Profile of an Organization

Road Research Down Under

ANITA COIA AND PETER MILNE

The following article is part of an occasional series appearing in TR News *in which transportation research organizations are profiled. The activities and goals of the Australian Road Research Board are discussed here.*

Australia is a large country, one with a land area roughly the size of the continental United States. The population of only 17 million is highly urbanized and concentrated along the coastline, making roads a critical communication link between the dispersed urban centers and the remote areas. Compared with the United States, Australia has twice the number of miles of road per capita. One can imagine the difficulties facing the small population in financing, constructing, and maintaining an effective road network.

The Australian Road Research Board (ARRB) has played a major role in the provision and operation of an efficient road system since 1960. ARRB conducts national research in such areas as provision and maintenance of road infrastructure, traffic operations and management, road safety, environmental issues, transport planning, and economics.

ARRB is a nonprofit organization owned and funded by the three levels of government in Australia—federal, state, and local. Representatives from each level serve on the board of directors, as do nominees from the transport industry. In effect, ARRB is managed by its major clients.

In addition to a core research program undertaken for its owners, ARRB provides research and related services commercially to a wide range of clients throughout Australia and Southeast Asia. Fifty research projects are now in progress, and approximately half of the 130 staff members are researchers.

Some of ARRB's major projects recently completed or under way are described in this article.

Productivity in Road Construction and Maintenance

Australia's extensive road network, much of it built during the 1950s and 1960s, is aging. Current economic conditions in Australia mean limited funding for road construction and maintenance. Practitioners are seeking methods and materials that reduce the cost of asset management yet maintain an acceptable standard of service.

Accelerated Pavement Testing

One of the largest research programs at ARRB involves accurate full-scale testing of pavements using the Australian-designed Accelerated Loading Facility (ALF). (See Figures 1 and 2.)

Australia's ALF program allows new pavement technologies to be evaluated rapidly and provides the essential link between field and laboratory studies of pavement performance and materials. During the 7 trials conducted so far, 90 experiments have been carried out and 14 million load cycles have been applied to 36 pavement types. The benefits to Australia are estimated to be at least five times the cost of the trials.

During the past eight years, ALF has been used to improve researchers' understanding of the performance of cement-treated bases, use of nonstandard materials, asphalt pavement rehabilitation techniques, new polymer-modified binders, and pavement designs for heavily trafficked urban roads.

The most recent trial produced some exciting results. In many parts of rural Australia, roads have been built in extremely dry areas subject to occasional flooding. A low-cost pavement containing a geotextile seal was tested during the trial. The results indicate comparable performance and possible savings of at least 50 percent over traditional construction methods.

ARRB's work in pavement testing is not restricted to Australia. The board also participated in the full-scale pavement testing

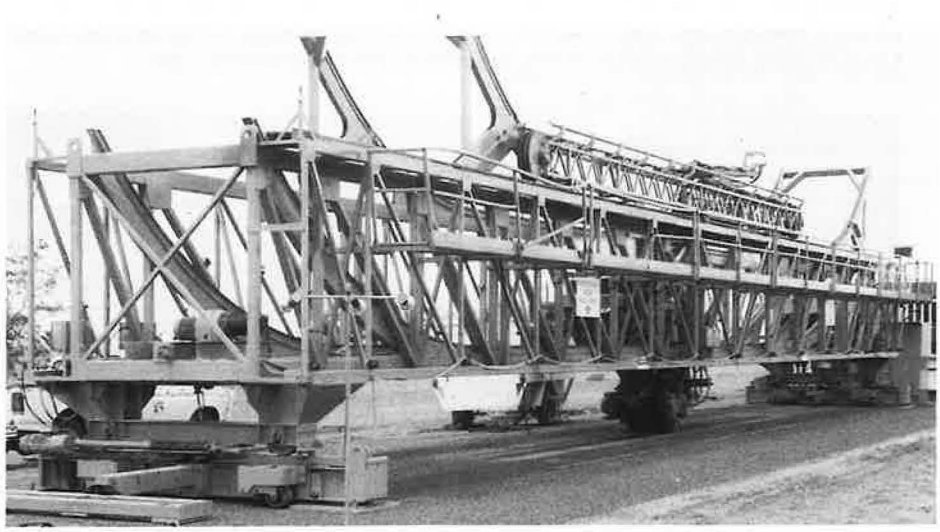

FIGURE 1 ALF is used for full- scale pavement testing.

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program of the Organisation for Economic Co-Operation and Development (OECD), which is discussed later.

The Federal Highway Administration (FHWA) of the U.S. Department of Transportation purchased the manufacturing rights for ALF in 1984. One ALF operates at FHWA's Turner Fairbank Highway Research Center near Washington, D.C., and a second will soon be commissioned by the Louisiana Transportation Research Center at the Louisiana State University in Baton Rouge. A third ALF operates in the People's Republic of China.

Performance-Based Specifications for Asphalt Mixes

ARRB and the AUSTROADS Pavement Research Group, in cooperation with the Australian Asphalt Pavement Association, are developing test procedures for determining the engineering properties of asphalt mixes—stiffness, rut resistance, and fatigue resistance. The emphasis is on relevant tests that can be undertaken quickly and routinely by using relatively inexpensive equipment. These properties will form the foundation for performance-based specifications leading to more appropriate use of asphalt mixes and concomitant savings.

FIGURE 2 Result of ALF trial in remote Brewarrina, New South Wales.

Participation in International Projects

ARRB currently is involved in two international projects on road construction and maintenance.

Responding to a call from the Strategic Highway Research Program (SHRP) for international participation, ARRB liaised with Australian road authorities to select appropriate test sites for inclusion in SHRP's Long Term Pavement Performance (LTPP) Program. To date, nine sites have been accepted for the LTPP data base.

In addition, for each of the five years of the operation of SHRP, a staff member from an Australian road authority has served on loan in the SHRP office in Washington. A liaison committee established under ARRB auspices has developed a strategy to facilitate effective technology transfer of the results of SHRP research to Australia.

The second project was initiated when the International Lead Zinc Research Organisation requested that ARRB test the effectiveness of the antioxidant lead diamyldithiocarbamate (LDADC) in reducing the hardening rate of asphalt cement. ARRB was asked to undertake this investigation because of the board's experience in organizing and monitoring full-scale field trials and its previous work on binder durability.

Samples and tests of the pavements containing LDADC after two years of service indicated that the antioxidant did reduce the binder hardening rate. Results of annual testing have shown continued improved performance of the LDADC sections, which are now six years old.

Polymer-Modified Binders

ARRB is leading a national effort to improve the testing and specifying of polymer-modified binders (PMBs). The properties of these new and important road-making materials are different from those of normal asphalt, and current test procedures are not appropriate.

ARRB researchers have developed a combined industry and user approach. Australian road authorities (through the national organization AUSTROADS), polymer producers, and paving contractors have worked together in task groups. Among the products presented at ARRB's national conference in Perth in November 1992 were guidelines for the selection, use, and handling of PMBs; test methods (which include specially developed ARRB instrumentation); and draft performance-based specifications.

Tools for Better System Management

Practitioners require a variety of tools to manage the road system so that it performs as efficiently and cost-effectively as possible. To this end, software and hardware for analyzing road and traffic performance are under development at ARRB.

Technology being developed includes less expensive, more accurate, on-board data-logging equipment to support studies of congestion, demand management, freight productivity, vehicle regulation, and communications technology. Technologies to improve information delivery to road users and system managers are also being investigated.

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Intersection Design and Research Aid

One of the best-known products of ARRB is the Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) software package, which is used for intersection capacity analysis and signal-timing optimization. (See Figure 3.) The software is used by more than 230 organizations in 40 countries.

SIDRA capacity and performance models are based on a lane-by-lane method instead of the traditional method of lane groups. The package is applicable to a wide range of intersection types and environments and can be used for driving on the left or the right side of the road.

The latest version of the software, SIDRA 4, has been expanded to incorporate un-

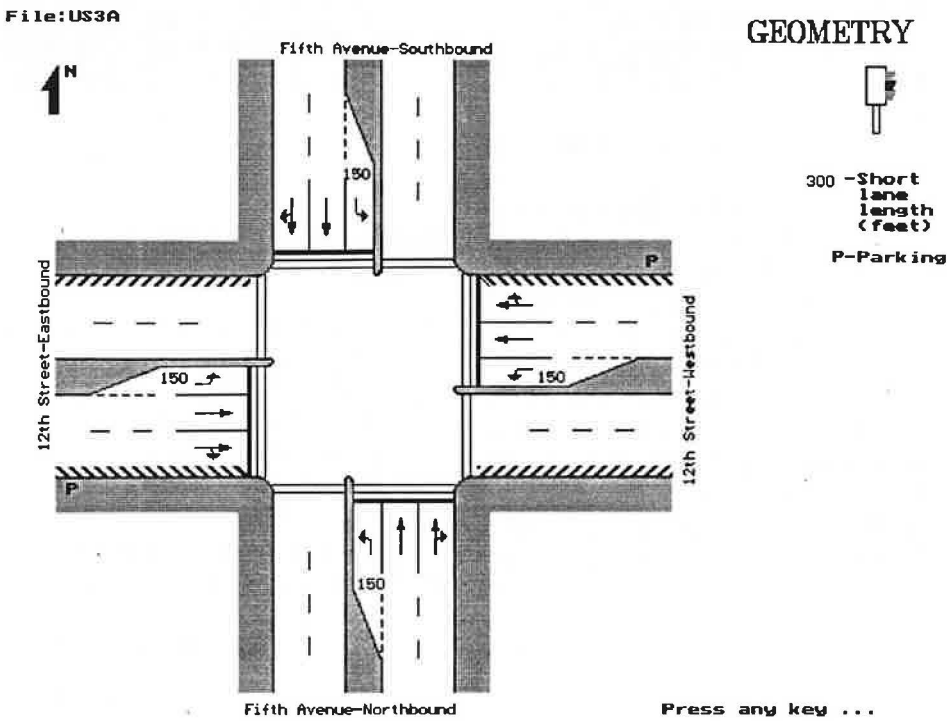

FIGURE 3 Intersection geometry graphic for driving on right side of road produced by SIDRA 4.1.

signalized intersections, including those controlled by roundabouts. The package is now menu-driven and incorporates graphics-based programs for the preparation of input data and for viewing output in graphical form.

A special U.S. version of SIDRA, based on the calibration of model parameters against the 1985 *Highway Capacity Manual*, is also available.

Pavement Management Systems

Pavement management systems (PMSs) play a significant role in managing roads, especially as funds for road rehabilitation and maintenance become scarcer. Using a PMS optimizes the use of funds and resources for maintaining and rehabilitating pavements. ARRB actively supports the use of these systems, and a set of guidelines and a promotional video have been developed to help local governments select systems most appropriate for their needs.

Materials Testing Apparatus

A unique system has been adopted as the national standard for measuring the physical properties of asphalt, especially stiffness and creep, after ARRB evaluated overseas and Australian asphalt testing devices and found that none met all the requirements for measuring the physical properties of the material.

Profilometers

Currently under development is a walking profilometer (Figure 4). This compact device will be manually pushed along a stretch of pavement to assess roughness, and the data will be provided at the end of a given distance by the on-board computer. Development of this profilometer will eliminate the need to use larger, more expensive equipment for small jobs.

For longer stretches of pavement, ARRB manufactures Class 1 three- and five-laser profilometers, which are mounted on an automobile. When the automobile is driven at highway speed, raw data from the lasers are recorded by an on-board computer. These precision systems are used for the efficient collection of roughness and rating information on more than 200 lane miles a day.

Road Geometry

ARRB also manufactures vehicle-mounted Road Geometry Data Acquisition Systems (RGDAS), which can record data on the geometric features of a road. One of the application programs for this system allows the user, by means of a personal computer, to "drive" down the road that has just been surveyed (Figure 5). The user can stop to look at certain features or isolate blocks of data. RGDAS is currently being integrated

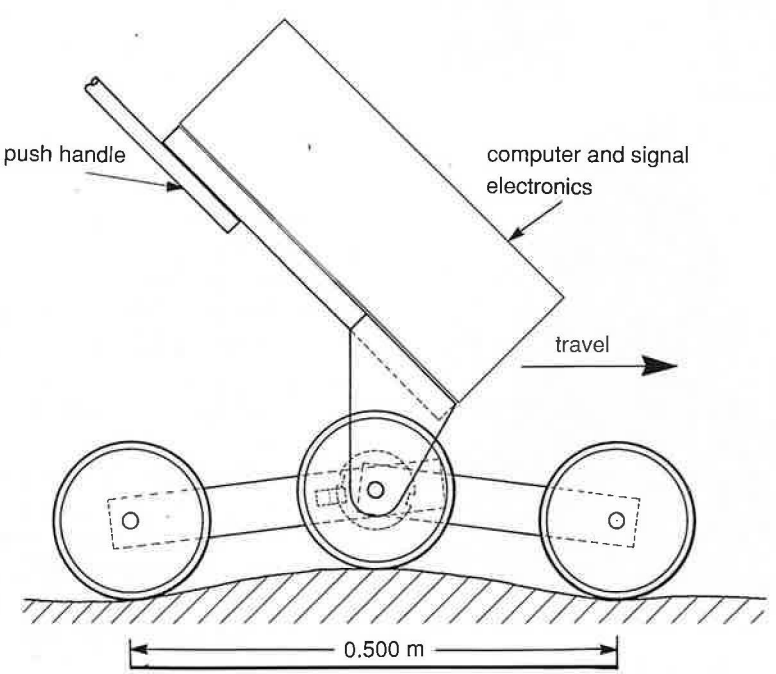

FIGURE 4 Schematic of walking profilometer currently under development.

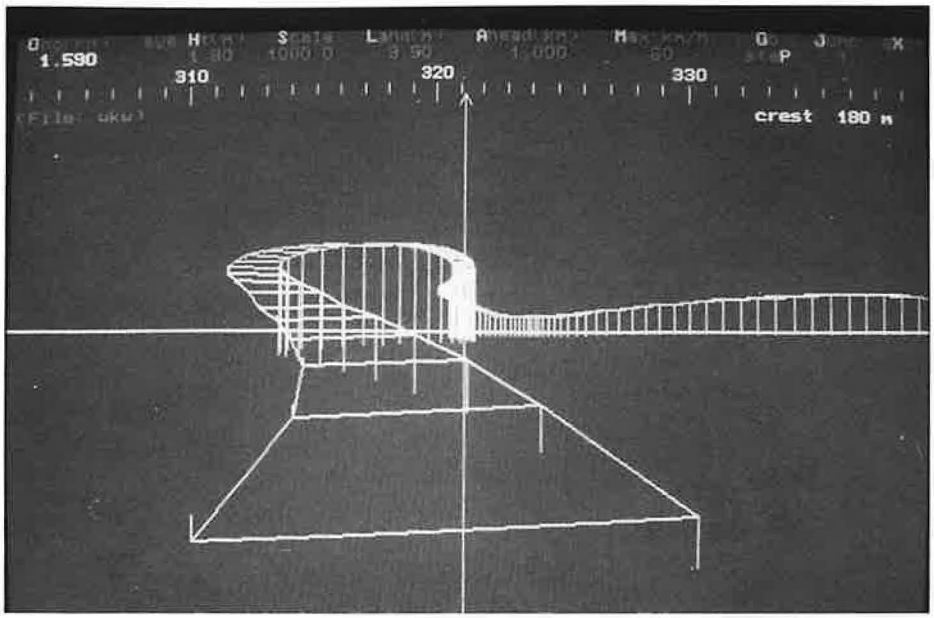

FIGURE 5 RGDAS data are converted to scene on personal computer that the user can "drive" down to examine areas of special interest.

with global positioning systems to extend its use to network mapping for graphical information systems.

Rural Traffic Modeling

Most of Australia's roads run through rural areas. Traffic on Rural Roads (TRARR) is a computer program that models traffic on rural roads so that use of these roads can be optimized. It simulates the effects on traffic operations when road or traffic conditions are changed (for example, extra lanes are provided, road alignment is improved, traffic flow is increased, or speed limits are changed). It has led to the cost-effective use of overtaking lanes on long stretches of two-lane roads in rural areas to provide smoother flow and reduce bunching. As an alternative to duplicate lanes for the length of the road, overtaking lanes can be positioned at optimum locations, depending on the characteristics of the road and the traffic that travels on it. A new graphical user interface package has been written, along with software that allows geometric road survey data from RGDAS to be imported.

Video Vehicle Detector

The experiences of ARRB and those of its customers demonstrated the need for a less expensive, easier way to collect data at busy or complex intersections or in awkward positions such as on long bridges. Most methods for collecting information about traffic movement and vehicle numbers rely on pavement sensors. ARRB has developed a video vehicle detector that allows a traffic scene to be analyzed in real time using a videocassette player and a personal computer equipped with plug-in hardware.

This system has generated a great deal of interest in Australia, and wider applications of vision technology are being examined in low-cost traffic sensing, vehicle identification, and pavement condition measurement.

Road Cost Recovery

Another major area of research is the allocation of road costs to road users. This work underpins the revised system of road user charges expected to be introduced by the Australian government. The basis of the government's reform is that users will pay for the costs they cause on public (arterial) roads. Because these charges are likely to particularly affect heavy vehicles, this research is being closely monitored by road authorities and various road transport organizations. It appears likely that Australia will adopt a pay-as-you-go approach to charging road users. ARRB staff have reviewed overseas cost allocation processes and are developing relationships between road costs and road usage for a sample of arterial roads.

Congestion Management

Traffic congestion in Australia's major cities is a growing concern. ARRB's travel demand management research will initially be focused on travel costs and demand elasticities, community attitudes, and likely responses to possible transportation demand management initiatives. Congestion management research will be concentrated on queue management techniques and collaboration with other organizations in incident detection and management.

Freight

Truck Safety

Truck safety research in recent years has received a great deal of interest and cooperation from the road transport community. Heavy vehicle safety is a major concern for the transport industry; about 400 people are killed and 1,700 are injured in Australia each year in accidents involving trucks. Damage to trucks, their payloads, and the property of drivers and passengers of other vehicles also results in high costs.

During 1991, ARRB and the Australian Road Transport Federation embarked on a major study of truck safety in Australia. The three broad areas studied were road and traffic factors, vehicle factors, and driver, organizational, and enforcement factors. A number of important recommendations covering road characteristics, multiple trailer vehicles, speed limits, driver education and counseling, and fleet management are now being implemented jointly by the government, the road transport industry, and researchers.

In addition to many recommendations for immediate action, a wide-ranging program of research was proposed, covering issues such as road geometry, delineation, fatigue, braking, front and rear protection, drugs, and driver training.

FIGURE 6 ARRB is developing truck rollover warning device using equipment such as tilt-deck, shown here.

Speed Limiters

Use of speed limiters, devices that govern the top speed of vehicles, recently has been introduced for new heavy vehicles in Australia. When the legislation was introduced, some expressed concern that being limited to speeds of 100 kilometers per hour might encourage drivers to speed up in low-speed areas (such as in towns and around curves) to compensate for lost time. ARRB intends to study the impact speed limiters have on safety when a sufficient number of vehicles equipped with the devices are on the road.

Truck Rollover Warning

From work on heavy vehicle behavior on curves, ARRB researchers determined that it is possible to warn drivers of semitrailers when their vehicles are about to roll over. Following that study, which was conducted with the cooperation of the trucking industry, ARRB began development of a prototype warning device. (See Figure 6.)

Weigh-in-Motion

The ability to enforce weight regulations is critical, and its effectiveness depends on the availability of equipment that improves the check-weighing process.

One of the best examples of an ARRB product to aid enforcement is the High Speed Electronic Mass Unit (HSEMU), which was recently installed in a truck weigh station on a major expressway to screen trucks for load-limit violations. Trucks are diverted off the expressway and over the HSEMU at speed. The HSEMU weighs and classifies the vehicle within two seconds, determining whether the vehicle conforms to axle weight and vehicle length limits. Trucks that do not conform are diverted automatically to a static weigh bridge; others continue on to the highway. The unit is a reliable enforcement screening tool that reduces delay for truck operators.

Other weigh-in-motion systems are used primarily for planning. CULWAY is a portable data acquisition system that is installed in existing culverts and weighs trucks moving at highway speeds over the culverts. Although the data obtained through CULWAY are not suitable for enforcement, they are valuable for planners who must make sure a road is suitable for the heavy vehicles traveling on it. The system was demonstrated to the Structures Research Office of the Ontario Ministry of Transportation, Canada, in 1990 on Highway 402. The Canadians were particularly pleased with the speed and ease of installation and removal and that little access was required to the roadway and little disruption to traffic occurred during installation.

Dynamic Loading of Pavements

ARRB also participates in the OECD's Road Transport Research Program. One of the major projects of the program is the dynamic loading of pavements. Australia was the lead country for this international study, in which the effects of dynamic loading on road pavements were examined. Results of the study will eventually be used in establishing design rules for heavy vehicle suspension to minimize road damage. The final report of the OECD expert group was presented at a conference at ARRB in November 1992.

Road Safety

Some success has been achieved in reducing the death toll on Australian roadways. In 1991, 2,112 people were killed on the roads (2.26 per 100 million vehicle miles); this number was the lowest in more than 30 years. ARRB has had a major role in road safety research, particularly safety associated with the nature and use of the road infrastructure. The board currently conducts a mature road safety program covering factors associated with accidents, cost-effective countermeasures, and heavy vehicle safety.

Visibility

Accidents at the intersections of local streets with arterial roads are a significant and poorly understood problem. Results of an ARRB study revealed that more than half of all drivers involved in these accidents did not see the other vehicle in time to avoid a collision. Somewhat surprisingly, daylight conditions made little difference; the results for both daytime and nighttime accidents were similar.

A number of situations usually thought to be dangerous actually contributed to few accidents. Incorrect signaling, failure to use headlights when required, visual obstruction caused by roadside furniture (e.g., lights, signs, benches, etc.), and visual interference caused by headlight glare and by fogged windows each occurred in no more than 1 percent of accidents.

As a result, the recommendations were focused on improving driver training to increase driver awareness of visual obstructions caused by other traffic and on the use of curb extensions that place pedestrians in a protected position where they can see and be seen before crossing the road. The use of compulsory daytime running lights was also considered to be worth investigating; their costs and benefits are currently under evaluation.

Unsafe Driving

Young people are overrepresented in accidents, and the causes of this phenomenon must be identified. ARRB researchers are studying the driving errors that lead young people to be involved in such a large proportion of accidents. ARRB officials plan to work with the Monash University Accident Research Centre, a world leader in road safety research, to continue this research on young drivers. The results will help Australia improve the basis for driver training curricula, graduated licenses, and enforcement activities.

Accident Costs

The cost of accidents is another area of research interest. Accident costs are required by practitioners in assessing the value of measures such as duplicating a highway (increasing capacity by doubling the number of lanes), installing traffic signals, enforcing specific road laws, and putting reflective plates on trucks. When these measures are being considered, a specific cost is required to determine the benefit.

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In 1990, ARRB researchers began a project to generate up-to-date information about accident costs. The purpose of the project was to produce an analysis tool, using the concept of a "unit cost," covering many different categories of accidents and their associated costs. So thorough is this approach that it accounts for such factors as the costs of delay and frustration to the uninjured people involved in an accident. A spin-off from the accident cost study is a set of guidelines for recording and analyzing road accident data and accident types. This resulted from the difficulties of analyzing accident data from different states because of a lack of compatibility in what information is collected, how it is collected, and how it is processed.

The Environment

The majority of ARRB's work related to the environment has been concentrated on noise pollution from roads, fuel consumption, and environmental traffic management (now commonly known as traffic calming). For example, the most recent product is Interrupted Traffic Flow Noise Simulation (ITFNS), a computer package that predicts traffic noise at single- or dual-approach lane, signalized intersections. ITFNS is used by organizations all over the world.

Another product, the Australian Road Fuel Consumption Model (ARFCOM), accurately estimates the fuel consumption of vehicles, from cars to articulated trucks with several trailers. ARFCOM was recently improved, allowing a link to be made between road roughness and fuel consumption.

To guide an expanded research program on environmental issues over the next three to five years, a comprehensive strategy is being prepared to identify measures that will lead to sustained environmental improvements. The program will be focused on the environmental and ecological consequences of transport that are priority areas for ARRB's client groups, where potential community returns are high and ARRB's resources can be most effectively used.

Technology Transfer and Liaison

The value of research can only be measured in terms of its impact on practice. This demands a commitment to technology transfer. High priority has been given to improving the ways in which knowledge gained through ARRB's research is transferred to the practitioners.

One major initiative was the dedication of one section of ARRB to streamlining the technology transfer process. ARRB organizes conferences and seminars, provides communications training and assistance for staff, and produces a research journal, brochures, and report summary flyers. Every two years, ARRB holds a major conference, attracting practitioners, researchers, and industry members from all over Australia and the world. The conference, hosted by a different state each time, was held in Perth, Western Australia, in November 1992. The conference theme was Technology for Transport Productivity.

International technology transfer and liaison are also perceived as valuable ways to communicate with the world transport community. ARRB Executive Director Ian Johnston is Chairman of the Road Engineering Association of Asia and Australasia (REAAA) Technical Committee, and ARRB is the Australian member of REAAA. These links provide a key mechanism for cooperation with countries in Southeast Asia, where the experience gained in Australia can assist in the development of transport networks. ARRB has contributed significantly to the transfer of pavement construction, maintenance, and testing technology.

ARRB plays a major role in Australia's participation in the OECD Road Transport Research Program. ARRB coordinated the Australian response for the International Technology Transfer Conference held in Orlando, Florida, in 1990, and Australia was 1 of 14 countries that financed and carried out the full-scale pavement test in France in 1989.

Contact with Australia's local government authorities, which own about 75 percent of Australia's roads, is a priority for ARRB because the local authorities are the most diverse and widely distributed of ARRB's customer groups. They are often not as well informed as state road authorities about road research and technology, yet they stand to benefit a great deal, especially during the current tough economic times. They are also a valuable source of input for the research program. Accordingly, ARRB appointed a Local Government Services Manager to oversee the quality and relevance of its service to local government and to serve as a point of contact for local government authorities.

For more information on ARRB, contact Peter Milne, General Manager, Technology Transfer, Australian Road Research Board, P.O. Box 156, Nunawading Vic 3131, Australia (fax 61-3-887 8104). For more information about SIDRA, contact McTrans, University of Florida, 512 Weil Hall, Gainesville, Fla. 32611-2083 (fax 904-392-3224).