FEATURE ARTICLES

OUR HIGHWAY HERITAGE ABROAD

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Last summer the author boarded a plane at the Dulles International Airport for an exciting round-the-globe trip that took him first to the world's most populous city in the "Land of the Setting Sun."

I remember in Tokyo the eight-lane, free-flowing busy boulevard; the modern expressway through great congested manufacturing areas; and the elevated monorail; and in the suburbs of Tokyo, the Chiba Branch of the Public Works Research Institute. This country is also the "Land of the Rising Sun."

Next, I became a part of the pulsating, congested streets in Manila, a city crowded with a million people—a city of "jeepney" buses and public markets. Adjoining Manila I remember Quezon City, capital of the Philippines, where 17,500 students are learning the arts and sciences in the modern University of the Philippines.

Thence to the "Jewel of the Sea"—one of the most fabled and fascinating cities of the world—the British Crown Colony of Hong Kong, a metropolis of 4 million people in the twin cities of Kowloon and Victoria.

I remember the crowded Star Ferry crossing in a procession every ten minutes between the twin cities with cargo of people and vehicles—a ferry to be complemented soon with a vehicular tunnel under the deep, dark, mile-wide harbor. I remember the new, glistening white high-rise apartments, and the refugee shacks on precipitous hillside. I saw the busy streets, the streetcars, the rickshas, the trucks, and people—people always immaculately clean—young, old, poor or rich.

Leaving Hong Kong we headed for Bangkok, "Abode of the Angels," halfway round the world from home. Crossing the "Land of the Free"—the Land of the Thais—we saw spread out below as a map in bas-relief the hills, the winding roads and rivers, the water-sheeted rice fields, and the Friendship Highway—arrow straight mile upon mile. At dusk we arrived at the temple-studded city of Bangkok.

I remember the divided highway to Nakorn Pathom, Thailand's oldest city, a modern highway in standards of any country.

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I remember the SEATO Graduate School and the wide range in highway research projects under way and noted their relevance and significance to our country.

We left this quaint city of 1. 5 million "happy" and dainty people in late evening. Less than four hours later we were over the lighted streets of India's capital city New Delhi with radials and circles imposed on its rectangular grid (and the adjacent old Delhi with formless pattern of streets). Thus to the "City of Seven Cities" and nearly 3 million people.

Out of an encyclopedia of experience what can one recite of remembrances of India?

I remember the modern divided highway leading to Agra, city of the Taj Mahal. I remember the people at work on new sections of the road . . . the women in colorful clothes.

I also remember the Central Road Research Institute on the outskirts of Delhi on the road to Agra, and in this large laboratory a program of both sophisticated and practical research which has been going on for fifteen years.

We left Delhi and flew to Teheran, capital city of Iran with a teeming population of 1. 5 million people.

I remember the modern expressways, modern bridges, and the superb geometry of highways penetrating formidable mountain ranges, but against this the breathtaking switchbacks on the precipitous mountains between Chalus and Karadj.

I remember the modern highway laboratory of the Plan Organization of Iran, and its great potential for highway research. I also remember the University of Teheran with its 4000 students and an expanding engineering college where 350 students were studying civil engineering.

We left Teheran and, crossing the anti-Lebanon Range near the snow-capped Mt. Hermon, flew to fast-growing Beirut, Lebanon, a city of a quarter million people. As we approached Beirut we saw the white villas on the suburban hilltops beautiful to behold—and then the Beirut Peninsula and the International Airport.

We spent several exciting days in Beirut visiting the American University, the highway department, and taking excursions around this modern-old city and into the countryside. The graduate program in highway education and research at the University and its great potential for the countries round about—and to highway research in general—was a fascinating highlight of the visit to Lebanon.

The trip to Asia was completed and we flew home. The total round-the-globe flight time had been 62 hours. The trip ended but its implications continue to grow.

This recital is not intended to be a travelog but rather to give a feel or fleeting glimpse of some transportation aspects of countries abroad and to serve as a framework for the development of the theme of this monograph. Time will not be taken to elaborate on visits made previously to England and Nigeria, and since then to Brazil. These will be brought into the monograph later.

These visits, superficial as they were, brought an awareness that we could receive outstanding values from highway research and highway engineering from the four continents abroad which I have had the opportunity to visit. It has been said that "a look is more revealing than a book." And it has been stated, too, that one needs detachment and an objective viewpoint to discover and assess values. And one needs newness to see contrasts between other people and ourselves. If these adages are true—and I believe they are—then I have a good basis for proceeding with my observations.

This is an essay of the obvious. Yet into it I am adding a tincture derived by interviews with many knowledgeable people both here and abroad, and from letters received from eminent researchers in other lands and from technical journals published here and abroad. For during the past year the subject of our potential highway acquisitions from abroad has surfaced many times. Yet this is still an essay on the obvious—the subject needs a more profound probing.

In a recent address I heard these words "Science has no frontiers . . . every man receives a heritage . . . every man leaves a legacy . . . each man is a connecting link."

During the early years of our Republic and even into the 20th Century we looked to England and France and other European countries for substantial scientific contributions. In highway engineering, the Macadam and Telford pavements, techniques in engineering economy and many other important developments came from Britain. The automobile was pioneered in Europe and exhibited in the 1889 Paris Exposition. The popular plank road of mid-19th Century came from Russia by way of Canada.

We have a more ancient heritage from Rome and from Mesopotamia. We have a nearer heritage in the monumental works built during the classical age of the Mayas and Incas of our hemisphere whose roads were "the best in this hemisphere until the Lancaster Turnpike was opened in 1792."

This essay deals with our modern heritage. What technological information do other countries currently have that is applicable to our highway problems? What blindspots can we remove by taking a careful look at the highway research and development programs of other countries? Assuming that transportation is a prime factor in the economic development of a country—in a cause-effect-cause relationship, what do other countries reveal to us as we compare transportation facilities and economic activity?

Global Comparability of Highway Problems

An engineer in the Federal Ministry of Works and Surveys in Nigeria during a conversation about their problems said "our problem is to get the best return from each road dollar, to build to standards feasible to the community economy and to preserve the investment made." Could there be a more neat and simple statement of our own need?

Discussions with eminent researchers and engineers on four continents regarding specific needs resulted in statements of problems many of which were mirror images of our own and could have come out of highway departments in the United States. There were, of course, some problems more common to the tropics, e.g. lateritic and cotton soils (yet we have lateritic soils in the southern United States) and problems due to accelerated physical, chemical and biological action resulting from long hot seasons, and monsoon weather, noted in asphalt and wood problems. And there was the problem of mixed traffic, characteristic of less developed countries . . . of our own but 50 years ago. But problems not peculiar to other countries, whether in tropic or temperate zone included these:

1. Soil compaction and stabilization
2. Construction practices and management
3. Maintenance practices and management
4. Highway traffic operation and accident prevention
5. Highway signs and markings
6. Erosion
7. Socio-economic impact of highway development

8. Structural design of pavements and bridges
9. Updating highway engineers
10. Information exchange and application
11. Design of low cost roads
12. Research organization, administration, application

These are "old familiar faces." Fortunately for these countries—and for us—they are working on these problems and on others in 3000 research projects. From abroad we are receiving up to ten or twelve papers annually for the Annual Meeting of the Board. These are distributed among relevant departments for programming.

Comparability is also reflected in the programs of international road meetings attended by interested representatives from the world around. A scanning of these programs or a scanning of research programs from other countries reminds us that this in indeed one world.

Potential Contribution

"Scientific research has no frontiers" yet research consumers in our country have had difficulty even in straddling state lines. Can we straddle oceans, foreign languages, different cultures and economics? An old adage says: "What we are not up on we are down on." This oversimplifies the matter. As researchers and as research consumers we need to know the research parameters. Only then do we know whether the findings are transportable and applicable in other times and places. Yet we have found that even though every completed research project raises additional questions, likewise there is a carryover from nearly every research project to other similar projects.

The potential contributions from other countries may be sorted into several groups:

1. As validation of our own research through usage.
2. As a laboratory for bilateral and joint endeavors.
3. As intangible values to the researcher in the form of mirror reflections and clarification of his own ideas.
4. As concrete findings applicable in the United States as accretions to knowledge or as confirmation of our own findings.

Items 3 and 4 will be discussed under separate headings. I should like to address at this point Items 1 and 2.

Validation

The less developed country depends upon the more advanced for research and for "How to" ideas. And it may be surprising to learn that in many areas of work the less developed country is leading us in making application of our recommended techniques and practices. In particular, consultants employed for socio-economic studies, systems studies, five-year plans, highway administrative studies and other vital highway studies are given great latitude in testing our recommendations in other countries. This provides validation where testing is simpler due to reduced number of variables, and is easier because the subject country is amenable to such a trial whereas a highly developed country will be more skeptical of any suggestion requiring radical innovations in existing practices—and more resistant to change.

Joint Endeavor

One of the finest potentialities is in organizing and cooperating in research through bilateral agreements with other countries. In health matters we do

recognize the value of cooperative action around the world. Laboratories and researchers are established in areas where certain diseases (malaria, smallpox and cholera) are prevalent—diseases which can be carried from those areas to the United States and which pose a constant threat to our health.

With a little imagination we can see how there exists the makings of a worldwide highway research laboratory, covering many facets of administration and technology. Using tropical field testing, for example, we can accelerate those actions or reactions affected by long-term high intensities of heat and light, rain and drought. In other areas we can accelerate by taking advantage of cyclic changes of greater frequencies and extremes; e.g. earthquake, flood, freeze and thaw.

This world laboratory need not cost a lot of money. Roads are being planned and built in 148 countries under multi-variant and changing conditions of soil, climate and traffic; under various road-building techniques, economies, and cultures; under various forms of highway administration, finances and laws; and with various policies for maintenance, repair and traffic operation and control. Experimental road sections and research teams would provide some needed answers for the United States.

Intangible Contributions

A friend in one of the countries across the sea was apologetic regarding what his country could offer in highway technology, practice and experience: ". . . we can offer only negative suggestions. In a way these can be useful to emphasize the merits of practices and standards recommended from abroad." This neat statement preceded an outstanding recitation which crystallized the problems confronting the highway engineer in his struggling, young country. Negatives can help us and in many ways.

When we look at the roads and road work in some of the newer underdeveloped countries, we see ourselves at work some fifty years ago. In this we discern the dramatic advances possible in research technology and administration. In observing what has been done we see what can be done—the seed of hope for their future—the earnest of our own.

We see in the negatives of others the inadequacies and defects that we do not as readily discern in self-examination. Assuming that we receive only negatives—which would be presumptuous indeed—this in itself is a contribution. Negatives are always an asset to the researcher. Whether found in administration, engineering, or in research they have something to tell us:

- In administration they reveal wastes in funds, talent and effort—in short, wastes in service.
- In engineering they reveal acceleration in obsolescence and poor performance.
- In research they reveal dead-end alleys, wrong approaches, lack of tools, lack of information, faulty analysis or interpretation.

Hence, we learn much from a close look at negatives.

Sometimes we can "see ourselves as others see us" through their eyes and discover that we have some blind spots. For they see us with more objectivity than we see ourselves—our knowledge gaps, our technological deficiencies. I have found it very helpful to get the viewpoints of researchers in other countries on research needs in context with the worldwide spectrum of highway problems.

But there are positive intangibles that outweigh the negative: the opportunity to get a clearer perception of the prime relationship of transportation to individual life and statehood in providing cohesion, communication and

commerce; the opportunity to think with eminent highway administrators, technologists, researchers and educators; the opportunity to crystallize our own thinking about problems, objectives and solutions; the opportunity to see our needs in context with world needs. These open up new vistas for ourselves.

Concrete Contributions

A brief resume of offerings by broad subject areas from the countries I have visited will be the extent of coverage in this monograph. This limits the coverage to ten countries out of 148, namely: Brazil, Britain, Canada, India, Iran, Lebanon, Japan, Nigeria, Philippines, and Thailand. Only the most relevant and significant topics can be selected for mention. A book-length report would be required to cover all their contributions of interest.

Brazil. —The Brazilian Highway Research Institute established in 1957 held its First Annual Seminar in 1965 with 56 quality papers in ten broad areas of highway research. Three of these were presented at the 45th Annual Meeting of the HRB in January 1966. Some 50 reports were programmed for their Second Seminar, September 1966.

The Institute is currently operating on an annual federal budget of about $40,000. The states budget individually for research. Research of particular relevance to the United States is soil stabilization with lime and with cement and the study of physico-chemical properties of laterites related to performance.

Brasilia, capital city, a total city designed and "built from scratch" offers a design-performance study of unique character.

Britain. —Great Britain has been spending about $6.5 million annually for research, about one-fifth that spent by all of the highway organizations in the United States. It has been estimated that this is equivalent to an $18 million effort in the United States—an effort of about two-thirds that of the USA. The publications of the British Road Research Laboratory contain a wealth of information. Some 400 projects are being conducted currently in the United Kingdom.

Especially noteworthy is its work in safety, behavior studies, traffic operations and area traffic control. Their test track for traffic problems is outstanding. In snow and ice control much worthwhile work has been done. Skid-resisting pavement research is also worthy of note. Stresses in layered systems and wave propagation techniques are other offerings. Britain also offers opportunity to study functioning of satellite cities, land-use control, and other items of interest to the urban planner. The complementing services of mass transportation and private transportation are of importance to us also.

Canada. —The Canadian Good Roads Association reports more than $2 million spent annually on some 300 current research projects in Canada by about 100 organizations. About 150 items in R & D are abstracted annually by the CGRA.

Researches on frost heaving, frost action and permafrost have been noteworthy, as also has been the research on deicing and snow removal. Work in construction programming and scheduling, in quality control and construction management has been of excellent quality. "Road Research Needs in Canada, 1965" is a notable brochure. Also in the following areas Canada has made notable contributions:

- Flexible pavement design and evaluation
- Prediction and prevention of scour around bridge piers and abutments
- Evaluation of corrosion of vehicles caused by road salt

India. —The Central Road Research Institute in Delhi is the clearinghouse for highway research throughout India as well as the operating laboratory for highway research. An "independent" government agency, its laboratory, built in 1952, spends about $500,000 annually and employs 126 technical personnel.

Among the many projects in their cross-the-board research are the following which have interest for the United States:

- Burnt clays as pozzolanic cements
- Brick-sandwiched cement concrete pavements
- Cement-soil stabilization and lime-soil stabilization
- Soil-aggregate blending for low cost roads
- In-situ burning for soil stabilization
- Flexible-raft technique in foundation treatment for soft clays

Iran. —The Technical and Soils Laboratory of the Government's Plan Organization is a model highway laboratory with excellent capability and unused capacity for research—a potential for cooperative research. The Ministry of Roads is interested in setting up a research program and in keeping engineers updated in highway technology. While this recital is not indicative of a highway heritage from Iran it does indicate an active interest and a high potential in highway research.

Lebanon. —Studies have been made to adjust parking and capacity manuals for their extensive use of small cars and to adjust highway design to local economy. These studies would be helpful to consulting engineers in foreign lands. Other studies of relevance are the effect of grades on truck performance and the use of fiber in concrete to strengthen, fire-proof and lighten dead load. Some eight or ten projects make up their research program.

One of the greatest potentials in Beirut is the possible use of the American University with some American professors added for short courses to update engineers in a dozen nearby countries.

Japan. —The Public Works Research Institute employs 554 people in research, issues four series of research publications and conducts a biannual meeting at which some 400 research papers are presented. Their budget is about $2.5 million annually. Japan as a whole lists some 300 current projects from the several highway research laboratories there, with much of substance and relevance to complement research in the United States. Work of special interest there includes landslide and earthquake prediction and protection, peat drainage, advances in steel and prestressed concrete structures, and advances in traffic control. Modern expressways, high-speed trains, and monorail speak of transportation development in Japan. A high sophistication has evolved in techniques and a considerable amount of basic research is undertaken.

Nigeria. —Considerable work has been done in lateritic soils. Studies in agricultural soils are proceeding and may provide useful results to the highway engineer. Nigeria is a young republic with a great potential for highway research.

The Philippines. —Though having less than 20 current research projects, several have been undertaken that have relevance for us:

- Maintenance study for allocation of funds
- Road-user operating costs
- Costs of various modes of transportation
- Relative efficiency of various modes

Thailand. —The SEATO Graduate School (the graduate school of Chulalongkorn University) reports some 80 current projects in highway research. The following items are among the contributions from Thailand:

- Long hydrologic records of stream runoff from tropical rainfall can shed light on stream runoff in the USA.
- Low-cost road building practices.
- Worldwide research on lateritic soils being conducted in Bangkok.
- Glue-laminated structural components from tropical timber.
- Use of international signs and other than Latin letters may afford help in legibility studies of characters for signing in USA—and with the great amount of international travel to and from America, such signs might assist us.
- Lime-soil stabilization.

In these ten countries some 1100 or more projects are under way. When projects are added from other European countries, from Australia, from Central and South America, Asia and Africa the total number may be three-fold.

Dimensions of the Highway Research Effort and Its Implications

There are 148 countries noted in almanacs (two-thirds classified as under-developed) and 114 of these have membership in the United Nations. There are some 37 highway research organizations among these 148 countries, some 22 of which are comparable counterparts of the Highway Research Board or the British Road Research Laboratory. Firm statistics on the research program and budget are difficult to assemble even in the United States. It is still more difficult to assemble firm statistics from the rest of the 148 countries.

It has been estimated that there are about 3,000 research projects in current operation in the United States with an average term of about two years per project. Something on the order of $30 to $35 million is now spent annually on highway research here. Reduced to averages, something like $10,000 to $12,000 is being spent annually on each project, with a range from zero up to $250,000. About three-fifths as many are completed each year as started during the year. Annual acceleration of new effort, projects becoming inactive or delayed in completion, or completed projects not reported as such result in this differential.

It has also been estimated that there is a comparable number of projects in operation abroad. (The current census in 17 countries by the International Road Federation gives a count of about 2,400 projects; although many of the highly productive countries have been canvassed, the remainder of the producing countries may bring the total up to or exceed that of the United States.) Project costs are elusive and expenditures may not quite equal expenditures in the United States due to differentials in salaries and other costs. An estimate of $25 to $30 million annual expenditure abroad may not greatly be out of line, but the effort in manhours may even exceed our effort.

Of particular interest at this point are two questions:

1. How much of the research abroad is useful to the highway profession in the United States?
2. What will translations, publication and dissemination cost?

If a bare minimum of current research projects that are specially useful and distinctive numbers only 5 percent of the total effort abroad, this would amount to about $1¼ million. Much of the effort abroad parallels and confirms the work in the United States. A substantial amount is of purely local interest with local parameters. It is clear, from what we have seen in but ten countries, that the effort abroad has substantial relevance and significance to the highway professional in the United States.

The second question recognizes that there are seven or eight major language barriers. The minimum price for translations is about two cents per word of English text. Assuming half of the incoming research abstracts require translation into English, or say 1,500 abstracts annually of 300 words each, the translation cost of these would be about $9,000. This would be for informational or indicative abstracts. A research report itself would cost $6 to $10 per page. Publication costs are about $40 per page, and on mass production can be sold at about $0.02 per page. But the problem of translation is not quite as simple as it appears. One has to know what to translate. This requires scanning by knowledgeable engineers. Abstracts may require translation of full text and consequent abstracting. Abridgments may be more than $100 per page complete and printed. In offset, English has become the second language of most countries of other tongues and some reports emanating from other countries appear in English. This matter needs further exploration before valid estimates of cost can be given—in any event translations should hardly cost one percent of the cost of the original research. We can buy what we want of this effort abroad for one-hundredth of its initial cost—a small inheritance tax.

At this point it should be stated that the total annual flow of information into the Highway Research Information Service of the HRB is approximately 10,000 items a year, one-fourth of this being in the form of abstracts of operating research projects the balance being abstracts of R & D items taken from technical journals and periodicals from around the world. Nearly half of this input comes from British Road Research Laboratory and includes translations of items on research and development coming to BRRL from France and Germany through the auspices of OECD. Through this trilateral arrangement a coverage of the whole globe, with the exception of the United States and Canada, is obtained.

Concluding Remarks

In our early years as a developing nation we looked abroad for help. Now we have the high privilege and equally high responsibility of interdependence, recognizing that more is to be gained by exchange than by hoarding in isolation and in declining a great highway heritage from abroad. We can profit from their advances. We can profit from their mistakes. Where we find ideas we need to get them into our own thinking.

As we look abroad and see the different ways things are done it helps us to appraise our own ways, to see our own problems more clearly, and it helps us to rethink in terms of principles. Much remains for promising exploration.

Let me conclude on this note: "The concerns of one nation inevitably become the concerns of other nations. Science and technology are inescapably international. The avenues of ideas must be kept free." In plain blunt truth we cannot afford to walk alone.