TRB's International Activities Committee traditionally sponsors the International Roundtable at the Annual Meeting of the Transportation Research Board. At the 1985 meeting the focus was on international technology transfer. Speakers from a diversity of developing nations and international organizations provided equally diverse views on the concept of technology transfer with respect to the maintenance of the transportation infrastructure. In the following article, the presentations of the speakers are summarized.

1985 TRB International Roundtable

International Technology Transfer as Related to Maintenance of the Transportation Infrastructure

INTRODUCTION

The major facilitators of technology transfer are:

- Multinational organizations,
- International consultancies,
- Manufacturers and suppliers of equipment, and
- Governments of both developed and undeveloped countries.

The processes of technology transfer occur principally through the counsel of the international aid and development loan institutions, and the products and services of equipment suppliers, design engineers, and construction companies. Adapting technology to meet local conditions appears to occur most effectively when there are mechanisms for feedback. Technology transfer requires an environment for learning in which the involved institutions allow time for the learning process and in which there is the capability to modify technologies to suit local conditions. Technology transfer tends to function poorly in sit-

Robert A. Hubbard, President, Wilbur Smith and Associates, and Chairman of the Committee on International Activities, welcomes participants from around the world to the International Roundtable held during TRB's 64th Annual Meeting in January.

uations in which the provider has no incentive to teach the recipient or to allow the learning and adaptation process to occur.

One of the most interesting processes of technology transfer described at the International Roundtable involves organizations that are neither providers nor recipients of technology but exist for the sole purpose of providing a forum for technology transfer and adaptation. The Organisation for Economic Cooperation and Development (OECD) and the South African Institute for Transportation and Road Research are examples of this type of organization. It should be noted that in order for this system to function properly, the member countries must possess a considerable amount of expertise in the subject area. Obviously, this requirement inhibits transfer of new or emerging technologies.

The speakers at the 1985 International Roundtable sponsored by the TRB Committee on International Activities and held at TRB's Annual Meeting in January are listed below.

1. Yoshiaki Abe, World Bank, "Transfer of Technology for Maintenance of the Infrastructure."

2. Duane Freer, International Civil Aviation Organization, Montreal, "Transfer of Technology in Civil Aviation."

3. W. P. Wambura, "International Transfer of Technology and Its Application to Transport and Communications Infrastructure in a Developing Country: The Kenya Experience." Synopsis provided by Adolf D. May, University of California, Berkeley.

4. T. V. Runnacles, Transport Branch, Hong Kong, "International Transfer of Technology—The Process and the Facilitators: The Hong Kong Experience." Synopsis provided by Gerald Wilson, International Road Federation, Washington, D.C.

5. Zu Yin Zhang, Institute of Highway Research, Peoples Republic of China, Beijing, "A View of the Highway Research Situation in China."

6. Jean Reichert, Belgium Road Research Center, Brussels, "Belgium's Participation in the Technology Transfer Process."

7. S. H. Kuhn, National Institute for Transport and Road Research, South Africa (presented by C. R. Freeme, NITRR), "Transfer of Technology—Emphasis on Transport Infrastructure Management, Operations, and Maintenance."

WORLD BANK VIEWPOINT

During the past 20 years of the expansion of the transportation infrastructure, in-

Participants at the 1985 International Roundtable include *(left to right): top row,* Kenneth B. Johns, Assistant Director for Technical Activities, TRB; Gerald Wilson, President, International Road Federation; Duane Freer, International Civil Aviation Organization, Montreal; John D. Cutrell, Chief, International Programs Division, FHWA; Robert A. Hubbard, President, Wilbur Smith and Associates; *bottom row,* Jean Reichert, Director, Centre de Recherches Routières, Brussels; C.R. Freeme, National Institute for Transport and Road Research, South Africa; Huai Wang, FHWA.

sufficient attention has been given to building up maintenance capability. The institutional, financial, and human capabilities need to be steadily reinforced, and improved utilization of equipment is necessary.

There has been a major shift in World Bank policy in order to encourage more emphasis on maintenance by member countries.

Balancing indigenous and imported technology to bring about a sustainable system of maintenance will be a long-term effort. In some cases where no appropriate technology exists, new technology must be developed carefully. Creative solutions for specific local problems must be developed with careful consideration of the alternatives and thorough understanding of the prevailing conditions.

Now that the imperative of institutional and policy development to sustain transportation infrastructure maintenance has been recognized, and given that change in these areas is a long and difficult task, efforts to meet the challenge must be increased.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

The building and equipping of airports around the world has reflected technology transfer difficulties. The principal suppliers are equipment manufacturers and consultants. The adoption of appropriate technology that is neither too simple nor too sophisticated has not always been realized. One of the missions of the International Civil Aviation Organization has been to serve as a facilitator of technology transfer and training of the world's cadre of civil aviation technicians.

Creating self-sufficient civil aviation infrastructures in developing countries that are safe, efficient, and serviceable will require patience and wisdom. There is no room for inappropriate technology and ill-conceived strategies that sometimes serve only the interests of the suppliers of equipment. Only the combined dedication and energy of all parties will result in the realization of self-sufficient civil aviation infrastructures in developing nations.

MINISTRY OF TRANSPORTATION AND COMMUNICATION, KENYA

Kenya is a developing country with an infrastructure that includes a road network of 150,000 kilometers (7,000 of which are paved), a 2,000-kilometer railroad, a modern 22-berth ocean port, and a system of four major airports and eight feeder airports. Technology is a matter of great interest and importance in Kenya, especially in light of the scarcity of resources for recurring costs.

Kenya recognizes the importance of transportation to economic and social well-being. The transport of raw materials, agricultural produce, and consumer goods are all vital links in the economic chain. Kenya is concerned with appropriate technology to assist in the optimal use of human and monetary resources. New ways of using its large pool of unskilled laborers to meet maintenance needs must be developed.

Another concern is that transportation investment strategies and analytical tools are designed for use in developed countries, and thus the level of need in a country such as Kenya is not well addressed in this new technology. Telecommunications equipment that is easy to operate and maintain and is suitable for use in developing countries has not yet appeared on the world market.

In addition, there is concern in Kenya over the lack of training available for civil works contractors. More local contracting firms are needed to augment the larger contracting capability. There is also interest in Kenya in achieving better integration of the transport modes. Kenya is also concerned that the policies related to the technical standards of international institutions are invariably controlled by the developed nations.

TRANSPORT BRANCH OF THE GOVERNMENT OF HONG KONG

Hong Kong is a major adaptor of technology for use in Southeast Asia. Hong

Kong, an intensely developed territory, provides excellent examples of the successful transfer of ideas, equipment, and operational methods. Technological adaptation has been successful in Hong Kong because of a unique set of factors: an industrious, resilient, and adaptable population that is mainly Chinese, and the strong technical influence of the United Kingdom, Japan, Australia, continental Europe, and the United States.

There are two primary facilitators of the technology transfer process: (a) a widespread reliance on international consultancies for design work on transportation projects and (b) the use of English as the language of government and industry.

One conspicuous area of imported transportation technology is the public transport sector, which handles 75 percent of all passenger trips. A fleet of 3,500 buses, 95 percent of which are double-deckers, serve 4 million passengers each day. These vehicles use a design based on the London double-decker but modified to meet local conditions. The buses are 12 meters long, use three axles, and have an expanded capacity of up to 170 passengers. These vehicles are now being exported for service in Jakarta, Manila, and Singapore. A fleet of 4,350 minibuses and double-deck streetcars complete the public transit surface system.

Future plans include the expansion of the light-rail system. The design is based on a combination of European, Japanese, and American technologies. The recently constructed 26.1-kilometer subway system in Hong Kong was designed using technologies from both the United States and the United Kingdom. A subway system modeled after the Hong Kong system is currently being planned for Singapore, providing a demonstration of the way in which technology is adapted and transferred.

Hong Kong's 1,238-kilometer road system carries a dense traffic load of 270 vehicles per kilometer, the highest in the world. Highway design standards need to recognize the limitations on space and budget for the expansion of the highway system, which when coupled with the physical dimensions of rugged terrain, high-density urban development, and an ocean harbor, creates a challenging need for technological innovation. As an example of innovation, Hong Kong is about to run pilot tests on electronic road pricing as a means of allocating the use of road space.

Developments in air transportation and transportation planning in Hong Kong were also discussed. Hong Kong represents a unique transportation situation, demonstrating innovative technology adaptation.

PEOPLES REPUBLIC OF CHINA

For the first time in the history of the Transportation Research Board, a speaker from the Peoples Republic of China made a presentation. The speaker discussed the transportation research program in his country and indicated an interest in joining the world community of transportation researchers.

In 1949, when the Peoples Republic of China was established, the Highway Institute of Research did not exist. The Institute was formed in 1956 and expanded in the city of Chungking in 1965. Specialized research offices have subsequently been established: for communications research information, for standardization, and for computer research. In addition to these research offices of the central government, research offices have been established in each of the provinces.

The research program covers the following areas: highway foundations, pavements, and capacity; bridge foundations, substructures, and superstructures; hydrology, construction materials, and equipment; maintenance and repair of vehicles; and energy conservation.

A subject of great concern to the Chinese is the interference of slower travel modes, such as bicycles, with the speeds of motor vehicles on the highways. The efficiency of the highway as a high-speed transport system is severely affected by the large volume of bicycle traffic. The highways are designed for travel at speeds of 120 kilometers per hour.

The two major thrusts of the highway construction program for the future are: (a) construction of the missing links in the 100,000-kilometer national network and (b) construction of several vital links between major industrial cities using "superhighway" design standards.

The speaker from the People's Republic of China, Zu Yin Zhang, Ministry of Communications, Beijing, delivers his presentation on the status of highway research in his country in his native language while Huai Wang *(foreground)*, FHWA, translates into English; a lively question-and-answer period followed.

BELGIAN VIEWPOINT OF TECHNOLOGY TRANSFER

Belgium relies on membership in several global organizations as a source of technology transfer, such as the Permanent International Association of Road Congress (PIARC). Through membership on several technical committees Belgium has both contributed to and gained new insights into such topics as pavement management systems. For example, Belgium, as a member of a PIARC technical committee, prepared a questionnaire on drainage practices for use in establishing a code of good practices for developing countries. The

Jean Reichert, Director, Centre de Recherches Routières, Brussels, described examples of the transfer of highway technological innovations between Belgium and other countries in his presentation at the International Roundtable.

World Bank, the Asian Development Bank, and the InterAmerican Development Bank all support this effort of the PIARC.

Belgium uses its membership in the Organisation for Economic Cooperation and Development (OECD) to facilitate technology transfer. Currently, Belgium is testing unpaved road maintenance techniques under an OECD-sponsored program. The results of the test will be published shortly.

NATIONAL INSTITUTE FOR TRANSPORT AND ROAD RESEARCH, SOUTH AFRICA

The National Institute for Transport and Road Research, through its various publications and meetings, serves as a technology transfer facilitator for the various state and local road authorities in South Africa. The road and transport practitioners require diverse information on the provision and the maintenance of the infrastructure as well as on the operational and safety aspects. Authoritative information consisting of codes, standards, specifications, and regulations is necessary to set acceptable standards and provide a measure of uniformity.

Additional information in the institute's system is supportive and consists mainly of guides, reports, and similar publications.

Technology transfer also occurs through the sponsoring of liaison meetings with associated industries and other African countries. At these meetings, information is exchanged and strategies for solving common problems are developed. Recently, attention has been given to low-cost road construction methods, road construction materials, and construction and maintenance techniques.

The Annual Transportation Convention has become a principal event on the South African transport research calendar. The third such convention was attended by 500 delegates from the fields of operations, administration, and research.

Another more specialized conference on asphalt pavements is held every 4 years. Here the focus is on technological advances in flexible pavements. The institute has worked with state road departments to improve methods of pavement management. Each state is encouraged to develop a system that takes cognizance of the varying engineering, budget, and policy constraints and the decision-making process in each state.

A system for managing the maintenance of unpaved roads has also been developed. For example, the volume of material needed to replace loss and the frequency of maintenance practice on each link are determined. Other areas of effort by the institute include traffic-signing standards, safety, and roadside communications.

Highway Research Program Fosters Worldwide Links

International cooperation will be a top priority for the new Strategic Highway Research Program (SHRP), a $150 million research plan to seek innovation in highway technology. SHRP will focus a concentrated 5 year research effort on achieving significant improvements in six basic technology areas.

One third of the funding will be devoted to asphalt research. A total of $50 million is earmarked for pavement evaluation studies. The pavement program is to continue beyond the initial 5-year effort at a funding level of $10 million per year for an additional 15 years, during which the full life cycle of many types of pavements can be monitored and analyzed.

A total of $20 million is budgeted for research in maintenance management and maintenance operations. The basic chemical and physical characteristics of cement and concrete will be studied under a $10 million budget. Protection of concrete components on both existing and newly constructed bridges against damaging environmental effects, such as moisture and brine, will be studied under a $12 million budget.

The remaining $8 million research study will be directed toward improving highway snow and ice control. Calcium magnesium acetate (CMA), which was developed under earlier research studies by the Federal Highway Administration, will be studied to determine its environmental effects and the feasibility of quantity production at acceptable costs.

The international community has contributed significantly to the development of technology in the foregoing study areas. The accelerated loading facility (ALF), developed by the National Association of Australian State Road Authorities, is a good example of international technology used in the United States. The FHWA has acquired engineering drawings and manufacturing rights to produce this equipment in the United States, where it will be used as an important tool for the SHRP pavement evaluation studies. Extensive snow and ice control studies have been performed in the Scandinavian countries and Japan. Pavement materials and maintenance operations studies in the United Kingdom, Europe, South America, and other parts of the world will be important resources.

SHRP seeks to establish open lines of communication with researchers throughout the international transportation community to ensure that research planned in this program can build upon technologies being developed elsewhere. To be explored is the possibility of undertaking cooperative studies with other countries in which both parties contribute directly to the research effort and draw benefits directly from the results.

Gary Byrd,
Interim Director
Strategic Highway Research Program

From *Urban Transportation Abroad*, Council for International Urban Liaison, Washington, D.C., Vol. 8, No. 9, 1985.

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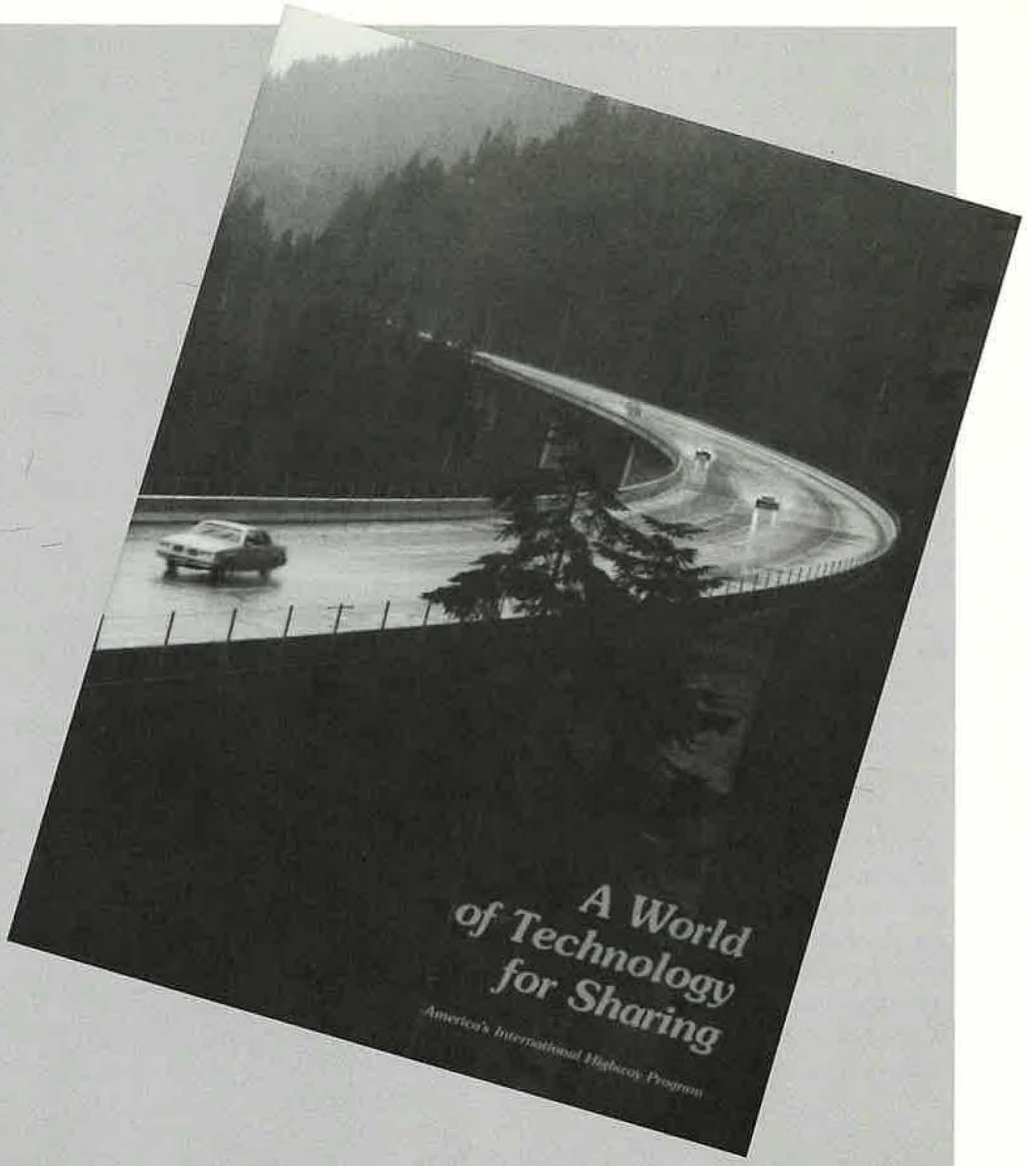
Francis B. Francois, Executive Director, American Association of State Highway and Transportation Officials, discusses AASHTO'S new Task Force on International Involvement (chaired by Harold King, Commissioner, Virginia Department of Highways and Transportation) and plans for AASHTO's international activities program at a meeting of the TRB Committee on International Activities held in Washington, D.C., in April.

A World of Technology for Sharing



There has been a major new emphasis on international activities by the Federal Highway Administration. Ray A. Barnhart, Federal Highway Administrator, states: "As a member of the world community, the United States has long recognized the importance of highways to international economic prosperity and quality of life because we have seen its effects throughout the development of our own country. During the past 60 years, we have worked with over 70 other nations of the world to build better roads through the sharing of technological advancements and engineering expertise. In this process, we have been both a contributor and a beneficiary of this pooling of knowledge. As the world faces even greater technical and fiscal challenges, America's highway engineers stand ready to continue this tradition of international service and cooperation."

As part of its program of international cooperation, FHWA has recently published an illustrated booklet entitled *A World of Technology for Sharing: America's International Highway Program.* The booklet outlines recent highway experiences and accomplishments in an effort to share these ideas with other nations. As stated in the FHWA publication, "The commitment of American technical experts, with their hands-on experience, can be a valued addition to road administrators in other nations. Through this technology sharing, along with better communication and education, road systems can be expanded, economies can be strengthened, and nations can grow."

Described in the booklet are FHWA's goals and its programs for technology transfer, instructional training, and international visitors. In addition, FHWA resources and assistance available to other nations in the following areas are discussed: engineering design, construction, maintenance on roads and bridges, low-volume roads, safety, traffic operations, highway system planning and programming, urban travel forecasting, research, and microcomputer applications. "The FHWA can assist other nations in every aspect of their highway transportation needs—from overall system administration to specific technical areas of concern."

For further information on U.S. highway technical assistance contact: Federal Highway Administration, International Highway Programs Division, 400 7th Street, S.W., Washington, D.C. 20590.