IDEA PROGRAM
INNOVATIVE APPROACH TO HIGHWAY RESEARCH

K. THIRUMALAI AND WILLIAM G. AGNEW

The Strategic Highway Research Program was created with the expectation of finding solutions to a predefined set of major, long-standing problems in highway engineering and operations in a relatively short time. This expectation had several consequences. First, selections among potential research pathways had to be made early in the program. Second, as work progressed, projects had to be assessed to ensure that dollars were being invested in the most productive initiatives. Third, relatively large teams of researchers experienced in highway studies had to be recruited to complete the work on schedule.

At the outset, the SHRP Executive Committee recognized that this approach would close the door to truly novel, but untested, concepts and to researchers wanting to explore innovations in SHRP areas. To avoid closing this door completely, the committee set aside a small portion of SHRP funds (about $3 million) for a program to investigate innovations deserving exploratory analysis. Although the SHRP-IDEA program addressed the same research areas as the Strategic Highway Research Program, it operated with different project-selection procedures and management arrangements. Because it was intended to explore technically creditable concepts with potentially high payoffs but no predesigned practical applications, proposals submitted by researchers with no previous highway research experience were given the same consideration as those submitted by researchers with such experience.

K. Thirumalai is program manager, TRB-IDEA programs, Transportation Research Board. William G. Agnew is former director of research, General Motors.

SERVING SHRP STAKEHOLDERS AND USERS

Under the Strategic Highway Research Program, the IDEA program identified and explored innovative concepts that either were incorporated into or supported mainstream SHRP research. It also focused on proactive research, investigating concepts that might not result in products before SHRP ended and examining issues that began to emerge after some SHRP projects had yielded preliminary results.

The principal users of highway products include approximately 40,000 public agencies at city, county, state, and other local levels. These agencies depend on the private sector to produce and deliver a wide array of products for highway systems. However, the highway industry does not have a strong incentive to pursue innovation because of the long lead time needed to develop and market its products. In a price-based, contractual procurement process, new products that may perform better and have lower life-cycle costs—but higher initial costs—than other products may not be competitive in the marketplace. At the time the IDEA program was created, there were no public-sector programs that conducted research on technically creditable concepts or undertook the risk of developing new products that had uncertain market potential for highway applications.

Highway research is decentralized and serves a fragmented highway industry. Therefore establishing a productive link between innovators in the area of highway systems and users of highway products is difficult. Yet as demand for research to support the development of a growing network of highway systems lessens, and demand for the application of new and advanced technologies to effectively use and maintain these systems increases, the need for such a link has never been greater.

DESIGN OF IDEA PROGRAM

The design of the IDEA program reflects five recommendations by state highway representatives and the SHRP Executive Committee. First, solicitation for the program emphasized the investigation of technically creditable concepts that might not prove feasible (and thus represented an investment risk) but, if feasible, offered a potentially large payoff in improved highway practice.

Second, the program was opened to any individual, institution, or industry from the United States or abroad. Third, the technical merit of proposals was evaluated by a panel of interdisciplinary science and technology experts uninvolved with highway programs; awards were then decided by an advisory committee consisting of national experts in highway and engineering practice. Fourth, the progress of each IDEA contract was managed by the program under a matrix management arrangement with other SHRP efforts. Finally, a mechanism was introduced to perform follow-up investigations as projects progressed. The purpose of these investigations was to conduct prototype testing of successful IDEA products and facilitate the transfer of these products to mainstream SHRP efforts.

The IDEA program was improved in each successive year of the Strategic Highway Research Program. First, the program announcement was revised each year to report the progress of current projects and to identify areas in which new concepts and products were needed. Second, the awards for proposals were limited to $100,000, but provision was made to exceed this amount when successful IDEA concepts were ready for testing. The costs for these follow-up projects were shared by the user, state agencies, and the contractor.

Program Outcomes

Participants in the IDEA program investigated 38 concepts. Of these concepts, 7 proved unfeasible or unattractive and were discontinued; 13 proved technically feasible but have not progressed to the development of a prototype; and 18 resulted in usable products, 5 of which significantly improved highway practice.

One of the success stories of the IDEA program is a small Colorado firm's development and testing of a technology for predicting site-specific snow accumulation on an hour-by-hour basis. The technology, which can reliably forecast snow hazards within 1 square mile on the basis of local temperature, topography, and wind-velocity data, has been successfully marketed by the investigating firm to the states of Colorado, Utah, and Michigan. Where the technology is being applied in Colorado, annual winter highway-maintenance costs are being reduced by an estimated 10 percent.

Another success story is the development and testing of a sprayed-zinc anode system as a sacrificial anode to prevent corrosion in marine substructures. No electrical systems are needed to drive impressed currents for cathodic protection. Using commonly available metallizing equipment, the sprayed-zinc anode system establishes an electrical current between a layer of zinc sprayed over the cleaned surface of corroded rebars. This method of cathodic protection proved to be cost-effective in preventing corrosion and was selected for large-scale field trials on the Howard Franklin Bridge across Tampa Bay by the Florida Department of Transportation, with funding support from the Federal Highway Administration.

The concept of a strip-type weigh-in-motion system using a capacitance-type transducer to measure pavement loading under vehicle operating conditions has also proved feasible. The system was developed by the University of Michigan's Transportation Research Institute in cooperation with the University of Cambridge in England. Several U.S. transportation agencies are using the system, which now is manufactured in the United Kingdom.

A new, noncontact method of measuring pavement thickness using ground-penetrating radar (GPR) data has also proved successful. The innovation of this concept was to develop software-analysis schemes for use with commercially available GPR systems. The investigator, a small Massachusetts firm, is using the method to measure the thickness of asphalt layers in pavements, a service it performs on site for state highway agencies.

Unique Program Features and Payoffs

Seven features of the IDEA program have supported aggressive, yet cost-effective, mechanisms to solicit and manage leading-edge technological research.

Proposal of Concepts by Investigators

In conventional highway research, specific products are prescribed, the requirements for producing the products are fully developed by sponsors, and proposers compete on the basis of uniform criteria. Under the IDEA program, the burden of proposing concepts shifted from the sponsor of the research to the investigator. Several IDEA concepts that proved feasible for highway application would not have emerged from a conventional research-procurement process. Site-specific prediction of snow accumulation using local temperature, topography, and wind-velocity data and pavement-thickness measure-

ment using GPR systems are examples of investigator-driven concepts that worked.

Promotion of Proactive Concepts

The IDEA program has nurtured concepts far ahead of state-of-the-art developments in highway engineering. One of several concepts leading to new solutions to important highway problems is a crash cushion that recovers its shape after a collision, thereby reducing the costs of repairing appurtenances and traffic barriers. Vanderbilt University used a high-molecular-weight–high-density polyethylene to test the feasibility of a maintenance-free appurtenance-design geometry. Several highway agencies are experimenting with the geometry or have deployed it.

Application of Industrial and Defense Advances

The IDEA program has continued to provide support for the novel application of proven concepts and products from industrial and defense research to highway practice. One such application is measurement of the amount of asphalt in asphalt-aggregate mixtures through the use of nuclear magnetic resonance (NMR) developed for quality control in food packaging. The IDEA project that experimented with this application for quality control of asphalt has revealed that NMR relaxation data could be used to determine the rheological characteristics of both neat asphalt and asphalt in aggregate mixtures.

Recruitment of Experts in Interdisciplinary Technical Areas

The IDEA program has supported examination of concepts proposed by experts in interdisciplinary technical areas who may not be familiar with highway practice and product requirements. The program has helped to recruit new investigators and channel their technical expertise to solve important problems in highway practice. Meteorologists from the firm that explored the technology for predicting snow accumulations and NMR specialists from the food industry are cases in point.

Cooperative SHRP-IDEA Project Initiative with NSF

Federal agencies have major mission-oriented research programs in several technical areas important to highway practice. The National Science Foundation, for example, conducts research on cutting-edge, basic engineering developments of interest for emerging highway technologies. A cooperative research initiative of NSF research programs and the IDEA program was created through a Memorandum of Understanding between the foundation and the National Research Council. As specified by the memorandum, the foundation and the council shared the cost of IDEA projects of mutual interest. Foundation funding was used for basic engineering research performed by academics on selected IDEA concepts; SHRP funding was used to determine if these concepts were applicable to highway practice.

Through the National Science Foundation and the National Research Council/Strategic Highway Research Program initiative, the University of Michigan–Ann Arbor developed and tested the concept of an automatic bridge-load monitoring system. With the cooperation of the Michigan Department of Transportation, the system was installed on approximately 20 bridges, and its applicability regionwide was examined.

Cutting-edge technologies for the repair of concrete structures have also been explored through the initiative. The University of Santa Barbara in California developed a pulsed-echo tomographic microwave system for quantitatively determining the extent of internal cracking in concrete structures. The University of Illinois at Urbana–Champaign investigated the concept of automated self-repair of internal cracks in concrete by releasing crack-filling chemicals embedded in hollow fibers mixed with concrete.

Negotiation of Cost-Effective Investigations

The SHRP-IDEA management staff conducted extensive negotiations with investigators on approved projects before awarding contracts. These negotiations focused on cost-effective design of technical tasks. Meeting this goal would mean that a greater number of research projects could be funded. In turn, the probability of developing winning products could be increased.

Negotiations for each proposed investigation also involved the development of work plans in two or more stages. The first stage generally focused on critical technical issues that might have to be resolved to prove the principles of the concept and thus reduce the risk of failure before more extensive testing or experimentation was initiated. In the event that the early stage of research did not produce anticipated results, the

project was either discontinued or redirected, with a change in scope, technical approach, and product delivery.

Cost Sharing

The program encouraged the practice of cost sharing by investigators and potential users of an IDEA product. In addition to leveraging the program's resources, cost sharing increased the commitment of the investigator to product transfer and application. Cost sharing was generally negotiated on a project-by-project basis in consideration of research and business interests as well as anticipated gains to the proposing institution from an IDEA award. The practice was generally emphasized during pre-award negotiations on concepts proposed by businesses to enhance their product lines.

Contributions by investigators added to IDEA projects the equivalent of 50 percent of the total funds expended by the program. On average, about one-third of cost sharing took the form of direct contributions to a project; about two-thirds took the form of indirect contributions and in-kind payments that directly supported research. Such in-kind payments were generally the dollar equivalent of the investigator's time on a project or of the equipment and facilities leased or used on a project.

Offspring of the SHRP-IDEA Program

As the Strategic Highway Research Program wound down in 1993, the IDEA concept was reborn in three new programs currently managed by the Transportation Research Board.

The scope of the new IDEA research was expanded and incorporated into the National Cooperative Highway Research Program. The NCHRP-IDEA program is jointly funded by state highway agencies through the American Association of State Highway and Transportation Officials and the Federal Highway Administration. The program focuses on broad technology issues for highway practice, including the design, construction, safety, maintenance, and service-life renewal of highway pavements and structures.

The second program was initiated in support of the national program on Intelligent Transportation Systems (ITS) with joint funding from the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Federal Railroad Administration. The ITS-IDEA program focuses on using advanced communications, information, and sensor and automated-control technologies to develop and deploy ITS user services.

The third program was founded as part of TRB's Transit Cooperative Research Program, which was created through a cooperative agreement among the Federal Transit Administration, the National Academy of Sciences acting through the National Research Council/Transportation Research Board, and the Transit Development Corporation (an affiliate of the American Public Transit Association). The TRANSIT-IDEA program explores innovative approaches to improve the operational efficiency, maintenance, and safety of transit systems as well as to increase the systems' ridership. The program is funded through the Federal Transit Administration.

These three IDEA programs have maintained and extended the basic principles and unique features of the SHRP-IDEA program while evolving to address emerging issues and meet the transportation-systems needs of new sponsors. Since 1993 approximately 100 awards for IDEA proposals have been made through the programs.

Proposals to the NCHRP-IDEA, ITS-IDEA, and TRANSIT-IDEA programs are accepted year-round. Proposal forms can be downloaded from TRB's home page on the Internet at http://www.nas.edu/trb/about/idea.html/.