available granular materials and soft rock, and the best binding or stabilizing agents for road base material. Other highlights in Australia include many studies correlating flexible pavement design with wheel loads imparted by actual traffic. An extensive investigation is being made of the brittle fracture of welded steel in bridges at low temperatures. Teams of engineers, sociologists and medical workers are analyzing the causes of highway accidents, with particular attention to drivers' abilities and skills. A long-range program is devoted to city transportation planning. An interesting local study is that of the economics of operation and road capacity requirements of cattle road trains (two or three trailers in tandem pulled by one truck) in common usage in the out-back Northern Territory.

In Japan almost all types of research can be found, reflecting problems peculiar to the country. Investigations are being made of the working capabilities of various types of compaction equipment, and of optimum soil conditions for compaction. An indoor concrete pit has been constructed, large enough to accommodate full-sized machines working on material up to one meter in depth. "Kanto loam," a disintegrated volcanic ash, offers unusual difficulties as a base for roads, and is the subject of numerous research attempts at stabilization. The design of structures to resist earthquakes and storms is a significant problem. Many studies of stability are being made for a major suspension bridge, including tests in an excellent wind tunnel. Several universities are applying computers to problems of traffic, and to the engineering design of structures. There are numerous studies of long-range industrial development, land use and transportation demands. In the densely crowded areas of Osaka and Tokyo some viaducts are being built along and over rivers, calling for interesting studies of foundation and waterway problems. Research on tunnels is concerned with earth pressures and lining, and with problems of lighting and ventilation. A full-scale lining ring has been constructed for testing.

In New Zealand, the roadway approach to a toll tunnel has provided an excellent research laboratory for the study of flexible pavement behavior. On a uniform subgrade of rather poor quality, short sections were built in several different base and pavement designs, varying especially in the thickness of layers. With accurate information on the volume of traffic and the sizes and weights of all vehicles available from the toll records, periodic checks are made for surface deflections, cracking and other signs of stress. In quite another field, experiments are under way for the stabilizing of bank slopes through the establishment of vegetation. Methods tried have included the spraying of seed and fertilizer into place with an admixture of size, gelatin, asphalt emulsion or other adhesive agents, with promising results.

In the Philippines, studies are seeking to develop better techniques for building roads and structures out of locally available materials, including investigations into the use of bamboo as reinforcement in portland cement concrete.

Ireland is trying to find answers to soil problems, particularly the drainage and stabilization of peat and boulder clay. There is also a wide range of other research, from the design of highways and bridges to psychology of the driver and transportation planning.

Norway emphasizes economic research, with numerous studies of highway and transport costs and planning. In the field of soils, frost and drainage problems naturally receive much attention.

The countries that were surveyed in Europe in 1965 can be broadly divided into two groups:

1. Large countries with developed programs of road research, e.g., United Kingdom, France, Germany, and possibly Italy; and
2. Smaller countries or countries with less-developed programs, e.g., Spain, Portugal, Ireland, and Norway.

There is no rigid line between these groups, and no two countries organize their research in the same way, although the government, the universities, the local authorities, and industry are involved in one form or another in all cases.

The highest degree of coordination exists in the U.K., where activity centers around the Road Research Laboratory, now of the Ministry of Transport and formerly of the now-defunct Department of Scientific and Industrial Research. This high degree of coordination exists because the Laboratory's terms of reference were drawn on comprehensive lines, covering materials and methods of construction, traffic, economics and planning, as well as road safety in the broad sense, to include vehicle, road, and human problems. The Laboratory was early in the field and it is linked cooperatively by committees and in other ways to practically all organizations concerned with road research whether in universities, in other government departments, or in industry.

The central position of the Road Research Laboratory is unique and, in the United Kingdom, the task of collecting information about current research is basically a more direct and straightforward process than in the other large European countries. Moreover, the language barrier with America is not of significance.

In Germany, responsibilities are more dispersed and there is no central body concerned with all aspects. The Forschungsgesellschaft für das Strassenwesen, which is the main focal point for information on road research, does not concern itself except in a limited way with traffic problems and not at all with road safety. It has been reported, however, that the German government Road Research Laboratory has recently had its scope widened and is in process of reorganization.

In France, the set-up is somewhat similar, the materials and construction research being well covered by the Laboratoire Central des Ponts et Chaussées, while more recently formed organizations are developing research into traffic and planning. Here, the universities play a small part compared with the major part they and their professors play in Germany.

Because of these differences the most appropriate organization for the collection of information is not the same for all countries in Europe, although, in the major countries, a focal point around which the collection can develop seems essential.

In the U. K., the Road Research Laboratory is the obvious center and in 1965 we were fortunate in securing their enthusiastic cooperation; the work has been conducted by Mr. Sparkes, an engineer working inside the Laboratory and making use of the extensive facilities available there.

The Forschungsgesellschaft für das Strassenwesen in Germany and the Laboratoire Central des Ponts et Chaussées in France have participated. But although these organizations have cooperated generously, an officer has not carried out the work as a part of the organization as in the U. K. This needs further consideration in planning any continuing activity. It appears that the first group of countries, the larger ones with developed programs, needs this kind of nucleus.

In the smaller countries, with a less highly developed road research program, a nucleus is still likely to be advantageous, but not equally important at the present stage of development of the inventory. Visiting experts, linked to central bodies such as a government research organization or a national road federation, are able to supply most of what is necessary.

At the center of those cooperating in Europe in the survey is the OECD, which is developing harmonization and cooperation in research with special emphasis on documentation. The linking together of the efforts of IRF and OECD was one of the first things arranged in Europe.

There are a number of interesting points worth mentioning about research in the U. K. The first has already been mentioned—the extent of coordination between central and local government departments, the universities, and industry, all of which work closely with the Road Research Laboratory. The Laboratory works in an advisory capacity to all these groups and is in daily touch in one way or another with individuals from all of them, both formally and informally and at all levels. This has been developed through the cooperative research and the committee and consultative structure that has emerged over the years. A recently formed high-level Advisory Council on Road Research to advise on all research undertaken in the highway field will, it is expected, continue and develop this cooperation, and will help to assure, as the British universities play an increasing part, that the whole structure of research is soundly based and operated.

Another point of interest in the U. K. is the growing investment in research of the contracting industry. For many years the larger contracting firms have been developing and using their own research centers; a big firm may spend several million dollars a year on its own research. In addition they have collaborated with consulting engineers and the senior professional body—the Institution of Civil Engineers—in setting up the Civil Engineering Research Association with the help of the government. In this way the civil engineering industry is becoming infused with a scientific spirit which enables it to approach its problems with an expertise and scientific knowledge which places it on an altogether higher plane than formerly.

One matter of great importance to contractors and to government is the degree of control that is exercised on works. This has been the subject of much discussion in the U. S. It is of great moment in the U. K. and it figures significantly in the thoughts of the research workers.

The rapidly developing use of science and the scientist in reaching governmental decisions is also of note in the U. K. This applies markedly in highway matters. For example, the practice is growing for scientific planning and assessment of legislative measures by research personnel, such as, for example, laws relating to speed limits and to drinking and driving.

There are many other matters of interest about the research in the U. K. There is the new research center at Crowthorne which is being built at a cost of some $10 million. There is the research and development leading to the outstanding suspension bridge across the Firth of Forth, and the advanced aerodynamic design of the box-section, aero-foil type deck and suspension system in the Severn bridge. There is also the active Tropical Section of the Laboratory working as it does on major projects in many parts of the world.

Generally, therefore, in the leading countries of Europe the phase is one of developing, coordinating, and remodeling organizations for highway research. In France, the

Laboratoire Central des Ponts et Chaussées is remodeling its program, and bodies for traffic and safety research have appeared. In Germany, the government has widened the scope of its research organization. In the U. K., the Road Research Laboratory has recently been transferred to the Ministry of Transport and its activities are being regrouped and an overall advisory council is being formed.

In the smaller countries, organizations are being expanded or set up. Without exception they show a keenness to cooperate internationally and to become active in research and its documentation, interest in which is growing fast. For Europe it is therefore a particularly opportune time for the inventory and exchange of information on current research and development on roads and road transport.

The achievements of the past two years clearly justify the continuation of the work, and the study of how it can best be put on a permanent basis. Many countries have yet to be covered and in those countries already covered there is a need to provide the machinery for bringing the inventory up to date on the projects already noted, for including any new projects and for continuing vigilance to insure that relevant material is not overlooked. This is demonstrated by the fact that the two countries covered for a second time have yielded much new material.

There is another reason for pursuing the work as a continuing operation: the more engineers and scientists become involved in this activity, the more they recognize and appreciate the benefits they can give to their profession as well as to their own organization and to the institutions with which they are affiliated. As they realize that a source of guidelines is being provided and that these are helping to stimulate much needed research and development, their own personal interest is strongly aroused. Indeed, it is found that there has been developed, through the two years of work, a most cooperative and friendly relationship.

For the future, therefore, it is hoped to continue and expand this international research and development exchange just as far as it can go. As has been stated, the inventory in 1965 was extended to 15 new countries (plus two previously inventoried), and three Information Centers were created by the Organization for Economic Cooperation and Development through which our findings will be made available. Already plans are being made to cover another 16 countries in next year's inventory. There is no lack of momentum. But it is expected that many improvements will be made from the valuable experience already gained.

Plans are under way to employ permanent personnel to visit countries already inventoried in an attempt to keep current research data up to date. We are also studying other suggestions of high merit to continue the flow of information and the cooperative arrangements.

The main handicap has been shortage of time, and had there been more time, a more thorough job would have been possible in each country. Inevitably, even with the best of advance arrangements, some appointments will be broken, and others will take more than the scheduled time. Personal check-backs are often valuable.

A more defined policy in the selection of "current" research will have to be attempted and decisions made as to how long a completed project is to be kept on file—particularly if that project has been superseded by another in the same agency.

Finally, in planning the next phase of the inventory it is proposed to examine selected research fields and research problems in greater depth, that is, to study in detail some or all of the major projects on a given theme in certain countries, considering how they are sponsored, the techniques and laboratory facilities employed, the types and qualifications of the people engaged in them and the findings and publications. These studies will help, it is thought, in providing useful information about effective research and the conditions under which it is conducted.

In this work the International Road Federation is not engaged in physical research or development. Rather we are attempting to provide adequate guidelines to promote and expedite the exchange of data and to utilize it fully and safely in road communications designed to improve life for all persons.

The Challenge of Highway Technology in Developing Countries

M. EARL CAMPBELL, Engineer, Special Assignments, Highway Research Board; and ROBINSON NEWCOMB, Deputy Director for Transportation, Technical Cooperation and Research, Agency for International Development

•MUCH TIME and money has been put into the foreign aid effort since the adoption of the Point Four Program. Excellent advances have been made in the physical development of highway transportation in many of the new states with our help. Notwithstanding, there is a consensus that an accelerated and self-continuing evolution of highway administration and technology among the nationals is needed. And they need help in this evolution.

This conclusion was reached after visiting seven countries in various stages of development on three continents. Roads built and building were viewed and the status of technology and eminent problems in highway transportation in highway departments, universities and research institutes in these seven countries were discussed. In the light of perspective gained in two score years of work in many facets of highway administration and technology in the United States, and in travel in all of our United States, it was clear that a gigantic job remains in every developing country visited, and that each country must progress to the point that it can handle its own highway programs. This is the broad challenge.

This report derives specifically from visits made to Nigeria, the Philippines, Thailand, India, Iran, Lebanon and Brazil. The suggestions made evolved from discussions with 117 people in these seven countries. This report can provide the foundation and framework for working plans to serve the present need and to prepare the special competence needed in countries abroad. Therefore, this report is addressed to two audiences: the highway administrator and technologist in the United States, and the highway administrator and technologist abroad.

PURPOSE OF TRIP AND PREPARATION

The trip to Asia was sponsored by the Agency for International Development. The National Academy of Sciences recognized the potential benefits to the Academy as well as to the institutions in the countries visited and gave its full cooperation in support of the trip. Dr. Robinson Newcomb, coauthor of the paper, Deputy Director for Transportation, Technical Cooperation and Research, Agency for International Development, arranged the trip and has assisted with the preparation of this paper.

The trip was planned to enable the principal author to talk with key people in the highway departments, universities and research agencies in developing countries, to explore their technological needs and to learn how AID might appropriately employ the resources of the Highway Research Board in providing assistance in highway technology to them. The trip was made to find also how these countries in turn could assist the highway profession in the United States by providing information from their research and practice for our Highway Research Information Service.

A great deal of planning was necessary to outline a framework for discussions, including check lists of discussion topics and enunciation of questions formulated in conferences with the staff of eight departments in the Board. Pertinent things to look for on field trips were also reviewed and listed.

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

Though not sponsored by AID, similar explorations were carried out during visits in Brazil and Nigeria.

FUNCTIONS OF HIGHWAYS

Inasmuch as the exploration concerned highway administration and technology it was desired first of all to consider the function of highways in the developing areas. The fundamental function of the highway is more clearly discernible in countries where life and life's activities outwardly appear simpler than in the United States. Here we have had the basic road systems for many years and our accumulated road needs are expressed in terms of lower transportation costs, comfort, and time saving. One may lose sight of the original purpose of highways in the United States, which was for communication and cohesion.

In many countries the prime concern is still communication and cohesion. In a country where many dialects are spoken, where many cultures exist side by side, where many separate and individualistic tribes remain, where mountain ranges, rivers and deserts isolate communities, the tie that binds the people together physically is the highway that crosses all of these erstwhile barriers. There is a need for roads in deserts, for there is a need for pure connectors—connectors for cohesion, for communication, and for commerce between producer and consumer. Such connectors are needed in many developing areas. Their need is seen most easily, however, in countries such as Iran, where mountains and deserts separate communities that must be linked to preserve the country as a nation.

THE GATEWAY TO DEVELOPMENT

The obvious is often overlooked because we seek some new magic gateway to development. The proven gateway is made up of the doorposts of research and education, capped with the lintel of practice. In the context of highway development each part of the gateway needs examination.

Highway Research

As highway engineers we are concerned with the mathematics of performance. To understand this we need scientific research because it determines the criteria for action within the norms of the economy, and it shows how to put forces to work most effectively (through orientation, combination, opposition, etc.) to provide the maximum service at minimum cost. It gives us the optimum measures and scale of values for policies, procedures, practices, specifications, standards and warrants.

Research has shown that costs are reducible. Cost of research compared to savings produced therefrom in one statewide study showed a 1 to 10 ratio from one year's use of findings. Controlled investigation stands first because we need to know the interrelations of energy, matter and mind before we can anticipate the consequence of choices or predict the performance of designs.

Education

Education involves stimulation and access to information—it involves method and content. Content naturally proceeds from research and from tested practice.

What are the processes for updating knowledge?

A minister of public works in Asia put this question: "How can we keep our engineers updated, recognizing that we can't require them to study at night and also recognizing that most of the developing information is printed in a foreign language?" The question is pertinent not only in the country where asked but really around the world. His key men had been well educated, many having masters degrees in some phase of highway technology, but few new graduates had been added to his staff in the past decade. Apparently, the engineer in a far-off country and out of the mainstream of advancing technology senses more than we do in America that advances in technology during the past ten years are so far-reaching and significant that without self-renewal and continuing evolution an engineer is soon left behind. How would you answer this question?

Our answer was to suggest programming short courses for each division of the department directed toward its continuing evolution in terms of advances being made in each field—and the establishment of two-way avenues of communication with the highway information centers.

But in the final analysis an engineer cannot escape his need for self-involvement in evolution and renewal through reading. The Highway Research Board publishes annually enough reports vital to highway development to fill 15 inches on a bookshelf. These publications can and do bring about changes in policies and practices that provide better services and greater economies. Other organizations are likewise adding vital information to the storehouse. But the potential rewards from these depend upon the publications being disseminated to the engineer and the necessary stimulus provided to get him to read. There is need for programmed short courses.

Incidentally, the Highway Research Board has begun its initial operation of the Highway Research Information Service (HRIS), which provides for the exchange of information among participating countries on research findings and tested practices. This will provide an invaluable service to the developing technology of all 148± countries, especially to those in their dawn of motorized transportation.

There is no intent to overlook the need for translations in the field of education. Although English is the second language in nearly every country of another tongue, many highway engineers cannot read it, and few American engineers speak a second language. Any two-way avenue for communication has this barrier to free flow—and the flow towards the United States has seven or more major language barriers.

Practice

Education is not enough. New knowledge must be applied. One question that comes to the Board as often as any other is this: "How can we get findings put into practice?" This is the crux of the matter—the lintel of the gateway. This requires putting newly learned principles into context, securing any necessary changes in legislation, modernization of manuals, standards, specifications and warrants, and finally, the understanding and use of these new laws and manuals by those at the respective working levels. This requires rapport between research engineer and operations engineer.

Does the challenge to accelerated evolution include the development of coordinated or linked programs in research-education-practice?

COMPARABILITY OF GLOBAL HIGHWAY PROBLEMS

Similar forces, animate and inanimate, are at work the world around, but they are focused at different intensities and have different durations. The tropics intensify and prolong certain forces. The temperate zone provides greater cyclic frequency and emphasizes forces differently. Materials differ. People belong to different cultures, and hold to traditions exerting subtle and powerful influence on behavior.

But research discovers and measures intensities, frequencies, combinations and orientation of forces, in both the physical and socioeconomic realms in terms of effects and consequences. Physical forces, whether in the Congo or on Manhatten Island, are measured in the same units and by the same instruments. Properties of materials are determined by the same physical and chemical tests. People have the same inherent drives and desires and basic motivations. Diversities are basically of degree, not of uniqueness. Tests are the same the world around and findings from Britain, Brazil, India and Japan can be traded for findings in the United States.

PROBLEMS OBSERVED

Some of the problems observed abroad from which technological challenges come are these:

1. Extreme mixtures in traffic (animals, pedestrians, cycles, carts and cars),
2. Inadequate lane discipline,
3. High accident involvement,
4. Low average speed,

5. Inadequate signing and marking,
6. Inadequate management skills,
7. Much hand labor,
8. Maintenance needs,
9. Stabilization of fills by settlement,
10. Many rough surfaces and uncomfortable riding,
11. Library needs—basic reference literature,
12. Lag in use of research findings,
13. Updating needs in technology, and
14. Great areas without adequate road development.

A similar list of problems might have been written after a trip across the United States—the problems are mostly of degree, not of uniqueness.

TWO COMMON OVERALL PROBLEMS

In every country two problems were stressed. Actually these two grew out of the others and were a part of the other problems. Therefore, these—traffic safety and economy—are ranked first for discussion.

Highway Traffic Safety

When we are insisting here in the United States that we must cut our fatal accidents to a figure much lower than the present 5.7 fatalities per 100 million vehicle-miles, it is appalling to find that the fatal accident rates in the countries visited are from 3 to 15 times that of the rate in the United States. "We surely pay for safety whether we have it or not and we pay more when we do not have it."

With quick expansion of paved mileage, registrations doubling each four or five years, the introduction of so many new, untrained drivers, and with extremes of slow and fast traffic mixed together, naturally a high accident rate results. As in the United States the causes are complex, and there is a paucity of accident statistics on which to premise an action program. Reliable accident records are sorely needed. And the development of records must be followed by an action program supported by the heads of government. If accidents cost 1 cent per vehicle-mile in the United States they may cost 10 cents per mile of travel in some of the countries visited. These countries can far less afford such costs than can the United States.

Socioeconomic Problems

In many of the developing countries the basic highway systems are being developed. This is raising many fundamental questions. What is the best technique for making feasibility studies? How much, how fast and where should we build? Should existing rail systems be replaced with highways? What impact will the program have on resource development? . . . on exports? . . . on the overall economy? . . . on sociology? How can the roads be financed? Should costs be allocated to user? How? Roads are not built for the sole purpose of moving goods and people. This is what we see, but the larger implications are not so easily seen. What is the mission of roads in developing countries?

SUMMARY OF TOP PROBLEMS

What appeared as obvious challenges might or might not be relevant. We wanted to learn their needs. Needs are relative. They are related to some norm, and the norm is based broadly on economy and culture. So we asked the key people concerned with needs in each of the countries visited to name their top problems.

Twenty-five problems were named. In nearly every case the person asked considered the question several days, reviewed it with associates and then gave a listing as representing not his individual opinion but as the consensus of his organization or division. These were elicited from highway departments, universities and research institutes. They are grouped by the frequency of times noted and by number of countries including the problem in their listing. In this listing the challenge to highway technology is expressed.

Inasmuch as the problems of highway safety and economic analysis ranked at the top in all countries, and inasmuch as safety and economy of transportation are related to nearly all of the other problems, they were given first place in this discussion by way of special emphasis. Hence, they are not included again as separate problems among those now listed.

FIRST RANK (Listed by all countries)

- Management of Construction
- Compaction and Stabilization
- Selection of Suitable Materials
- Maintenance, Management and Methods
- Traffic Operations and Capacity (for mixed components)

SECOND RANK (Listed by 5 or 6 countries)

- Construction Practices
- Testing Techniques
- Research Organization and Administration
- Stage Construction, Methods and Economy
- Signs, Signals and Markings

THIRD RANK (Listed by 3 or 4 countries)

- Highway Laws
- Low Cost Roads
- Maintenance Budget and Construction Budget
- Needs Inventory, Methods and Feasibility
- Financing

FOURTH RANK (Listed by 1 or 2 countries)

- Resource and Revenue Apportionment
- Snow and Ice Control
- Materials Mapping
- Highway Organization and Administration
- Asphalt Mix Design

FIFTH RANK (One country)

- Drainage and Hydrology
- Equipment Maintenance
- Weed Control
- Computer Technology
- Secondary Road Design

THE ACTION PROGRAM

In light of the listing of top problems enunciated by the people most concerned and most involved in their challenge, certain areas of activity are seen as specific and important and universal.

Administrative Planning

The challenge of planning lies in the collection, selection and interpretation of facts. Planning must show the consequences of decisions, show trends, point the way, and provide guidance in the choice of alternatives. Planning must also assist in the establishment of norms—or standards—compatible with current socioeconomic conditions.

Planning should be both the steering wheel and the fuel for the action program. Planning should help set goals and objectives for highway administration. It must use the scientific method in the controlled design of research, investigation, analysis, interpretation and use of findings. It is the planner's business to see that the findings from the $60 million annual expenditures on research around the world which are pertinent to the problems of his country are made available.

The planning division gathers facts as a means, not as an end.

Research

One of the most elementary yet most significant considerations in highway research is simply: How does the design perform?—not in the laboratory alone but particularly in the field. Research may determine the properties of materials—physical and chemical—in component parts and in combinations by testing in the laboratory under controlled conditions for effects under all the recognized significant field forces that will be brought to bear. But this gives only indications of field performance. It is not the final answer. The research must now be applied in the field and be carried out without control of ambient forces. It is important that test sections be rigidly controlled and observation be carefully planned and precisely measured—and finally that the analysis and interpretation be subjected to rigid scientific methods. This may be difficult for developing countries. And unless there is adequate engineering control of construction, the performance of the projects thence built will hardly parallel the performance of the researchers' test sections.

Performance goes beyond structural requirements. "How does it perform?" is asked with just as much validity by the traffic engineer as by any other engineer. In some cases the annual cost of accidents has exceeded the annual costs of the plant. In the United States it is estimated that accidents cost about 1 cent per vehicle-mile, plant costs are but slightly higher on a vehicle-mile basis, and average shipping costs are about 6 cents per ton-mile. In some of the pioneering countries the cost of transportation may exceed 10 cents per ton-mile and the accident costs approach 10 cents per vehicle-mile.

Soils and Materials

The soils problem is one of relating their properties to manipulation and to performance. There is much to be done in developing countries to determine performance characteristics of soils. Laterites and lateritic soils of "a thousand varieties," for instance, are abundant in many areas. But their performance is diversified and unpredictable today.

The economics of stabilization and of compaction provide challenges to highway technology. Compaction by settlement may be an economic answer on lightly traveled roads.

Construction

Standards and specifications for construction in the new states must be in the form of putting new wine in new bottles. The new knowledge should be made available for application to local conditions in developing countries. This goes far beyond the adoption of our old county standards of 1925 simply to match an economy perhaps comparable to our 1925 county economy. Technology has advanced on all fronts in an amazing way since 1925. The problem is adaption, not adoption; it is the application of new methods, materials, and practices to road problems for maximum service at minimum annual cost. It is the adaption of new knowledge of soils, steels, cement, asphalt, and traffic. It involves the extension of machine work to appropriate elements of construction, and the limiting of manual work to the elements most appropriate for it. It involves a continuing rearrangement of science and engineering, of man and machine for economic balance.

Project management is very important in developing countries. This is why it was mentioned by so many people. Work quantities and operations need to be blended into an optimum balance of men, machines and materials. This requires scheduling of operations through an activity analysis comparable in theory, though not in detail, to

PERT or CPM, so that all components of the work flow will merge in a continuous stream of desired volume. It will lead in time to a coordination among contractor, engineer, and public service officials, a goal hard to realize in a hurry. Efficient construction in developing countries needs analyses of the relative costs of stage construction versus "turn-key" construction as related to traffic volume for each project. This is rarely done in developing countries. And it needs better relationships between construction tolerances and maintenance standards. This, too, is often ignored abroad.

A pencil can be more potent than a pick.

Maintenance

In general terms: "The greater the investment, the greater the upkeep." Even if it should cost the highway department less to neglect maintenance, the cost to the user is increased. Such costs include the effect on motor-vehicle operating costs and accident costs of potholes; pumping and faulted slabs; low, unstable, narrow shoulders; loose gravel; and wavy, rutted, or slick surfaces.

A proper balance between well-handled construction expenditures and well-managed maintenance expenditures can make the maintenance dollar go much farther. This requires equitable allocation of funds and trained management in both fields.

Traffic

Although the traffic problems could be recited at some length, the greatest of these include (a) a way to segregate the dissimilar components of mixed traffic for safety, greater capacity and accelerated flow; and (b) a lane discipline assisted by signs and markings, and, for camel and donkey traffic, by roadway design.

Design

In this discipline the standards and specifications and warrants provide the guidelines for merging the data from the specific locale into plans. Within the tolerances allowed, the design engineer fashions out of the information provided from the field by topographical, soils and materials surveys the finished action plan. He balances safety and convenience with economy. He balances construction economy with maintenance economy. In short he merges field data often supplied by other divisions into a plan balanced for safety, economy, convenience, and other pertinent qualities of transportation. His watchword is "optimization"—maximum service at lowest cost.

Legal Studies

The framework for nearly every activity of the highway department is established in law. The body of law pertaining to these activities can provide guidelines to safety, to economy and to convenience in highway administration through constraint. It finds its greatest effectiveness in its paralleling and interpretation of the ethical and physical laws in the highway field. Highway accident prevention, for example, rests in large measure in the legal provisions for driver licensing and motor-vehicle operation.

IN PERSPECTIVE: PRIORITY AND IMPLICATION

The summary of top highway problems provides a subjective popularity ranking or indicator of universal need rather than an objective priority rating. Popularity may reveal importance but not necessarily the greatest promise, whereas priority stems from a significant difference in the benefits. Priority also considers the scheduling of sequential operations. Priority guidelines offer the maximum return on investment for the state and the maximum service at lowest cost for the highway user. In light of this definition the problem areas were reviewed for priority. All are of importance. All are not of the same urgency in accomplishment. Cost effectiveness is a determinant.

The sequential staging of activities is arranged as follows (through three levels):

I. ADMINISTRATIVE FRAMEWORK

1. Highway Organization and Administration
2. Research-Education-Application (programming)
3. Resource and Revenue Apportionment
4. Highway Needs Study (including socioeconomic analyses)
5. Highway Law (formulation)

II. OPERATIONS PLANNING

1. Maintenance Budget vs Construction Budget
2. Construction Management (planning)
3. Maintenance Management (planning)
4. Traffic Operations and Capacity (planning)
5. Stage Construction, Methods and Economy

III. OPERATIONS PRACTICE (manuals)

1. Signs, Signals, Markings
2. Construction Practices
3. Maintenance Methods
4. Selection of Suitable Materials
5. Compaction and Stabilization (and other operational functions)

The reason for the sequential staging is self evident. But for the significant return from investment the accent should be placed on certain of these activities. The following listing suggests the activities for special priority:

a. Research-Education-Application
b. Socioeconomic Analyses of Highway Needs
c. Construction Management
d. Maintenance Management
e. Traffic Operations and Control
f. Manuals of Practice (in native tongue)

A coordinated program of research-education-application, as noted elsewhere in this report, can provide benefits related to costs of the order of 10 to 1 for one year's use of findings. Skill is needed, however, in the blending of sophistication and pragmatism.

The socioeconomic analyses of highway needs will reveal the benefit-cost of the system and its component parts and the alternatives, thus providing the administrator a device for investing the dollar for its greatest effectiveness.

Construction management and maintenance management by system analysis and stratagem has shown marked reduction in costs in the United States at insignificant costs in providing management skills.

Traffic operations and control has proved itself by providing very substantial reductions in congestion and in accidents at relatively small cost. It is the first must in traffic engineering.

Manuals of Practice provided at little cost can provide the means for "accomplishing with a penny what anyone can accomplish with a dollar."

To whom is the challenge? Certainly to the responsible officials of the developing country. Certainly to all who have any interest in the preservation of democratic principles in free countries. Certainly to all who will benefit by a substantial reduction in costs of transportation in the developing countries (both in ton-mile cost and distance hauled), and certainly to all who will benefit from the greater socioeconomic activity awaiting reduced transportation costs, and finally to those who have a genuine compassion for the world's underprivileged.

When we look at the problems of developing countries we see a reflection of our own problems. When we state their problems we crystallize our thinking about our own. When we help them solve their problems we learn things that will help us. We learn by sharing knowledge. And we may ask ourselves, "Are we truly learned if we remain unacquainted with the viewpoints and practices of other countries?"

SOME DIMENSIONS OF THE PROBLEM

The problem could more easily be seen if we could give finite dimensions to it. These we have not been able to obtain. But we do have evidence that the present hard-surfaced roads are just the "first easy increment" of needed road mileage. We have suggestions that there are needs now for up to 20 times the surfaced mileage already completed. We also know that the demand is related to motor-vehicle registration, which is doubling in some countries every four or five years. We know too that the potential demand is related to population growth, which may double by the year 2000 A.D. in the less developed countries. And we know that economic activity and transportation facilities go forward hand in hand. This pressing need gives some perspective to the problem.

The first need without doubt is seed money for research-education-application. Bootstrap escalation is inadequate. Many more technologists and technicians are needed now because at the present time large segments of work are being done by consultants from more advanced countries. Finally, we know that there are about 150 countries in the world and half of these need fiscal and technological help in some measure—especially in the form of technological information. The challenge is to match the resource capabilities of more advanced countries with the priority needs of the less developed countries. Many of the developing countries have reached the stage where they can lend a helping hand in numerous fields to the neighboring, comparatively less developed countries, and this help can be realistically applied in the lesser developed countries, or in lesser developed technologies. Technical assistance from abroad can reach its greatest potential if it is used to supplement or complement the resources already available locally and to the extent that it cannot be provided locally.

WHAT THE UNITED STATES CAN DO

We have built more than two million miles of roads to a variety of standards in the past 50 years in the United States. We have maintained highway courses in our undergraduate curricula and advanced courses in highway administration and technology in our graduate curricula in many universities. We are conducting more than $25 million worth of research in the highway field annually and we are publishing more than 10,000 pages a year on highway technology.

Out of this historical and current experience the United States has gained competence to aid in the priority areas noted, and in terms of research, education and application can provide various helps, including:

1. Exploration of needs in technology in specific countries;
2. Special courses in subjects relevant to highway management and technology;
3. Manuals of practice;
4. Highway literature (including translations);
5. Information service on research and practice;
6. Research on local soils and materials—their use in highways; and
7. Assistance in establishment of highway research units and their priority programs.

CONCLUSION

Let me say in closing that the words "developing country" have no absolute meaning. We usually think of the newer or less industrialized states as developing countries, but the United States is still a developing country, certainly in transportation administration and technology, for we still have a long way to go. Our own top problems tell us so: congestion, parking problems, traffic accidents, soil problems, pavement-design problems, travel costs, etc. Our problems, too, can be reduced to a substantial degree.

These observations, therefore, do not apply exclusively to the seven countries I visited. Years of travel in the United States and travel in other countries have made this amply clear.

Research and Worldwide Urban Transportation

WILBUR S. SMITH, Wilbur Smith and Associates, New Haven, Connecticut

•SINCE COMMERCE, and therefore traffic, are both essential ingredients of national and regional growth, and since these expanding activities are generally tending to strangle the world's urban complexes, it is essential that transport research flourish and that the findings be disseminated as widely as possible. In looking around the world, rapid increases in motor vehicle registrations can be observed, and much of their use is in cities.

Every urban area has problems of transportation. These are relative, and the extent of severity varies widely. On the other hand, public officials throughout the world have realized the importance of convenient and efficient urban transportation and have taken steps to provide it. By so doing, they have produced data and developed research results which are valuable to others as well as to themselves.

Since Americans have done much in the manufacturing, purchase, and use of motor vehicles, people in the United States have been required to deal with many transportation problems which are only now emerging in many other cities around the world. In the past two decades, research efforts on a worldwide scale have been very successful, but often they have not been known, understood, or appreciated. On the one hand, many officials in the United States look elsewhere for research results, while others concurrently look to America for applicable findings. As a result, the desirable international exchange of research ideas and their applications in separate urban areas is now being accomplished by many agencies, individuals, and private concerns.

DISCUSSION LIMITED TO URBAN TRAFFIC

In looking internationally at research in fields of highway transportation, noteworthy developments and contributions are found in all corners of the world. Reviewing processes of road construction would show how new techniques and the results of special studies and researches spanning many centuries have collectively produced the methods and materials which are so effectively used today, in a rather uniform way throughout the world.

The results of studies of driver behavior and driver performance under varying types of urban traffic conditions have indicated that human beings perform about the same wherever they live. The capabilities and fundamental characteristics of automobile drivers are not substantially different in most parts of the world. There is perhaps less variance in the attitudes and skills between a typical city driver of the United States and a typical city driver of Australia or India than there is between a taxi driver in New York and a typical city driver of a smaller American city. Studies which have been aimed at measuring attitudes, abilities, and actual performance characteristics of drivers have been far-reaching; results of such investigations overseas, particularly in England, have been outstanding.

It is not the purpose of this paper to deal with highway construction and maintenance, nor with fundamental characteristics of driver and vehicles, but rather to present a relatively narrow scope of urban transportation. This is further narrowed by limiting it largely to a review of data and findings from studies which have been completed by our firm in the past several years in typical overseas cities and in the United States.

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

DIVERSE TRANSPORTATION PROBLEMS

There are interesting variances in urban travel facilities and practices. To illustrate: In Athens, motor bus volumes alone amounted to 13,000 vehicles per day in 1962 on principal central streets, while 2.4 million persons were passengers on all transit vehicles each day. In addition, one section of Amalias Street carried about 73,000 vehicles per day, yet there are only about 68,000 vehicles registered in all of Greater Athens. Crossing the Hooghly River in Calcutta on a typical weekday are 29,000 fast-moving vehicles, 15,000 slow-moving vehicles, a total of 510,000 persons, up to 1,000 herded animals and some 400 stray, unattended animals. In Hong Kong, the ferries between Kowloon on the mainland and Hong Kong Island carry an average of 560,000 passengers each day. Moreover, street trams, bullock and donkey carts, tricycle cabs, hand carts, and even left-hand drive create diversity.

After observing the many differences in magnitude and modes of travel in different cities of the world, one is immediately concerned with numerous questions: To what extent do facts and research findings gathered in one country have applications in others? Are trends which have been observed in transportation in one place indicative of the way transportation practices will occur in other places? Are there correlations between urban transportation and urban economy? How can projections of transportation be related to projections of population and land uses?

Development of techniques to answer such questions have been evolved by engineers and scientists—too often, however, in isolation. From simple studies of traffic movements, to intense examinations of psychological processes involved in trip motivation, researchers have found study methods and results which have been, or can be, applied worldwide. In tests to date, there has been much satisfaction in the application of study techniques and data for the international exchange of knowledge, but more is needed.

TRAFFIC OPERATIONS

One of the most obvious areas of interchange of investigations and experiences is in the field of traffic regulations and controls. Similarity in the control of urban traffic has become relatively commonplace throughout the world. Nearly every motorist who must travel city streets recognizes that traffic has to be restricted so that the many components of the traffic stream can coexist. Most of the controls familiar to American drivers are also found in Europe, Africa, Asia, Australia, and elsewhere. This situation comes primarily as a result of many reciprocal international applications by traffic engineers.

Signs, signals, pavement markings, and other devices, ranging from simple and complex traffic controls to symbolic traffic messages and electronic surveillance gear, are generally similar in both style and application, thus achieving a high degree of international uniformity.

Applications of other well-known control devices achieve a degree of uniformity. Parking meters, reflectorized pavement paint, barricades, channelization islands, and other tools of the traffic engineer are found to be highly alike throughout the world. This results, in part, from many manufacturing companies and engineering concerns assisting in the spread of technology. Most important, the flow of information and knowledge is two-way.

TRANSPORTATION STUDIES

The goal of urban transportation researchers has been the development of techniques that will be applicable, under a variety of conditions, with only minor modifications. For example, the comprehensive home interview travel survey, developed originally by the U. S. Bureau of Public Roads, is found to be totally acceptable from city to city within the United States. More recently, the technique has been used in other countries.

The essential transportation elements, such as trip purposes, trip lengths, distribution rates, and modal choices, can be accurately defined. In addition, trip attraction and generation values, based on unit areas of land use, or on household units, can be developed and made applicable from city to city. This would make it possible to economize on the cost of comprehensive urban transportation surveys through greater synthesis of data.

Through the work of our firm, we now have available recent data on travel demands and travel characteristics in such diverse places as Baltimore and Boston; London, England; Athens, Greece; Bombay, India; Hobart and Brisbane, Australia; and Skopje, Yugoslavia. Basic facts about these cities are shown in Table 1.

Consistencies in travel characteristics are found in these places, as shown by the results of the surveys. Although perhaps not exactly the same values, many of the same trends and ranges are visible.

Variations in conditions must be taken into consideration in the projection of total travel demands. Nevertheless, standard survey and analysis techniques were found to be compatible in determining recommended transportation systems in these diverse areas.

URBAN AREA CHARACTERISTICS

The trended patterns for population, motor vehicle registrations and annual transit riding in four widely-separated urban areas are shown in Figure 1. In the more developed cities of Brisbane and Baltimore, vehicles and populations show increases, while transit patronage decreases substantially. In the lesser-developed areas, typified by Athens and Bombay, all three factors are still increasing, with vehicle registrations expanding very rapidly in the recent six-year span.

These trends illustrate how different the growth in the cities has been in recent years, but when separated into relatively similar categories (such as individual trip purposes or modes) urban area characteristics show surprising consistency from place to place.

Trip purposes were examined for seven cities (Fig. 2). Basic trip purposes for car drivers show that approximately 30 to 40 percent of daily trips are made for the purpose of getting to and from work. Approximately 10 percent are trips for social-recreation purposes, and a somewhat varying proportion of them are for shopping. It is essential to remember that car drivers in some of these cities represent a special segment of the population, since availability of a vehicle reflects a relatively high income.

Similar to the distribution of the trip purposes for car drivers, the purposes for segments of those urban residents using public transportation are shown in Figure 3. There is considerable variation from city to city with high work-trip percentages in both Skopje and London. In the Australian cities of Brisbane and Hobart approximately 40 percent of the transit trips are made for the purpose of work, which is also the case in Baltimore.

Since trip lengths for car-driver journeys are generally dependent upon the size of the city and the breadth of its development, the lengths of journeys were examined for individual purposes (Fig. 4). Again, the consistency of characteristics is apparent despite diverse urban conditions. It is also interesting to note that in those cities in excess of one half million population, the average car-driver trip length, for all pur-

TABLE 1

BACKGROUND DATA FOR SURVEYED CITIES

City	Study Year	Population	Survey Area (sq mi)	Vehicle Registration	Persons per Vehicle	Total Person Trips (internal)	Percent by Transit	Household Interview Sample (%)
Hobart	1963	125,400	78	36,900	3.4	238,000	27	5.4
Skopje	1965	220,000	42	10,600	20.8	163,200	74	6.4
Brisbane	1960	593,668	375	151,560	3.9	1,011,200	45	5.0
Baltimore	1962	1,600,810	780	437,540	3.7	2,604,463	14.2	5.0
Athens	1962	1,900,000	206	67,700	28	3,200,000	65	0.33
Boston	1962	3,584,420	2,300	1,168,200	3.1	7,851,000	18	4.2
Bombay	1962	4,345,202	328	62,200	70	2,700,000	70	0.40
London	1961	8,826,620	941	1,454,000	6.1	14,396,000	54	1.7

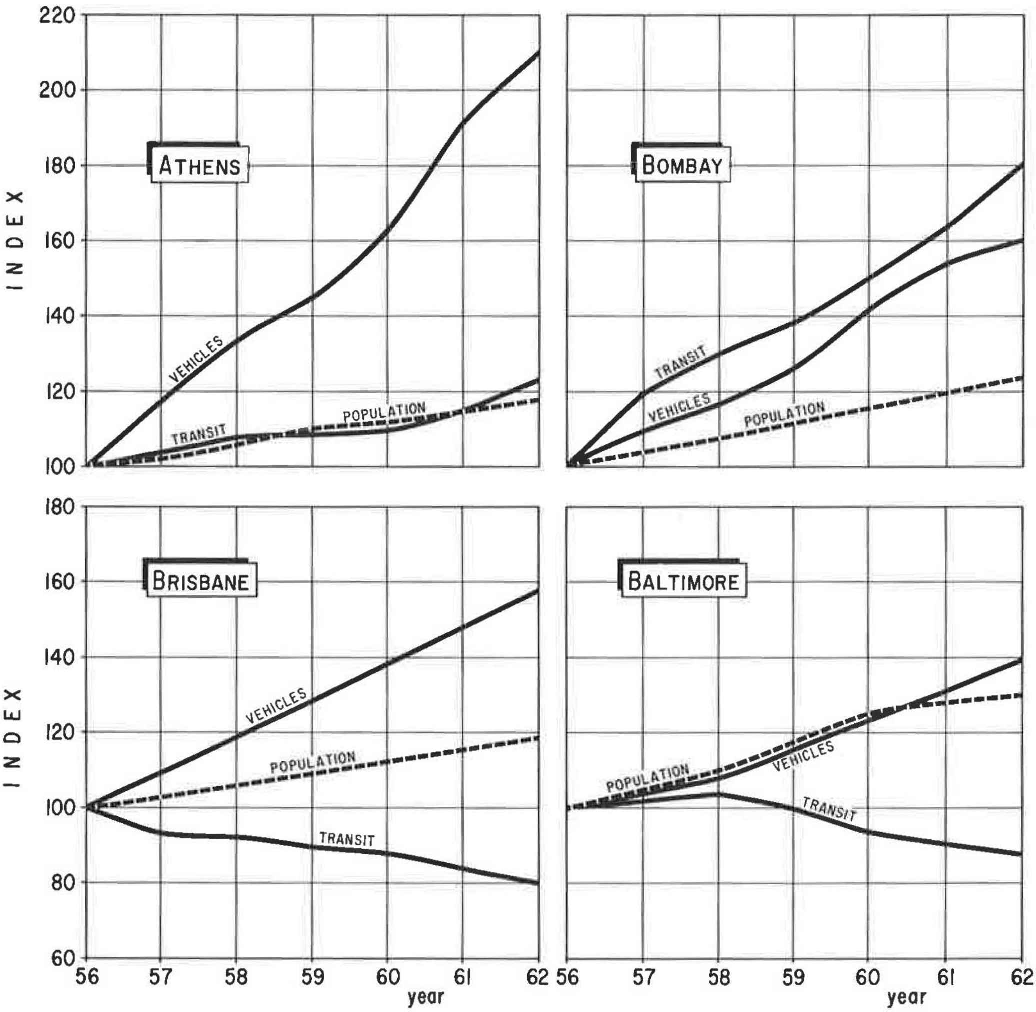

Figure 1. Population, vehicle registration and transit passenger trends, four cities.

poses combined, was stable, amounting to approximately 12 minutes. This general consistency also applied to shopping trips in foreign cities, but not to work trips which are probably more dependent upon employment locations and population density.

Investigating the mode of travel to work for several cities reveals that the choice is dependent, in part, upon car ownership (Fig. 5). As the number of passenger cars owned per household increases from 0.06 in Athens to approximately 1.0 in Baltimore, Boston, and Hobart, the usage of public transportation declines from 90 to 15 percent of the total trips made on a typical weekday. At the same time, car-driver trips increased from 10 percent to 85 percent of the total.

In the less-developed countries, many person trips on a typical weekday are performed on foot. As indicated in Table 2, Londoners made 18 percent of their work trips on foot. One third of the work trips in Skopje and 44 percent of all person trips were made by walking, whereas more than half of the person trips for work in Bombay and 25 percent of those in Athens were on foot. In the motorized countries, typified by Baltimore, only seven percent of the total work trips were made by walkers.

Given the same economic and social opportunities, trip productions tend to be generally consistent, changing primarily in relationship to car ownership. Figure 6

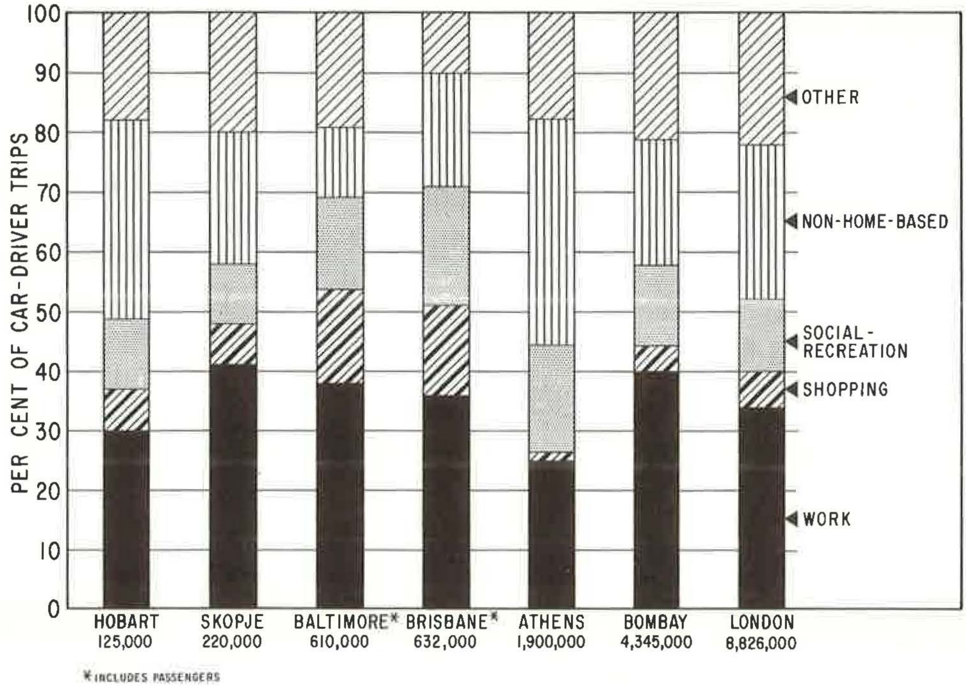

Figure 2. Car-driver trip purposes, seven cities.

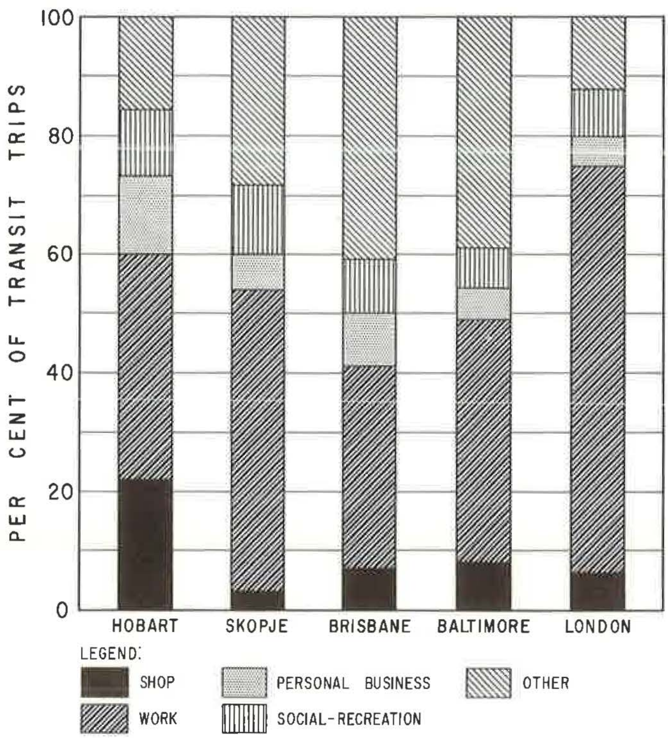

Figure 3. Transit trip purposes, five cities.

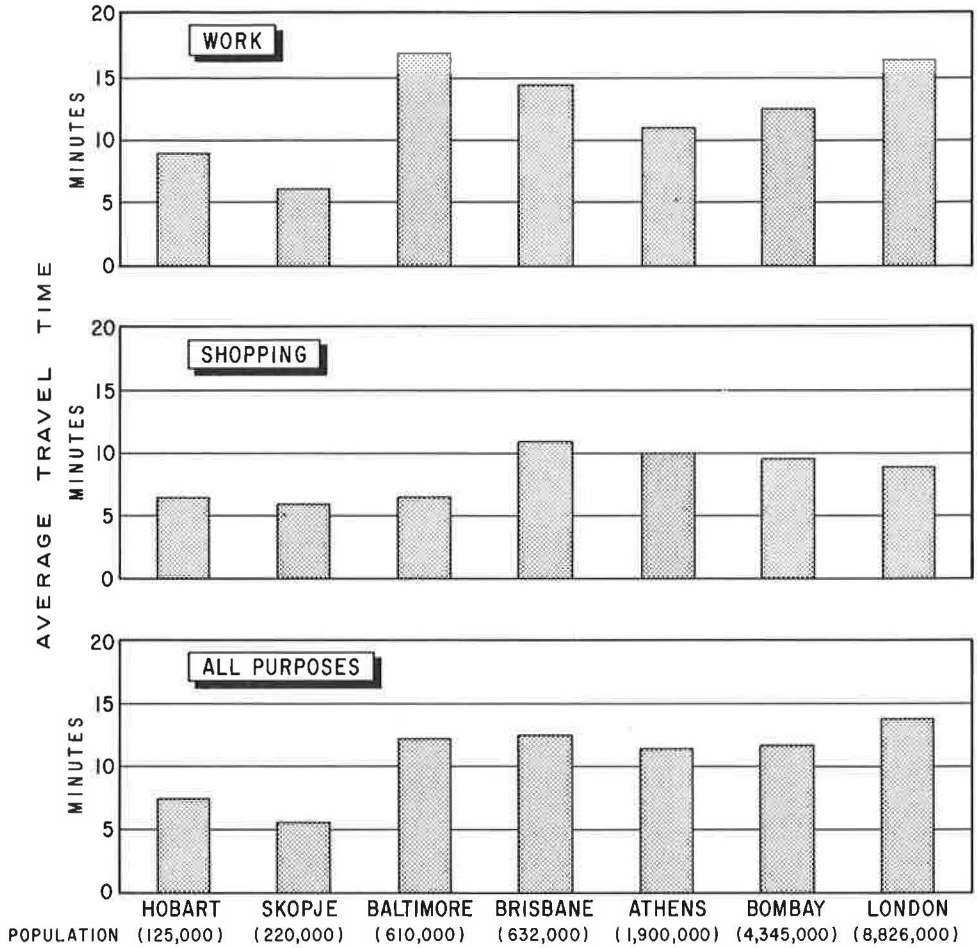

Figure 4. Car-driver trip lengths for selected purposes, seven cities.

shows trip generation, increasing with car ownership from approximately two trips per day in non-car-owning households to more than ten trips per day in those households owning three automobiles. Trends are quite similar in all the cities plotted; however, multi-car households are almost nonexistent in Skopje and Athens.

Figure 6 also shows that public transportation trips decrease with additional levels of car availability. In Baltimore, this decrease is quite sharp, but in overseas cities the general decrease is not as strong. This is probably due to the fact that the number of multi-car households is not large and the service afforded by public transportation remains relatively high despite rising ownership levels. For instance, a person may own two automobiles, yet prefer to use public transportation to and from work, as is often the case in Australia.

As one of the important parameters in modal split calculations, the average number of passengers occupying motor vehicles is determined from the origin-destination surveys. From those values can be determined, by purpose, the number of car drivers and car passengers from the number of projected total automobile trips. Table 3 indicates that the ratio of car occupancy for work-trips ranges from 1.08 in Boston to a maximum of 1.67 in Athens. For all purposes combined, the range of occupancy is from 1.43 in London to 2.16 in Athens. Those larger values reflect the fact that such trip purposes as shopping, recreation, and social journeys tend to produce greater car occupancies.

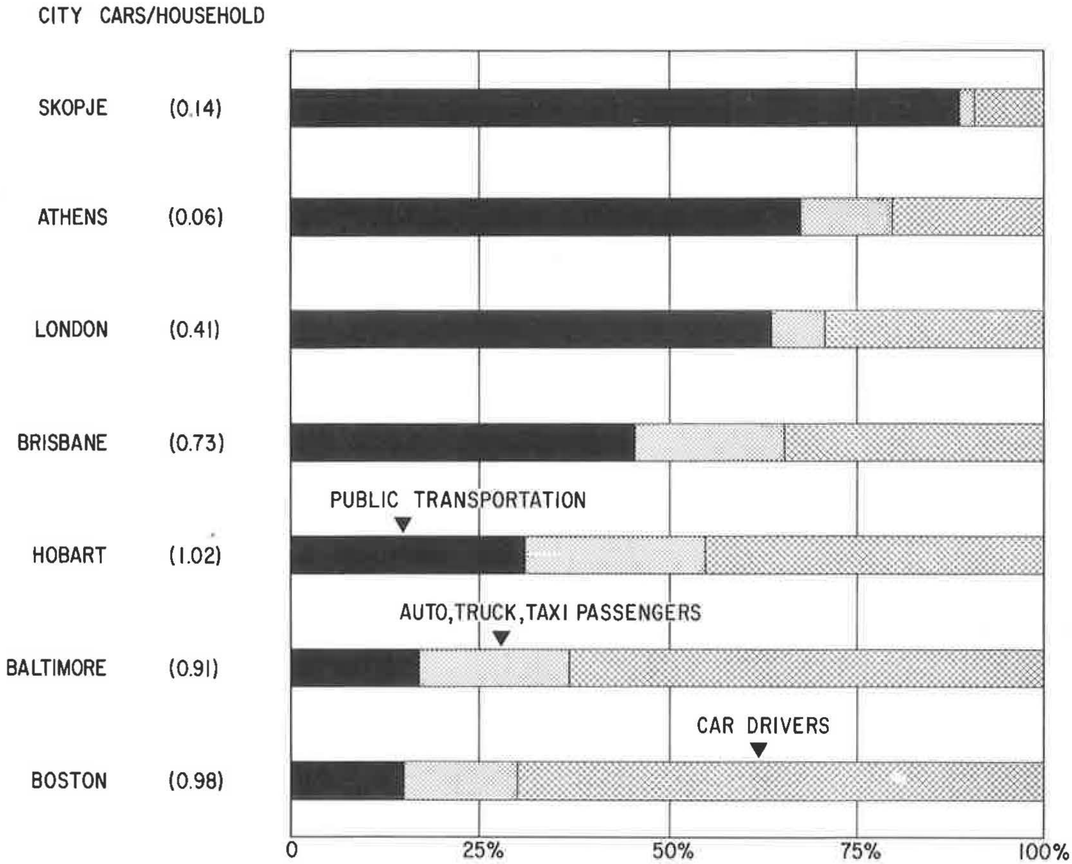

Figure 5. Modal choice for work trips, seven cities.

Comprehensive parking studies have been conducted in a number of overseas central areas. Some facts produced are shown in Table 4. In addition to the cities already cited, such surveys were conducted in Ipswich, a suburb of Brisbane with a population of approximately 52,000 people, and in Melbourne, with about two million residents. For reference, similar parking studies were conducted in Knoxville and New Orleans.

The data show that the average walking distance from the place of parking to the primary destination ranged from 314 feet in Ipswich, the smallest city, to about 500 feet in Athens and Knoxville, a relatively small difference.

The average parking duration for passenger cars, developed from records of time of entering or leaving a parking space, ranged from just over one hour in the city of Hobart to a total of 2 hours, 43 minutes in Knoxville, which, unlike the other cities, has a substantial number of off-street parking spaces. Parking at the curb is generally for a shorter duration and therefore the overall average is reduced for the overseas areas. In Australia, also, there is relatively intense usage of the curbside spaces. In Athens, only 6 percent of the parkers were there for

TABLE 2

PERCENTAGE OF TRIPS BY WALKING

City	Walk Trips	
	As Percent of All Work Trips	As Percent of Total Trips
Skopje	33	44
Bombay	51	—
Athens	25	34
London	18	—
Baltimore	7	—

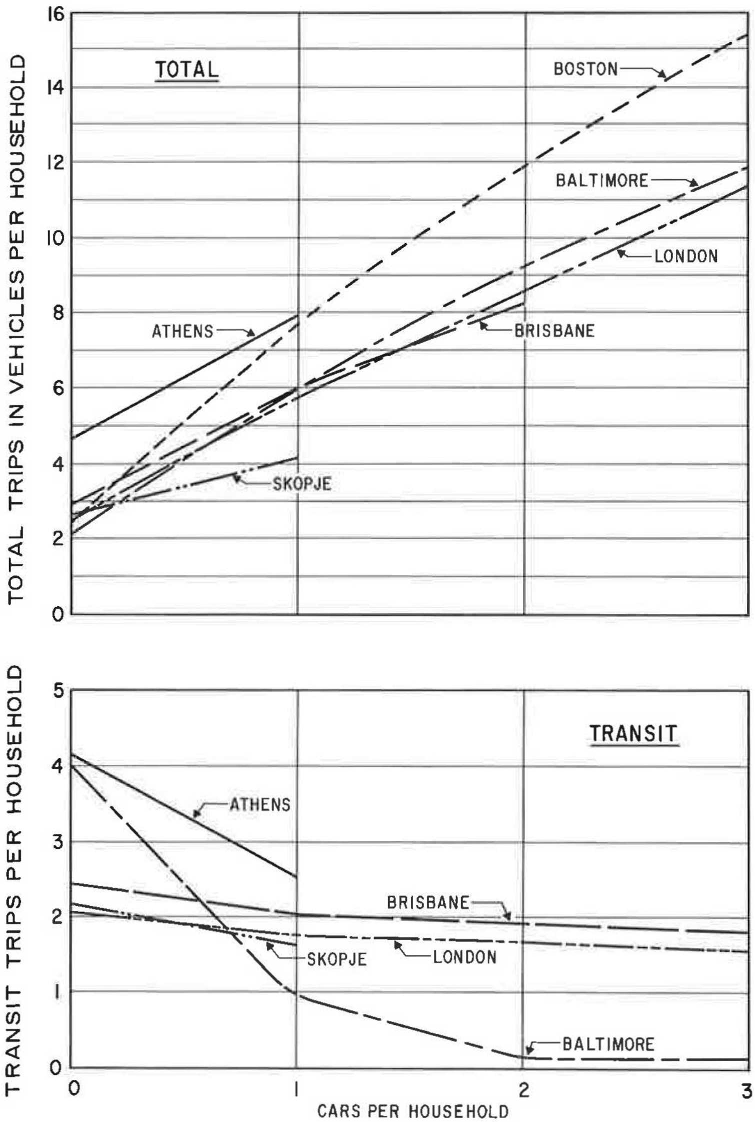

Figure 6. Daily trip generation, selected cities.

TABLE 3

AVERAGE PASSENGER CAR OCCUPANCY[a]

City	Work	All Purposes
Bombay	1.61	1.82
Brisbane	1.33	1.58
London	1.16	1.43
Athens	1.67	2.16
Hobart	1.47	1.74
Boston	1.08	1.51
Baltimore	1.14	1.48
Skopje	1.54	1.60

[a]Internal-area trips, including driver.

shopping, whereas in Ipswich, 27 percent of the motorists parked to shop. Alternatively, 56 percent of the parkers in Athens were there for work purposes while the general average is approximately 18 to 20 percent of all the parkers for working.

APPRAISAL OF METHODS

In discussing urban transportation planning studies with technicians abroad, they frequently raise questions as to the need for as much detail as now attempted in the United States, even though it can be

TABLE 4

SELECTED PARKING CHARACTERISTICS IN CENTRAL CITY

City	Average Walking Distance (ft)	Average Parking Duration (hr:min)	Trip Purpose	
			Percent Work	Percent Shop
Athens	500	2:06	56	6
Hobart	327	1:04	19	23
Adelaide	495	1:22	18	18
Brisbane	416	1:14	20	16
Ipswich	314	1:19	18	27
Knoxville	507	2:43	24	24
New Orleans	478	2:36	32	12
Melbourne	495	1:28	27	17

demonstrated that travel motivations are similar. They are apt to point out that traffic, generated by the movement of people and goods, is only one of the factors influencing the development of an urban area. They feel that sometimes a lighter study, easily applicable to various development plans, might give results as good as the very detailed analyses based on long and expensive surveys.

Up to the recent past, very few large-scale surveys on urban travel demands, like those conducted in the United States, had been performed in continental Europe. Travel demands had been based on surveys limited to small samples of households, with results compared to data collected on a larger scale. Forecasts of trips per capita were made and used as the basis for estimating travel demands between the vital parts of the urban areas.

It is likely to be further pointed out that, since in large U.S. transportation studies many assumptions have to be made all along the way, it seems that the accuracy obtained by the detailed surveys may sometimes be superfluous and not consistent with the many assumptions. Further, it might be felt that since their results are based on so many hypotheses, transportation studies should really be used comparatively instead of absolutely. In some countries it is thought that they should serve only to compare plans and solutions proposed for the overall development instead of giving the unique solution. These factors must be weighed seriously in the total urban planning process.

OVERVIEWS

The data presented and the examples cited are too limited to permit drawing conclusive results. However, there are some strong indications of significant similarities and correlations. In addition, it is possible to generalize about the significance of the reported findings.

The interchange of urban transportation planning knowledge among nations is valuable, practicable, and essential. Techniques and ideas promulgated in one area, under one set of conditions, will often have applications elsewhere. As nations continue to develop, these interchangeable methods and data will become more valuable.

As urbanization continues rampant, to a point that within the next two decades 80 percent of Americans will live in cities, emphasis will focus increasingly on transportation problems of cities throughout the world.

The consistency in data discussed tends to support the argument that, given the same social and economic opportunities—as reflected in car ownership—personal desires for travel are consistent, regardless of geographic locations.

Additional data stratifications would show the same type of consistency for trip purposes of public transport users. However, these generally represent lower-income groups and would be heavily oriented to work trips.

The consistency in basic urban travel motivations suggests that many of the data which are collected at considerable expense in modern urban studies could be reduced or simplified with acceptable accuracy by making greater use of both data presently available and proven techniques in synthesizing future travel needs.

Although there is a significant difference between the problems associated with the more developed nations and those associated with lesser-developed nations, the consistency among such population segments as auto-drivers is important. Projected car ownership seems to be an all-important link in transportation planning. Where countries are nearly equal in the degree of development, vehicle ownership, and thus overall transportation demands, tend to be the same.

Many of the aspects of this research are oriented directly toward long-range planning of facilities. It is essential that these research efforts be coordinated with other urban and regional planning. It is more significant that all of these research efforts in transportation can be, and are, interchanged through such agencies as the Highway Research Board. Other organizations, such as the research laboratories of the British Commonwealth nations, the International Road Federation, and the Australian Road Research Board are also making significant contributions. In addition, the personal contacts through student exchange programs are vital in this international cooperative atmosphere. The actual research program, the publication of findings and dissemination of reports, and the application of research are among the factors which will do much to foster sound urban transportation planning throughout the entire world.

Lessons from Personal Experiences in International Cooperation

HANS F. WINTERKORN, Professor of Civil Engineering, Princeton University

The basic reason for personal involvement in international cooperation is the same as for any other type of cooperation. It is the innate predisposition of human beings to lend a helping hand when they see others engaged in a worthwhile job and in need of help which to supply is within the capacity of the onlooker.

Prerequisites of successful cooperation are: (a) recognition by the cooperating agencies or individuals of the worthwhile nature of the project under consideration and the expectation of mutual benefit which need not be exclusively pecuniary or economic; (b) scientific, engineering and financial capability of the cooperating agencies or persons to see the project through; this often has to be supplemented by diplomatic ability on both sides which, however, does not mean a bag of diplomatic tricks but serious attempts at mutual understanding; (c) sincere dedication to the job on the part of individual protagonists; this is of greatest importance in projects of any and all sizes; (d) avoidance of unnecessary difficulties by trying to understand the different customs and habits, and even different codes of honor, one is likely to encounter in foreign parts; also, one should always keep in mind that other people are not as good as we ourselves should be.

The growth of personal involvement of the author in international cooperation is traced from the participation of the Vialidad Nacional of Argentina in his research at the Highway Department and the University of Missouri, to organization of international symposia within the frame of the Highway Research Board and to consultation and lecture tours to various countries abroad. Illustrative episodes are related especially from the fall and winter 1964-1965 tour to Europe and the Near and Middle East.

It is concluded that international cooperation is a very worthwhile undertaking even for individuals who are not involved in large-scale United States Government projects. The broadening of scientific knowledge and professional experience, the widening of human understanding and the friendships with sincere and devoted people that grow out of such cooperation can be highly treasured rewards.

•THE REQUEST for the preparation of this paper caused me to search my soul for the why and how of my involvement in international cooperation. I did not come up with a great philosophical maxim. It just happened that I became involved, and I think the reason why it happened is the innate predisposition of human beings to lend a helping

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

hand when they see others engaged in a worthwhile job and in need of help which is within the capacity of the onlooker to supply.

I was reminded of the time when as a young professor in Missouri in the depth of the Depression I had built, with meager means, an apparatus that was to supply important data. One day the apparatus started to collapse in the middle of an experiment. While I was using both hands to save what I could, there was a knock on the door and I gruffly shouted "come in." A young lady appeared, saw my situation and without any word spoken lent me her two helping hands to save the apparatus and the experiment. It took about half an hour of silent cooperation; after it was all over the young lady introduced herself as a student of journalism who had come to get a story out of me. Incidentally, she was the sister of Professor Edgerton, of Massachusetts Institute of Technology, which may explain her ability to help. For effective cooperation such ability must be added to the innate inclination of man to help his fellow in a worthwhile job. Another important element in this situation is, of course, that the job is recognized as worthwhile by the helper.

The ability to help does not presuppose that the helper is smarter or richer or stronger or generally superior than the one he is helping. Will Rogers once said, "It is not so that some people know more than others, rather they know different things." It is good to keep this great truth in mind when cooperating with others. My homely example about lending a helpful hand may be considered as too simple and too primitive by those who are planning, initiating or administering large cooperative international projects. But basic principles are always simple though usually pregnant with implications that may not be easy to discern.

The prerequisite that somebody must be engaged in what the potential helper considers a worthwhile job may not seem applicable to such an undertaking as the planning and hoped-for ultimate establishment of a Mekong Valley Authority in the image of our T. V. A. But certainly, the most important activity anybody, a person, a family, a nation, a country or even a subcontinent can be engaged in, is in living. Often the outsider has a clearer view of the means by which life can be made easier and more joyful. Therefore, effective planning may be done by an outside observer or agency; but such planning can be successfully put into effect only if the people concerned become wholeheartedly engaged in the project and make it their own. Here lies the great difficulty and also the great promise of international cooperation.

The one really successful, large-scale, multifaceted cooperative project in international cooperation was the Marshall Plan. This success was due largely and perhaps determinantly to the fact that the countries involved shared with us similar states of economic and industrial development as well as a corresponding general cultural background. This provided a good basis for mutual understanding and harmonious cooperation. Whenever such a basis was lacking in larger international cooperative projects, trouble and waste of money resulted, even if the economic calculations, on which the project was based, were correct.

This basis of mutual understanding plays the same role as the foundation of a building; it must be the stronger and larger, the bigger and more important is the structure to be built on it. For this reason international cooperation tends to be more successful if it deals with limited areas and specific endeavors. The European Common Market started with the Coal and Steel Community which still serves as its strongest structural element. Also, people in the same fields of endeavor possess a similar work and life philosophy that easily bridges language, cultural and racial differences. Good examples for this are the successful reorganization of the Turkish Highway Department by the United States Bureau of Public Roads, some eminently successful activities of our Department of Agriculture, those of the Rockfeller Foundation in the field of preventive medicine, and many more.

Yet, upon taking a close look, you find behind the curtain of success not only the common interest in the joint activity, but also a few personalities of deep understanding and sincere devotion to their task and to the human beings who are to be helped. Such dedication is sensed by the other side. Robert Pendleton, the U.S. soil scientist who did so much for the agriculture of Thailand, was beloved and honored by its people and given a princely burial when he died. The success of the Bureau of Public Roads mission to Turkey owes much to the understanding of American ways and ideals acquired by Vecdi Diker, then Chief Engineer of the Turkish Highway Department, during his studies at the University of Missouri. This, incidentally, is a very good example of the importance of giving foreign students an opportunity to study in the United States, an activity in which the International Road Federation has been effectively engaged.

NATURAL GROWTH OF PERSONAL INVOLVEMENT IN INTERNATIONAL COOPERATION

The preceding general remarks may appear to have little connection with the title of this paper that stresses personal experiences, especially since I was never officially connected with any of the large-scale government or private efforts financed by the United States in international cooperation. However, I have had for many years the privilege of being acquainted with and befriended by leading citizens and government officials in foreign countries, including heads of various ministries and of states, who discussed their problems freely with me and helped me to see the other side of the picture. Therefore, what has been said above should be considered as quintessence of this type of experience. Now I shall briefly relate personal experiences in proper sequence.

My involvement in international cooperation in the field of road building actually started when, as a young German scientist on a visit to Missouri, I learned about the urgent need of lifting this and other midwestern states out of the mud. Being a guest of a fellow Heidelberg student, the son of Jewel Mayes, then Secretary of Agriculture of the State of Missouri, I heard him and also Chief Engineer Cutler and Materials Engineer Reagel of the State Highway Department as well as others expound the problem of low cost roads and the attempts that were being made toward its solution by something called soil stabilization. Since the age of nine I had experienced nothing but destructive war, gnawing hunger, disastrous inflation, and foreign occupation of my homeland, and again at that time I could see the political clouds drawing together for a new thunderstorm. With this background I felt that here was something to be done that was really worth the time and effort of a young man. The matter was clinched when upon my question, "What is soil stabilization?", Mr. Reagel answered, "This is what we want you to find out."

From this assignment grew a cooperative project that expanded in ever-widening circles until it reached the farthest corners of the globe. The work was cooperative from the beginning; the highway engineers furnished a wealth of practical information and of clear-sighted observations; however, their scientific coordination and explanation had barely begun. Toward the organization and scientific evaluation of the available data I could contribute the newest concepts and theories of physics and chemistry and my own practical experiences in the construction industry. Very soon, fundamental investigations could be started in both laboratory and field. When Mr. Hogentogler learned about my work in Missouri, he persuaded the Bureau of Public Roads to join the project by sharing the cost of my salary with the State Highway Department. In 1932, the University of Missouri joined in the effort by contributing laboratory and other facilities, though no pecuniary remuneration, to the writer in exchange for teaching of courses in advanced physical chemistry. By 1936 word of the accomplishments of this project had spread sufficiently to bring me offers of positions from Argentina and Germany. I preferred to stay in Missouri but the Government of Argentina was induced to participate in the project to the extent of sending typical Argentine soils to Missouri and of contributing to my salary, equally with the Bureau of Public Roads and the State Highway Department of Missouri.

The year 1936 also saw three other important events: (1) the founding of the Soil Science Society of America; its sphere of interest included from the start the soil physics and soil stabilization problems of the road builder; (2) the first international congress on Soil Mechanics and Foundation Engineering at Harvard University; and (3) the reorganization of the Department of Soils, Geology and Foundations of the Highway Research Board, and the establishment of the Committee on Physico-Chemical Properties of Soils which was later renamed Committee on Physico-Chemical Phenomena in Soils.

All three events provided vehicles for spreading knowledge of the achievements of the cooperative venture in Missouri. As a result, problems encountered in many different parts of the world were brought to my attention with requests for help in their solution. My associates and I were very grateful for these requests. Each new problem submitted represented an opportunity to test the power and reliability of our scientific tools. Each problem solved added another supporting element to the structure of the new engineering science that we were building. Also, the specific facts and data that pertained to each problem increased our fund of useful information. In this manner, our work, insights and understanding could gain a much wider range and greater depth than would have been possible without the continued stimulus and supply of data from the outside.

The most interesting and valuable cooperative effort that is still continuing started in the late thirties with Colonel Wooltorton who at that time was Resident Engineer at Shwebo, Burma. The problems there concerned heavy tropical soils in monsoon climate. Many things happen with such soils that appear strange and often unbelievable to those who are acquainted only with soils in other climatic regions. Although, up to that time, I was not personally acquainted with tropical soils in their natural environment, I had learned enough about the importance of environment and microclimate on the performance of soil and road structures to be able to utilize my general physical and physico-chemical knowledge in assaying the new soil engineering problems submitted to me. In a way, this problem was of the same nature as that which faced me originally in Missouri, where the climate differed considerably from that in which I had grown up. In a more extreme form, an analogous problem confronts, at the present time, all of us who are concerned with the behavior of lunar soils.

When Colonel Wooltorton was subsequently transferred to India and later to Kenya, he brought knowledge of the problems of these countries to my attention and he introduced my or rather our joint approach toward solution of these problems to the attention of the countries concerned. One important by-product of this cooperation and exchange was a crop of promising young men who were sent to do graduate study with me; most of these have returned to their native countries and have become prominent engineers. Close contacts still exist between these former students and myself.

The Second World War interrupted peaceful cooperation with many parts of the world. However, the research and development projects in which I was involved for our armed services helped to expand my knowledge of soils in many parts of the world and my understanding of the particular engineering problems peculiar to various climatic environments. This proved of great benefit for peaceful work in the postwar years. In 1946, I spent several months in Argentina as a guest of the Direccion Nacional de Vialidad and of an association of estancieros that furnished the funds for this undertaking. During a subsequent stay in Brazil on the invitation of the Brazilian Government, I became, for the first time, personally acquainted with real tropical soils in their natural environment. I found that all my science and imagination had not been quite sufficient to predict the real thing. This experience was of great help in later cooperation with the Highway Departments responsible for road construction in tropical countries.

The postwar years brought many invitations for lectures and high level consultations from government and private agencies and universities of Western and Central Europe. In response to these, visits of several months duration each were made to Europe in the winter of 1951-1952, in the summers of 1955, 1956 and 1958. The visits were mainly to France, Germany, Austria, and Switzerland. In 1957 the President of the German Federal Republic honored me by awarding the Order of Merit in recognition of assistance given to Germany and of my efforts toward better mutual understanding between nations. Most recently, in the fall and winter of 1964-1965, my wife and younger son accompanied me on a five-month consulting and lecture tour to Europe and the Near and Middle East, including among others such countries as Hungary, Yugoslavia, Egypt, Lebanon, Syria, and Turkey.

It may be helpful to list here briefly the main types of international cooperation in which I have been engaged over the years:

1. Inclusion of soils from foreign countries in the research projects conducted in my laboratories first in Missouri and later in Princeton.
2. Assisting government and private agencies in foreign countries to establish research and testing facilities for soil stabilization and in the design and control of test roads.
3. Assisting in the scientific analysis of road failures, especially when they were due to interaction of peculiar microclimatic factors with the road structure.
4. Formal lectures and informal discussions with audiences and groups of wide ranges of background, such as high governmental planning bodies, academic audiences, contractors and industrial associations, groups of field engineers and others, representing practically the entire highway industry in various countries.
5. Field inspection of test and other roads and evaluation of design, construction, and maintenance procedures.
6. Enlisting the aid of foreign engineers and scientists in the organization of the various international symposia sponsored by the Highway Research Board's Committee on Physico-Chemical Phenomena in Soils.

Such activities, of course, have to be financed. The contributions of Argentina to our research in Missouri have already been mentioned. The overseas work was usually organized in connection with a paid sabbatical furlough and a round trip ticket to Europe furnished by my university. The additional overseas expenses were carried by the government or other agencies that asked for my services but were usually supplemented by my own means. There was never any help from the United States Department of State or the National Science Foundation or similar government agencies. In Hungary, where on the last trip we were guests of the Hungarian Academy of Sciences, I was handed on arrival a thick envelope filled with money that was ample for all the needs of our week's stay. In Slovenia on the same trip, we were guests of the University of Ljubljana; on arrival we were taken to the best hotel and advised to charge all our bills. Outside of the hotel, we were always escorted by members of the university and by government engineers who took care of expenses. In Egypt, Lebanon and Turkey, the honorarium for my lectures took care of the living expenses of my wife, son and myself in the best hotels. My own financial contributions consisted mainly in the air fares to get to these countries. However, I felt that this was a fair price to pay for what I and the members of my family learned on these trips. Now, let us turn to the main lessons I learned in addition to increasing scientific knowledge and professional experience.

LESSONS LEARNED

International cooperation is not essentially different from cooperation in more restricted areas. There has to be a recognized need and a potential solution, a promise of mutual advantages to be gained, and a willingness to cooperate. Also, in every nation as in every other group, there is about the same percentage of saints and of stinkers, and a normal probability distribution in between. However, one must realize that the concepts of what is honorable may vary widely among different nations—indeed, even within the same nation. This has long been known to the historian and ethnologist. Thus, the Roman historian, Corneliu Nepos, pointed out about two thousand years ago in his "Lives of Famous Men" that many things which are honorable in Greece are dishonorable in Rome, and vice versa. But such basic differences in customs and even concepts of honor are very easily forgotten in these days because the general adoption of Western dress and outside manners make us appear increasingly like each other. For the stated reasons, it is wise, before working in a certain area, to acquaint oneself with the range and type of behavior covered by the ruling concepts of honor. Often there is no ready guide to this; if one does not want to be a victim of prejudice, one must patiently gather and evaluate pertinent facts and concepts from the history, literature and general culture of the people or tribe with which one is concerned.

Cooperation presupposes communication, and communication normally is accomplished by means of the written or spoken word. The advantages of having a common language are obvious. Most educated people in Europe and other continents can understand English to a greater or lesser extent. But, as the president of the University of Ljubljana told me, "they understand English best when they talk it to each other; second is English English and only third American English." If one does not know the language of the host country and if comprehension of English by the foreign partner is not perfect, it is good to have another foreign language in common. Thus in both Hungary and Yugoslavia, I was asked to give my formal addresses in English but conduct the more important scientific and engineering discussions in German. In Egypt and in the Levante, a working knowledge of French is of great advantage. Need to express one's thoughts in a different language often helps to refine and simplify these thoughts or even to find out that what sounded good in English proved to be not much of a concept if translated into another language.

Effective cooperation is based on the scientific understanding of the problem and on practical knowledge regarding the potential and the actually available means for its solution. Outside advice is usually not sought for easy problems nor for any that can be solved by recourse to a handbook or a set of specifications from another country. One needs the ability of appraising complex situations from a fundamental physical and often also chemical point of view and of subsequently translating the scientific appraisal into materials and methods. Some of the most serious mistakes I have encountered in the field were due to blind following of non-indigenous specifications or literature, including some from over here.

When one looks at a job that is definitely a mess, one never knows whether it has been designed by the chief engineer or by some poor devil who is in danger of losing his job. Not to point out the error and to show the right way would be professionally and morally wrong. In most cases, one can also be sure that there are engineers in the audience who know what is wrong, though they may not dare to say it. Situations like this are the normal ones, not the exceptions. I endeavor to show, in such cases, how the error was of a kind that could be easily committed by people not having previous experience with the exceptional features of the situation. Then, I demonstrate what I consider the correct analysis of the problem and its proper engineering solution. In other words, the offender, whoever he might be, gets off the hook, but, hopefully, he has learned his lesson, and so have the other attendants of the visitation.

In relatively public meetings and in receptions or smokers with a wide range of participants it is often good to beware of the con-man who has some cure-all to sell. He will stay close to you and engage in conversation that usually has little or nothing to do with engineering or science. He just wants to be seen talking with you so that he can later claim that he has discussed his material or method with you and that he has your endorsement. Interestingly, the most conspicuous case of this sort happened to me in Germany; people who fall for such tricks, more likely than not, belong to the engineering "intelligentsia," i.e., those who know a great deal about theory and mathematics but very little about materials and their performance under different environmental conditions.

True cooperation involves mutual contributions and mutual benefits. The benefits cannot always be expressed in dollars and cents or other economic measuring units. In the case of a professor and consulting scientist, every new experience and new piece of factual knowledge ultimately benefits his students and his normal clients. Some of the "lessons to be learned from Europe" have been eloquently reported by Von Eckardt in Highway Research Record No. 97. Something that can help to make our own life richer and fuller can be learned from almost every country or nation. On the other hand, we can often increase our usefulness in other countries by serving as catalysts in bringing people and organizations together that should know each other and work with each other. In most countries I visited, I have found that the highway soil engineers do not know the soil scientists in their ministries of agriculture and agricultural colleges. I make it a point to bring these people together wherever I go, and I have seen important fruits of cooperation grow from this.

SOME PROGRAMS AND INTERESTING EPISODES

For illustrative purposes a few schedules are given below:

Austria: Sunday 18th to Saturday 24th October 1964:

Sunday—arrival in Linz and social evening with Dr. Aichhorn, Director of Highways of the province of Upper Austria, and other engineers and their ladies.

Monday and Tuesday—visit of construction projects involving high soil fills on the Linz-Vienna Autobahn route and of construction sites of the Enns-Chain Electric Power Works.

Wednesday and Thursday—participation in the International Conference on Soil Mechanics in Highway Engineering in Vienna, sponsored by the Austrian National Committee of the International Society for Soil Mechanics and Foundation Engineering; to this conference I had contributed two papers in German, entitled respectively:

(1) Critical consideration of the influence of chemical additives on the properties of soil-cement.
(2) New theoretical developments regarding the shear resistance of granular soils and their practical significance.

Also, the author served as the General Reporter for the group of papers on the theme: Soil as a Construction Material.

Friday—inspection of farm and farm-to-market roads under the guidance of Ministerial Councillor Scholz of the Austrian Ministry of Agriculture.

Saturday—obtaining visa for Hungary at the Embassy in Vienna and preparing departure for Budapest.

Hungary: Sunday 25th October to Sunday 1st November 1964

Arrive Budapest from Vienna on evening of 25th October.

Date	A. M.	P. M.	Evening
October 26 Monday	Visit to the Technical University, Dept. of Geotechnics	City tour	Spent with Prof. and Mrs. Kezdi
October 27 Tuesday	Preparing for discussion and lectures	Scientific discussions with Prof. Kezdi	Attendance at concert by Russian Violinist Ojestrah
October 28 Wednesday	Lecture in English on Soil Stabilization at the Hungarian Academy of Sciences	Free	Dinner with Prof. and Mrs. Kezdi at hotel
October 29 Thursday	Excursion into environments of Budapest including proposed building site for large Danube power project		Free
October 30 Friday	Reception at the Technical University and lecture in German on Soil Water Interaction	Visit to U.S. Embassy to have absentee presidential election notarized	Attendance of opera "Don Carlos"
October 31 Saturday	Lunch with Vice-President of Government Agency for Development and other dignitaries; afternoon with Vice-President of Development		Farewell dinner at the Kezdis
November 1 Sunday	Departure for Vienna and Linz, Austria		

Yugoslavia: Sunday 15th November to Saturday 21st November

Arrival in Ljubljana, Slovenia, by train from Salzburg, Austria, 4:14 p. m.

Date	A. M.	P. M.	Evening
November 16 Monday	Visit at the Soil Mechanics Laboratory of the University (Prof. Dr. Sulkje and his staff). Visit of the President of the University	Walk through Ljubljana and car trip through immediate surroundings	Free
November 17 Tuesday	Discussion in Soil Mechanics Laboratory. First lecture (in English) on: New Theoretical Knowledge on the Shear Resistance of Granular Soils and Its Practical Application	Trip to Bled Lake and inspection of highway and other engineering projects	Attendance at opera
November 18 Wednesday	Visit at Government Institute for Materials and Structures Research and discussion with its director and staff on various aspect of materials research	Lecture (in German) at this Institute on: The Basic Principles of the Stabilization of Granular Soils and Their Practical Application	Dinner at the home of Prof. Suklje
November 19 Thursday	Excursion to the Drawa River Canal and Power Station in construction. Discussion meeting with engineers from the Electric Power Authority on soil stabilization problems. Banquet in the evening.		
November 20 Friday	Trip to the Adriatic and inspection of new harbor facilities of Slovenia		
November 21 Saturday	Early morning departure by air for Belgrade and from there in the evening for Athens, Greece.		

THE NIGHT THE UNITED STATES LIBRARY OF INFORMATION BURNED IN CAIRO

Somehow, from every trip I have brought home memories of scenes or pictures indelibly engraved in my mind. One of these is a double feature, related in time if not in substance, but with sharp contrasts. It concerns the night when our Library of Information in Cairo was burned by African students.

The Dean of Engineering of Ain Shams University had invited us to the wedding of an assistant professor of civil engineering and his bride, an instructor in a medical school. The wedding celebration took place in a large rented hall on the outskirts of Cairo. It was a most impressive affair with hundreds of guests and enough food and drink for all of them. The guests came in families including children who could barely walk. This gave a special quaintness and warmth to the festivity which made it remain a family feast despite the crowd.

The entertainment was lavish; there was a stage and dance floor where outstanding artists performed including the beautiful dancers who at that time were featured in the night clubs of the Hilton and Shephard Hotels. While these performed their astounding and aesthetically impressive feats of muscle control and pleasing coordination of movement, little girls from among the guests went on the stage to show how much they had learned of this native art. The absence of even a drop of alcohol among the refreshments helped us to realize the inner meaning and significance of the development and cultivation of this art form. What man truly can call his own, is the trinity of body, mind and soul. Is not each of these worthy of fullest development? Do not all of our true joys derive from their capacities and degree of development achieved by serious training?

Still full of the experience of the evening, the Dean drove us back to the Shephard Hotel. Within a block of it the streets were wet and there lingered the acrid odor of water-drenched fire. Groups of soldiers stood at street corners. Our inquiries were answered with accounts of what had taken place. We drove around the United States Embassy and saw with our own eyes the dead, burnt-out remains of what had been our Library of Information.

The morning papers contained expressions of official regret on the part of the Egyptian Government about this act of students mainly from Equatorial Africa but also stated or implied that one could understand the fury of these students because of the recent United States-Belgian act of intervention in the Congo. Until our own Los Angeles riots, I felt that the Egyptian Government could have prevented this act; now I am forced to think differently.

All my Egyptian colleagues, friends and acquaintances expressed sincere regrets about what had happened and hoped that it would not have an adverse effect on United States-Egyptian relations. To me the sincerity of this was indicated by the shift I noticed in the composition of my lecture audiences. These became larger, but instead of students they were composed predominantly of mature engineers. I almost felt that the engineers of the highway department had been ordered to attend my lectures. At any rate, I enjoyed this changed audience and also the more significant discussions that followed my lectures in Cairo. The situation was similar in Alexandria where I lectured later on; however, I sort of missed the engineers from the state highway department whose sincere interest had really been a great stimulus to me in Cairo.

STAY AT THE AMERICAN UNIVERSITY OF BEIRUT AND A SHORT TRIP TO DAMASCUS

At the end of my last scheduled lecture in Alexandria, my throat closed with an infection and would not open again for about a week. During that time I lay in bed at the Shephard Hotel in Cairo, well taken care of by an Egyptian physician and shot full with penicillin. I was allowed to get up just a day before we had to leave for Beirut, Lebanon. There, I had been scheduled to give two lectures at the American University, one at the beginning and one at the end of about a ten days' period. In between, I was supposed to deliver five formal two-hour lectures at the University of Damascus in Syria. We arrived in Beirut in the afternoon of Thursday, December 10th and were made at home at the Alumni Club of the American University. My first lecture at the university was the next day, Friday, the 11th.

Still recuperating from my Egyptian infection, I could not face five two-hour lectures within five days in dry, dusty Damascus but I did not just want to write a letter to get out of the agreement. Fortunately, Dean Ghosn, of the School of Engineering of the American University of Beirut, had some business in Damascus on Saturday and had hired a taxi for the trip. He invited my family and me to go along to see the country and the city of Damascus and to arrange matters with the president of its university.

In Damascus, Dean Ghosn went after his own business but got us a local taxi driver whom he instructed to take us to the president of the university and afterwards back to an agreed-upon meeting place. Unfortunately, our driver knew only little English and less or nothing of any of the other languages in which I am able to communicate. First, he took us to the entrance pavillion of the university. There was discussion, telephoning, waiting, some more telephoning, and some more waiting and discussion. Then the driver took us away from the university into a suburban area. There he stopped at a crossing of several streets, got out, walked to a corner, gave a shrill whistle and waited, whistled again and waited again. Then we drove to another similar intersection where the same thing was repeated. After the third or fourth enactment of this scene, the driver seemed to have received a signal. He motioned us to follow him to a house entrance. While my wife preferred to stay in the taxi, my son and I went with him to the house and to an upstairs apartment where we stated our business to a lovely and dignified lady. We waited awhile in an anteroom and then were conducted to the living room where the president was lying on a sofa. He had suffered a broken leg in a recent accident. The experience we just had gone through was beginning to make sense, but my son and I felt, more than actually noticed, a sharp, distrustful scrutiny by the eyes of the president; however, after I had stated my business and had transmitted the greetings which I brought from old American friends of the president, the atmosphere became very relaxed and friendly.

When we met Dean Ghosn that evening, his first question was why we had not visited the acting president of the university who had been waiting for us the whole evening. We had not even been told about an acting president. By now, it was too late to do anything but return to Beirut. The mystery was cleared up by a notice in Monday's newspaper. There had been a political upset in the University of Damascus and the president had lost his job just during the time of our visit. His initial distrust of two big fellows in trench coats, calling at his residence on a Saturday evening, seemed quite plausible. This, though, was not quite as serious as an experience in 1946 in Argentina, where a day or two before I was to go to Bolivia as the guest of its government, the president and his ministers had been hanged on lantern poles. At that time, I preferred not to accept the invitation extended by the successor government immediately after its accession to power.

The time originally scheduled for Damascus and Syria was spent in Beirut and surrounding Lebanon; under Dean Ghosn's expert guidance, we visited the beautiful palace of Beta-Din, the overwhelmingly impressive ruins of Baalbek and under that of a former student, Dr. Nazih Taleb, the site of the City of Biblos which has been continuously inhabited for over seven thousand years. The American University of Beirut was like a friendly oasis where I fully recuperated. In addition to giving the formal lectures previously agreed upon, I played the role of a scientist in residence and had several opportunities for informal discussions with students and staff of the Schools of Engineering and Agriculture. Checking out of the Alumni Club, I found that the university had already taken care of the bill, in addition to paying the honorarium for my lectures. This I appreciate even more since I recently found out that the whole annual research budget of the Engineering School amounted to only $3,000.00 that year.

A STRENUOUS SCHEDULE IN ANKARA AND ISTANBUL

In order not to extend unduly the length of this presentation, I shall just give a brief list of the major activities during our stay in Turkey.

December 1964	
21 Monday	Departure for Ankara, 3:15 p.m., arrival late afternoon, received at airport by three professors of the Middle East Technical University.
22 Tuesday	Visiting the Middle East Technical University and city of Ankara.
23 Wednesday	(1) Lecture at the Middle East Technical University 10:40-12:30—Soil Water Interaction and Water Conduction in Soils under Various Energy Potentials.
24 Thursday	(2) Lecture 4:30-6:30—The Influence of Physico-Chemical Factors on the Shear Resistance of Cohesive Soils.
25 Friday	(3) Lecture 9:40-11:30—The Science of Soil Stabilization. (4) Lecture 4:30-6:30—New Theoretical Knowledge on the Shear Resistance of Granular Soils and Its Practical Significance.
26 Saturday	Visit museums in Ankara.
27 Sunday	Visit grave of King Midas in Gordion.
28 Monday	9:00 a.m. visit laboratories of Turkish Bureau of Reclamation. (5) Lecture at the Middle East Technical University 4:30-6:30—

December 1964

	The Basic Principles of Stabilization of Granular Soils and Their Practical Significance.
29 Tuesday	9:00 a.m. visit Highway Department Laboratories. (6) Lecture at METU 4:30-6:30—The Stabilization of Cohesive Soils That Possess No Coarse Granular Bearing Skeleton.
30 Wednesday	(7) Lecture at METU 4:30-6:30—Soil-Heat Relationships.
31 Thursday	Flight to Istanbul, late afternoon arrival because of fog.

January 1965

1 Friday- 2 Saturday	Sightseeing with Professor Kumbasar.
3 Sunday	Visit with Vecdi Diker, former Chief Engineer of the Turkish Highway Department and member of the Board of Trustees of the Middle East Technical University at Ankara and Robert College at Istanbul.
4 Monday	Lecture at Robert College on The Basic Principles of Stabilization of Granular Soils and Their Practical Application.
5 Tuesday	Lecture at Robert College on The Stabilization of Cohesive Soils That Possess No Coarse Granular (gravel-sand) Bearing Skeleton.
6 Wednesday	Visit to the local headquarters of Turkish State Highway Department; also inspection of Field Laboratory, Asphalt Paving Plant and main road connecting with the West. Afterwards, Hagia Sophia and old subterranean water reservoir.
7 Thursday	9:30 a.m. visit Testing and Research Laboratories of Istanbul Technical University; 11:00 a.m. lecture at the university on New Theoretical Knowledge on the Shear Resistance of Granular Soils.
8 Friday	9:30 a.m. visit Soil Mechanics Laboratory of Istanbul Technical University; 11:00 a.m. lecture at the university on Physico-Chemical Factors Influencing the Shear Resistance of Cohesive Soils.
9 Saturday	Leave Istanbul for Rome by KLM at 10:25 a.m.

CONCLUSIONS

In every country I have been in, I have asked myself, "What does this country need most and what least?" The specific answers differed, of course, for different places; but there was one general answer that fitted all cases and this was "Less talkers and more doers." Immediately, a saying of Bernard Shaw comes to mind: "Who can, does, who cannot, teaches." This whimsical bit of wisdom hits close to home when one has been a teacher for more than thirty-five years and also, hopefully, a doer.

There can be little or no doubt that everywhere and especially among the professors there are more talkers than doers. For our own sake and that of the world at large, we should find out the reasons for this. Doing should be more natural to man than talking. Why then does higher education produce more talkers than doers? An answer to this question is urgently needed for the sake of the human race. I think I know at least the direction in which the answer lies but time is lacking for further inquiry at this place.

Another question I often asked myself, especially when I was really tired and worn out from talking and working in foreign parts, is: "Why am I engaging in individual international cooperation, when I would be financially better off without it?" The answer to this question, and the reason why I shall probably continue these efforts, is that I feel amply recompensed by treasures accumulated that no moths or rust can destory or debase. Among these treasures are: increase in scientific knowledge and professional experience, widening of human horizon and understanding, friendships with sincere and devoted people all over the world, and, perhaps, even a little bit of wisdom.

International Road Federation Fellowship Program

E. A. HUGILL, JR., Member, Board of Directors, International Road Federation

•OVER THE past several decades planning, research, and training in the highway field have been characterized by a continuous broadening in concept, scope, and method. Advances in mathematics have provided us with greatly improved tools. No less important is the infusion of concepts of sociology, economics, and other social sciences that have afforded new insights into the broader purposes that must be served by transport systems. The increasing use of the motor vehicle, with the resultant traffic conditions in our cities and towns, affects the whole community both socially and economically. This is a natural by-product of the twentieth century world.

Consequently, there has been much discussion in recent years in both academic and industrial circles relating to training of engineers for the current and emerging problems of highways and highway transport. Various formulas have emerged that, in effect, have been unanimous in seeking provision for that form of a broadened curriculum that could help counteract the high degree of specialization the twentieth century has imposed. In the past, the need for an engineer to accumulate an imposing gamut of technical knowledge often caused him, by necessity, to bypass the wider aspects of the humanities. Today, the nineteenth century approach to the education of an engineer is being abandoned and a new one evolved with the twenty-first century in mind. The emerging world community encompasses new philosophies and a new way of life.

Fifty-eight percent of the people now industrially employed in the United States are making their living at jobs that did not exist 50 years ago. The automobile has become a major segment of the economy. Over 150 million vehicles are currently in use. In 1965, free-world expenditures estimated at $26.42 billion were devoted to highways. These are dramatic and compelling figures. Highways are an integral part of the make-up of our civilized society. They are too great an undertaking to be planned, projected, and constructed by less than a highly trained man.

Research and competitive innovation are dictating sweeping changes in our concept of highways and highway transportation. Discovery follows discovery at a startling rate. Today, in fact, we educate for change.

With these factors in mind, and pursuant to its goal to implement the development and improvement of highways and highway transportation internationally, IRF established a fellowship program through which highly qualified graduate engineers from around the world could be brought to the United States for an academic year in one of the major universities or technical institutes. This was to be followed by a post-academic tour which would include visits to highway projects, highway and traffic administrative offices, research laboratories, and industrial installations engaged in the manufacture of roadbuilding and transport equipment. Through its fellowship program for an elite corps of highway and traffic engineers, IRF believed that know-how, which through other sources might take years or even decades to find its way around the world, could be diffused within a relatively short time.

It was IRF's belief that technical assistance in the international field can have lasting effect only in the degree that it improves the ability of another country to do something for itself. Thus, the objective of its fellowship program was to assist other countries in the solution of their transport problems through exposure to academic facilities and industrial experience of the United States. Great care had to be taken to

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

avoid the temptation of trying to do too much, too fast. Tractor agriculture cannot quickly be developed in a society that has not yet learned to plow.

Thus it was that the IRF fellowship program was established 18 years ago, and it has continued through the present: 408 engineers from 80 countries have already been trained; fellowship grants totaling almost $1.5 million have been administered by the IRF as of the present.

The 80 countries represented in the fellowship program are geographically distributed to reach the most remote regions of the world as well as the highly developed areas of Europe. For instance, the program has included engineers from all the states of Australia and as many as 25 from Colombia and 16 from Nigeria. Areas such as Iraq, Iran, Indonesia, Martinique, Ireland, Nepal, Korea, and Viet Nam likewise have their corps of IRF graduates.

The IRF fellowship engineers who have come, are here at present, and will come in future years, are all placed in universities at which special arrangements have been made to provide them with advanced training in the many disciplines in their field and, further, to tailor their specific studies and observation programs to the problems they will encounter upon return to their home countries.

To the student from abroad proceeding on a course of advanced study in the United States, the greatest value of such a fellowship undoubtedly lies in his active participation in formal graduate study at a university or technological institute. Here, under the guidance of men who rank among the foremost in their specialized fields, new frontiers of knowledge are opened and the engineer gains new perspectives, a new sense of values, and a better understanding of new methods and techniques. Above all, he develops a high degree of confidence in his own judgment. In short, he enjoys every benefit of higher technical education.

At meetings, such as the one at hand, in the classroom, or during guest lectures, he has the opportunity to hear and personally meet leaders in his technical field, men with a deep store of knowledge and experience, and men whose technical publications will in the future appear with an entirely new significance to him.

However, the real value of formal study can be gaged only in conjunction with the second phase of the fellowship program, the practical observation tour. During the university course, and particularly after the course, the student is given the opportunity of observing first-hand the practical applications of the methods and techniques that he has learned in his particular field of study.

The technical benefits from seeing theories in actual application are immense. In addition, his personal contacts with officials responsible for construction projects, traffic and industrial installations, administrative offices, laboratories, and test sites provide him with a roster of experts that he may wish to consult at some later date to supplement the knowledge he has already received.

On returning to his own country the student is not only richer by a vast amount of technical knowledge, greater skill, and better judgment, but he is stimulated to greater efforts. And, he has established contacts of everlasting value that will enable him to keep abreast of new developments in the field—an absolute essential for the modern engineer.

The concept of the fellowship program originated in 1948. The first two grants were awarded for the academic year 1949/50 to engineers from Mexico and Peru. The number of awards has increased annually until 1965/66 saw fellowship awards to 27 engineers from 22 countries. Financial support for the current academic year has been provided, in major part, by United States corporations engaged in oil, rubber, automobile, and road-equipment production, and by the U.S. government through its Agency for International Development.

The method of awarding the fellowships involves the combined effort of public works ministries, engineering schools, national good-roads associations affiliated with the IRF, and, with AID fellowships, a representative of the AID mission concerned.

Once the engineer is selected, he completes the necessary résumé of his professional experience and his academic training to be reviewed by IRF. IRF then selects the academic institution that it feels can provide the particular training program best suited to the purposes of the fellowship engineer.

IRF is proud to review the record of its over 400 fellowship trainees. It is significant that these men are being utilized to the fullest and that they have been afforded every opportunity, upon returning home, to make substantial contributions to their countries' technical development of highways and highway transportation. Several have risen to the position of Highway Director, and two, M. D. Bautista (1953) of the Philippines and John Thijm (1962) of Surinam, became Ministers of Public Works. S. David Nayreau (1962) of Liberia is his country's Undersecretary for Operations in its Department of Public Works.

To mention a few of the graduates specifically, we are proud that in the Americas Camilo Carles (1963) of Panama is Chief Engineer of the Darien Subcommittee of the Pan American Highway Congresses. Dr. Manrique Lara-Tomas (1958) of Costa Rica has become a leading authority in soil-mechanics foundations and lectures annually in Venezuela.

Gustavo Uribe (1952) of Colombia is now one of the outstanding consulting engineers of the Western Hemisphere. He received his Master's degree from Ohio State University and, upon serving his tenure with the National Highway Department, established his own firm of consulting engineers. His contributions to engineering progress in Colombia indicate that the IRF aim to insure the availability of good national talent has been realized.

Enrique Cuellar (1955) of El Salvador is Program Officer with the Central American Bank of Economic Integration; Jose Bodadilla (1958) of Honduras also serves with the Bank.

One of our first two students, Rafael Cal y Mayor (1950), has had a variety of important assignments in his home country of Mexico, in part because of his training under the fellowship program, and is currently Technical Advisor to the Ministry of Public Works.

In Africa, Solomon Audifferen (1959) is Senior Executive Engineer of the Nigerian Federal Ministry of Public Works and Surveys, and Gaston Dossou (1964) is Director of the Regional Training Center for Operators and Mechanics of Heavy Equipment, which is administered by IRF in Lomé, Togo, for French-speaking countries of Africa.

Omar B. B. Sendze (1964) is Executive Director of the Public Works Department Headquarters in West Cameroon, and in Ghana, Emmanuel Lartey (1959) is Coordinator of Industrial Research of the Ghana Academy of Sciences. Also from Ghana, Edward Francois (1961) is Chief Engineer for Roads of the Ghana National Construction Corporation.

In Asia, Sirilak Chandrangsu (1958) holds the position of Deputy Director General of the Royal Thai Highway Department, and Sadamu Mino (1955), Chief of the Tokyo-Nagoya Expressway Department of the Japan Highway Public Corporation, has had the responsibility of negotiating loans for his country with World Bank officials in Washington. Last year he concluded arrangements for a $75 million loan to finance completion of the last section of the expressway between Tokyo and Kobe.

James Coree (1957) has risen to the position of State Engineer of the Public Works Department of the state of Aden, Federation of South Arabia, and has recently been appointed Permanent Secretary to the Ministry of Works and Water of Aden.

One of the greatest responsibilities, from a fiscal standpoint, has fallen on the shoulders of Ekrem Ceyhun (1963) who last year became Director General of Village Roads of Turkey with a budget equivalent to $50 million and an anticipated increase of 100 percent, or $100 million, for 1966.

The majority of today's European traffic engineers are students trained by IRF.

John Hillier (1951), who was graduated from Yale, has worked at Great Britain's Road Research Laboratory since his IRF training.

Giorgio Pellegrini (1957), who was granted an IRF fellowship following his graduation from the University of Rome, is now Chief Research Engineer of Autostrade Concessioni e Costruzioni of Rome; also, he was selected by the World Bank to make the road-communications study of Argentina.

In Belgium, Raoul M. Schaballie (1961) is Chief Engineer of the Road Control and Research Department, Ministry of Public Works, and in Finland, Heikki Salmivaara (1963) is the Traffic Planning Engineer of the City of Helsinki. Five IRF French grantees are now serving as traffic engineers in France's Ministry of Public Works.

In Spain, Mario Romero (1958), who formerly headed up the Traffic Planning Department in the Public Works Ministry, is now Secretary General of the Federal Council on Land Transport. The outstanding work in Spanish traffic problems of José Puy Huarte (1962) is known throughout Spain and Europe as well.

Evidence of the merits of the IRF fellowship program may be seen in the later work of these engineers in connection with our Research and Development Inventory. Among the various people who have contributed to this program are: Prof. Nicolas Manasseh (1956) who inventoried Germany and Spain this year while on leave from the American University of Beirut where he is Professor of Highway Transportation; Luiz R. Soares (1957) who provided the data covering Brazil where he is Coordinator for Scientific Activities of the National Road Research Institute; Dr. Gordon Campbell (1955), Director of Technical Services of the Canadian Good Roads Association, another IRF graduate; and José Zúñiga (1960), who has not only been active on the research and development program, but is also IRF's staff engineer.

Among others who have gone on to the international field are J. P. A. D. Fernando (1958) of Ceylon, now with the United Nations in Kuwait, and Marcel Martin (1962) of Haiti, who is Transport Officer for the United Nations in Luluabourg, Congo Republic (Leopoldville). Jorge Ernesto Erdmenger (1956) of Guatemala has become prominent in the field of international land communications through positions with the Central American Common Market and also LAFTA.

The IRF fellowship program has not been restricted to men. Miss Rainusso (1958) of Uruguay is a traffic engineer with the Uruguayan State Highway Department; Miss Antillon of Guatemala (1959) is a bridge design engineer with her country's National Highway Department; and Miss Hong (1962) is an engineer of Planning and Programming with the Highway Department of Viet Nam in Saigon.

IRF this year, for the first time, is collaborating with the Automotive Safety Foundation in underwriting a new type of "specialist" program. The aim is to train two engineers, one from Spain and one from the United States, under a joint program of data collection relative to systems used in municipal and state agencies for factual analysis of highway data. The program is now under way, administered through the Department of Civil Engineering at the University of Washington. It will cover three months of academic work and three months of observation and practical training and is expected to be mutually beneficial, both by providing faculty and graduate students at the University the opportunity to become acquainted with international highway and traffic problems and, at the same time, providing the Spanish engineer technical guidance.

In closing, we wish to point out that the perpetuation of the knowledge gained by these fellowship participants is realized not only as they take up their professional positions, but also in their many academic and publication activities that inevitably ensue. IRF's method is thus to select and help train this elite corps of highly qualified engineers and then, by evangelism and a sort of mental capillary attraction, their new knowledge takes root, spreads, and the expanded program is under way.

In each of the 80 countries from which they come there are at least some IRF fellows teaching part time in engineering institutions. Still more impressive, however, are the dozen or so former students who now hold full-time professorships in their national universities. Among others, these include the National University of Cuyo in Argentina, the Technical University of Graz in Austria, the University of Waterloo in Canada, the National University of Bogota in Colombia, the Technical University of Berlin, the American University of Beirut, the National University of Lima, the University of the Philippines, and the Central University of Venezuela.

The list of technical publications in the highway and traffic-engineering fields that have been written by members of the IRF fellowship group is imposing. It includes the first manual of traffic engineering to be printed in the Spanish language prepared by Guido Radelat (1961) in collaboration with many of the other fellowship students whose specialities varied slightly from his own; Topografia, co-authored by Eduardo Villate B. (1964); El Arte del Trazado de Carreteras, by Luis Vera (1960); and Tratamientos Asfálticos Superficiales y Macadam a Penetración, published under the direction of Dr. Jacob Carciente (1961).

In addition to the fellowship program emanating from IRF-Washington, many of the national affiliates, recognizing the value of such a program, have established programs of their own modeled after the IRF-Washington experience. The Good Roads Association in Canada, for instance, has from 10 to 12 grantees a year who study in either Canada or the United States, and the same is true of the Mexican Highway Association. We expect that in the near future additional national programs will be established.

The Federation hopes, through its fellowship program, to assist in equipping a fraternity of experts around the world with a vastly improved capability for solving the increasingly more complex transport problems. This means planning or design of international transport assistance on a level of refinement unknown in earlier decades; it means the training of well-chosen men who will be in a position to return to their home countries to put into effect the techniques they have learned; it means also the placing of a premium on the results of research and analysis, for the transport world moves at such a rate that we no longer can have the luxury of a long period of trial and error.

IRF feels that we learn as much from the visiting trainees as they may learn from us during their training year. Such mutuality of interests and problems creates a channel in which the best that is developed in one country may be passed along for application elsewhere. This is the essence of the International Road Federation's objectives and the fellowship program is its thesis in operation.

Highway Administration

BENJAMIN B. FRAENKEL, Brazilian Highway Department

SYNOPSIS

•IN A comprehensive review of problems in highway administration, the author suggests ways to improve present practices. The introduction points up the leading position that the highway occupies in transportation in the civilized world, noting especially its status in the United States. The observation is made that basic to road development, as well as overall economic and social development, is the need to face facts.

An analysis is made of conditions in general in underdeveloped areas showing how these reflect ineffective administration in public affairs. The contrast between the United States and less advanced countries is noted and ascribed to the historic difference in "drives" among the various countries. Psychological immaturity is named as a chief reason for economic problems.

Excessive formalism in procedures, the "paper barrier" which delays handling of even minor problems, and the indifference to important needs are given as the main reasons for underdevelopment in general and road underdevelopment specifically.

The role of local laws and policies is noted, including an analysis of their employment in civilized and uncivilized areas. The gross national product and its rate of change is mentioned as an indicator or index to national development. The methods used by private enterprise are pointed out as the pattern for government procedures.

In sections on "Highway Administrative Problems," "Finances" and "Human and Physical Needs," analyses are made of ineffective policies and procedures. Possible improvements are suggested, such as coordination of interrelated work, effective advance planning, thorough analysis of job requirements, adequate control through each operation, and adequate maintenance of completed projects. Need for education and training in highway administration is emphasized. The effective technological services and counsel of the U.S. Bureau of Public Roads in the developing countries is acknowledged as an example of developmental assistance.

In the sections on "Priorities," "Preliminary Studies" and "Design," attention is called to existing inadequacies and suggestions made for new approaches. In the section on "Contracts" the author declares that such an instrument is the engineer's charter for the job and not simply a legal device. The author also addresses himself to the prevalent practice of bidding for professional services and its effect on quality of work.

Four recommendations are made for Brazil with respect to highway administration:

1. Reformulation of procedures;
2. Appropriate selection of highway officials;
3. Creation of a permanent Secretariat for all agencies involved in highway development; and
4. Adaption of administrative functions and activities of other leading countries in road development.

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

The Brazilian Highway Research Institute as Compared With Other Similar Agencies

LUIZ R. SOARES, Civil Engineer, Brazilian Highway Research Institute, Rio de Janeiro

HISTORICAL NOTES ON HIGHWAY RESEARCH

•HIGHWAY RESEARCH is a relatively new scientific activity. A review of these specialized activities will show us this world picture:

1. In the United States, although the idea bore fruit in 1893 when the Office of Road Inquiry was established as the predecessor of the present Bureau of Public Roads, interest in highway research was not accelerated greatly until the establishment of the Highway Research Board in 1920 under the National Academy of Sciences—National Research Council.
2. In Great Britain, the Road Research Laboratory initiated its activities in 1933 through two divisions: (a) Materials and Construction of Roads and Airports; and (b) Traffic Safety.
3. In Canada—although the National Research Council is still the official agency of all Canadian investigations—the Canadian Good Roads Association established in 1962 a Special Coordinating Committee on Highway Research which published in 1964 a report of 441 projects under way or completed since 1958.
4. In France, the Laboratoire Central des Ponts et Chaussees concentrates in 10 different sections all highway research work of the French governmental agencies. Lately, the Centre de Recherches Routieres has been established.
5. In Germany, the STUFA (Society for the Study of Highway Construction), established in Berlin in October 1924, was succeeded in 1934 by the present Forschungsgesellschaft für das Strassenwesen (Society for Highway Research), located in Cologne. However, it was not until 1927 that the Ministry of Transport allocated the sum of 30,000 DM for the establishment of highway research institutes in each of the Technical Schools of the Universities of Braunschweig, Breslau, Danzig, Darmstadt, Dresden and Stuttgart.
6. In Sweden, the Statenvaginstitut is the central agency of all highway research work, concentrating specifically on paving materials, frost effects, and traffic characteristics.
7. In Italy, the Centrao Esperimentale Stradale dell ANAS in Rome has just started to assume the functions previously performed by the Instituto Sperimentale Stradale in Milan.
8. In Switzerland, the Union Suisse des Professionnels de la Route conducts its research activities through 11 different specialized committees.
9. In Spain, the Laboratorio del Transporte y Mecanica del Suelo performs its research activities in three different fields: (a) soil mechanics; (b) pavings and traffic; and (c) transport economics.
10. In Portugal, the Laboratorio Nacional de Engenharia Civil conducts also some highway research work.
11. In Poland, the Centralny Osrodek Kadan is the central agency for highway research work.

Paper sponsored by Special Committee on International Cooperative Activities and presented at the 45th Annual Meeting.

12. In the Soviet Union, the Soyuzdornii coordinates all the activities of the different highway research institutes.

13. In India, the Central Road Research Institute and Indian Roads Congress are the principal agencies devoted to highway research work.

14. In Pakistan, the Road Research Institute in Lahore tries to disseminate the highway research work being conducted outside the country.

15. In Japan, the highway research laboratories are grouped into three different categories: (a) those which practice fundamental investigations; (b) those which conduct research work directly related with design; and (c) those which primarily perform routine tests for field work. The first group is connected with the Universities; the second group consists of governmental institutes; the third group includes the laboratories subordinated to the eight Districts of the Ministry of Construction and the Municipal Governments.

16. In South Africa, the National Research Institute in Pretoria contributes to the improvement of highway techniques.

17. In China, the Ministry of Communications in Peiping established in 1949 a central agency for highway research, known as Communications Science Research Institute.

18. In Australia, the Australian Road Research Board is devoted to highway research work.

19. In Brazil, the Instituto de Pesquisas Rodoviarias was established in August 1957, conducting its activities through the following fields: (a) scholarships and grants; (b) specialized courses; (c) technical lectures; (d) monograph contests; (e) national and foreign meetings and congresses; (f) technical publications; (g) technical interchange with similar agencies; and (h) promotion of the first Symposium on Highway Research.

ORGANIZATION OF RESEARCH AGENCIES

In spite of so many agencies devoted to highway research, few of them have identical internal organizations. The basic structure of such agencies is determined in accordance with one of the following broad operating policies: (a) conducting research directly with its own personnel using its own laboratories; and (b) allocating or correlating investigations conducted by other agencies or individuals specializing in research work under their own coordination and orientation.

The first policy has been adopted by the majority of the European countries in accordance with the pattern of the Road Research Laboratory organization. One of the few exceptions is found in West Germany, which preferred to follow the policy of the Highway Research Board of the United States. This policy was also adopted by the Instituto de Pesquisas Rodoviarias in Brazil.

In trying to establish a brief comparison among the internal organizations of those three similar agencies which coordinate or correlate activities related to highway research in the United States, West Germany and Brazil, we have the following general picture:

Highway Research Board (United States)

1. Department of Economics, Finance and Administration;
2. Department of Design;
3. Department of Materials and Construction;
4. Department of Maintenance;
5. Department of Traffic and Operations;
6. Department of Soils, Geology and Foundations;
7. Department of Urban Transportation Planning;
8. Department of Legal Studies;
9. Special Committee on International Cooperative Activities.

Forschungsgesellschaft für das Strassenwesen (West Germany)

1. Administration Working Group;
2. Rural Roads Traffic Planning Working Group;

3. Urban Roads Traffic Planning Working Group;
4. Vehicle and Roadway Working Group;
5. Subsoil Working Group;
6. Foundations Working Group;
7. Asphalt and Tar Surfaced Roads Working Group;
8. Cement Surfaced Roads Working Group;
9. Metalled Roads Working Group.

Instituto de Pesquisas Rodoviarias (Brazil)

1. Design Working Group;
2. Soil Mechanics and Earthmoving Working Group;
3. Paving Working Group;
4. Equipment Working Group;
5. Traffic Working Group;
6. Materials Working Group;
7. Economics and Finance Working Group;
8. Legislation and Administration Working Group;
9. General Plans and Coordination Working Group.

The simple enunciation of those 8 or 9 departments or working groups indicates a diversification of research work on all highway problems in contradiction to what often occurs from adherence to the European policy which, for economic reasons, may confine the action field to two or three specialized items.

Although there is similarity in the structure of the activities of each of the three correlating agencies of highway research work in the United States, West Germany and Brazil, there are still marked differences in the grouping of some items. For instance, the Highway Research Board includes within the same department all of the subjects related to materials and construction, while the Forschungsgesellschaft für das Strassenwesen subdivides the subjects related to construction into flexible or rigid pavements and the Instituto de Pesquisas Rodoviarias radically separates materials from construction.

As for maintenance, only the Highway Research Board groups it with equipment. Equipment research is under a separate group at the Instituto de Pesquisas Rodoviarias. Neither of the two items shows up specifically in the Forschungsgesellschaft für das Strassenwesen.

Among the few comparable groupings in the three similar agencies are those relating to traffic, soil mechanics and administration. The same comparability does not occur, however, with subjects related to economics or legislation, which are included only at the HRB and IPR. As for subjects related to urban transportation, per se, they show up only at the HRB.

IPR might improve its Working Groups by converting them into the Research Sectors which constitute its Technical Scientific Service, in accordance with Articles 20 to 25 of its Internal Regulations. Taking into consideration the experience obtained during its eight years of existence, the following would be a practical structure for the Instituto de Pesquisas Rodoviarias:

1. Layout and Design Research Sector;
2. Soil Mechanics and Foundation Research Sector;
3. Paving and Maintenance Research Sector;
4. Traffic and Transportation Research Sector;
5. Equipment and Devices Research Sector;
6. Materials and Tests Research Sector;
7. Economics and Finance Research Sector;
8. Legislation and Administration Research Sector;
9. Drainage and Structures Research Sector.

FINANCING FUNDS FOR RESEARCH

Now let us examine funding of highway investigation in each of the three countries which follow a similar policy for highway research work.

Highway Research Board Special Report No. 55, published in 1959, enumerates for the United States the various highway research fiscal programs among the several governmental and independent agencies for the year 1958 (1). A summary of the data furnished by the Bureau of Public Roads, the State Highway Departments, the universities and the HRB indicates four different fund categories established for highway research work: (a) Bureau of Public Roads administrative funds; (b) so-called 1½ percent funds, Federal-aid with State matching; (c) State highway funds used independently of any Federal-aid matching funds; and (d) funds provided to universities by sources other than federal or state highway funds. For 1958, the funds were distributed as follows:

Bureau of Public Roads	$ 2,300,000
Projects financed under 1½ percent funds	4,700,000
Projects financed with State funds	5,000,000
University projects funds	1,500,000
Total	$13,500,000

Adding to this total one fifth of the total cost of the AASHO Road Test in Illinois (a five-year project)—$21.7 million—the total research activity in 1958 may be estimated as $17.8 million. Considering that the total amount of highway expenditures in the same year was $9,927 million or almost $10 billion, the corresponding percentage for research work represents 0.18 percent of that total amount.

It is interesting to compare the percentage of funds allocated to the Instituto de Pesquisas Rodoviarias in the last 7 years with the Brazilian Federal Highway Department (DNER) expenditures in the same period, which were as follows:

Year	DNER	IPR	Percentage
1958	Cr$ 9,117,767,917	Cr$ 2,292,640	0.020
1959	14,588,310,840	6,031,245	0.040
1960	23,348,134,552	8,878,125	0.038
1961	41,465,582,925	14,730,000	0.036
1962	74,407,223,235	55,070,000	0.074
1963	129,814,171,994	73,000,000	0.056
1964	164,378,628,385	72,000,000	0.044

It is also interesting to note that if the expenditures of the several state highway departments were included in the tabulation, the above percentages would drop to lower levels. At present DNER and the National Research Council are the only sources of funding for the IPR.

In West Germany, the highway research work is conducted by technical schools, the State Road Laboratory, and to some extent by the industry laboratories. Means for this work are provided by the Ministry of Transport, the States, a special organization for promoting highway safety and the Forshungsgesellschaft für das Strassenwesen. The following table shows the sums provided by the government, the states and counties during the years 1934-1962 for highway research work as compared with the highway expenditures for the same period (2):

Year	Highway Expenditures (millions DM)	Research Funds (millions DM)	Percentage
1934	312	1	0.320
1936	517	1	0.200
1938	848	1	0.120
—	—	—	—

Year	Highway Expenditures (millions DM)	Research Funds (millions DM)	Percentage
1950	539	0.3	0.055
1952	688	0.5	0.073
1954	900	0.8	0.089
1956	1,600	0.8	0.050
1958	2,200	1.9	0.086
1960	2,300	2.2	0.095
1962	3,500	2.5	0.072

It is of interest to observe the coincidence that in 1962 the percentages in West Germany and in Brazil were the same: 0.07%. However, after 1962 the percentages in Brazil have been dropping very rapidly, in spite of the fact that costs of research are increasing every year.

In the United States of America the several state highway departments contribute annually a modest sum of funds to provide a cooperative program for highway research to be shared by all highway agencies, a desirable objective for IPR.

NATURE OF HIGHWAY RESEARCH WORK

In an excellent report prepared for the Highway Research Board, Mr. M. Earl Campbell (3) enumerates five organizational patterns of highway research work in the United States: (a) noncentralized research; (b) centrally coordinated research; (c) formal research; (d) joint research; and (e) contracted research.

In West Germany, the Forschungsgesellschaft für das Strassenwesen, in connection with the Ministry of Transport, tries to register all research projects and financial sources to insure that no time or money is wasted in duplicative efforts. Its Board—in similar fashion to the HRB or the Technical Council of IPR—recommends projects for research and suggests institutes or individuals to perform the research tasks. Working groups discuss the procedure and its results. Evaluating such results, they draft specifications for planning and construction methods.

The Forschungsgesellschaft für das Strassenwesen, like the HRB but unlike the IPR, has many contacts with the highway departments, technical universities and research-oriented organizations in foreign countries. It also acts as an exchange organization for research work and it is able to match parallel projects, pick out the right institutes for special work and judge the results for practicable uses.

In Brazil the Instituto de Pesquisas Rodoviarias has maintained itself during its eight years of existence with the modest resources furnished by DNER and the National Research Council. Occasionally, some of the state highway departments contribute token amounts specifically for financing the specialized courses promoted by the Institute in several states, such as at Sao Paulo, Minas Gerais, Parana, Rio Grande do Sul, Bahia, Pernambuco, Rio Grande do Norte and Ceara.

In order to classify the funds spent by IPR according to the nature of research work, we have prepared the following table:

Nature	Fundings
1. Bibliographic	8
2. Dissemination	6
3. Economics	5
4. Educational	3
5. Probational	18
6. Experimental	8
7. Investigational	9
8. Legislative	5
9. Methodological	6
10. Operational	5
11. Organizational	3
Total	76

Grouping our 76 funds according to the five types of highway research work described by Mr. Campbell in his report (3), all of them would be classified in the last group as "contracted research."

NEED OF INTERNATIONAL INTERCHANGE

The single existence of some twenty agencies devoted to highway research work in the six developed continents attests to the need for establishing an interchange of information and technical knowledge related to common concerns. This interchange, at first exerted directly among interested agencies, now is demanding an international activity so that all agencies can participate in it as they deal with investigations related to highway problems.

In Europe, where the policy adopted by the Road Research Laboratory prevails in conducting research work directly with its own personnel in its own laboratories, there have been discussions since 1960 regarding the best way of establishing an international organization for coordination of all highway research laboratories. There is agreement that such an agency should be a center to collect and distribute all technical information related to the common objective, although some think that it should also conduct research work of a cooperative character. Although it has not yet been possible to establish such an international agency, a compromise has been reached between the two different points of view, namely, the funding of the new agency should be used only to finance ways to stimulate research cooperation leaving the research work of a cooperative character to those agencies directly interested in participating in it (4).

In the meantime, international documentation centers in a few countries are sporadically publishing bibliographical information concerning roads and transport and providing translation services and storage and retrieval of information related to highways. Among such international agencies, the following are the best known:

1. Committee for Scientific Research, OECD, Paris;
2. European Conference of Ministers of Transport, OECD;
3. United Nations Educational, Scientific and Cultural Organization, UNESCO, Paris;
4. Economic and Social Council, United Nations, New York;
5. Documentation Center, International Road Federation, Berne;
6. Permanent International Association of Road Congresses, Paris;
7. International Center for Documentation of the Inspection and Technical Aspects of Motor Vehicles, Brussels;
8. International Council for Building Research, Study and Documentation, CIB, Rotterdam;
9. International Union of Testing and Research Laboratories for Materials and Structures, RILEM, PARIS;
10. International Society of Soil Mechanics and Foundation Engineering, London;
11. International Federation for Documentation, FID, The Hague;
12. International Organization for Standardization, ISC, Geneva;
13. Highway Research Information Service, HRB, Washington (developing).

Recently, the U.S. Bureau of Public Roads authorized the International Road Federation to proceed with an investigation to determine the methodology of an international highway research and development exchange program. A preliminary report (5) based on pilot studies conducted in four Western European countries by IRF President Robert O. Swain, suggests that the initial inventory be continued into a second phase extending eventually to 30 additional countries, including Brazil.

As a consequence, IRF asked the Instituto de Pesquisas Rodoviarias to conduct such an inventory in Brazil. This has been in progress during the past six months in all of the Brazilian States in order to diffuse all around the world the research and development work underway in the largest country of South America.

REFERENCES

1. Highway Research Board. Highway Research in the United States. Spec. Rept. 55, Washington, 1959.
2. Goerner, E. W. Cooperation in Road Research. Madrid, 1962.
3. Campbell, M. Earl. Highway Research Organizations. Spec. Rept. 15, Washington, 1953.
4. Glanville, Sir William. General Report on Theme I—The Need for Scientific Research in Traffic Engineering and the Desirability of International Cooperation in Achieving It. Washington, 1961.
5. International Road Federation. Methodology of International Highway Research and Development Exchange. Washington, 1965.