DOT's Vision for Transportation Research

by David Smallen

Superpave is one of the products of the Strategic Highway Research Program.

With an eye on the transportation system of the mid-21st century, the leadership of the U.S. Department of Transportation (DOT) has an innovative new vision of the way research programs in the department will work.

The vision, promoted by Secretary Rodney E. Slater and Deputy Secretary Mortimer L. Downey, is transforming DOT's research program, adopting many approaches that are proving successful in private industry. The department is now moving beyond the five-decade-old concepts that currently dominate the way research is conducted in much of the federal government to a new posture of fostering the innovation process.

In June 1999, Downey told the TransNow conference in Seattle, "In today's fast-paced, global economy, the race doesn't go to someone who makes things 5 percent or even 10 percent better -- but to the one who literally makes things at least 10 to 100 times better, the one who produces a product or service which revolutionizes the world of work. That's the new economy, and we want our transport sector to be part of that new economy."

More and more, the surface and maritime programs in DOT are being tied to the strategic goals for the nation's transportation system: safety, mobility, human and natural environment, economic growth and trade, and national security.

The new approach to research emphasizes cooperation, information-sharing, and development of formal research agendas among the agencies within DOT and across the entire government. It promotes partnerships with state and local governments, academia, and the private sector to accelerate the transformation of new technology, concepts, and ideas into better transportation systems, processes, and services quicker and more cost-effectively.

It also reflects an added sophistication in research decision-making and program formulation. Secretary Slater promises, "A new decision-making architecture at DOT ... will help move America toward a high-tech transportation system that helps save lives, money, and time while providing all Americans access to affordable, environmentally friendly transportation."

Slater also has high expectations for the role that innovation will play in delivering the transportation system of the next millennium.

The National Science and Technology Council (NSTC) Committee on Transportation Research and Development identified three partnership areas, one of which is transportation information infrastructure. This includes technologies like variable message signs.

"We intend to aim so high that we will be forced to establish stretch goals that will push the transportation technology envelope to higher heights than we presently dream or imagine. … We hope to identify possible technological innovations -- innovations that offer genuine promise for meeting the transportation challenges of the next century and a new millennium," Slater told the Conference on the Spirit of Innovation in Transportation last June.

The key change will be an increasingly close relationship between the research activities and the demands of the transportation system and society at large.

"Innovation requires more than new ideas. It requires bringing these new ideas to the marketplace," Slater told the conference.

Earlier in the year, Slater pointed to the need for innovation -- not just invention -- in a speech to the Transportation Research Board.

"Innovation is more than invention," Slater explained. "Daimler invented the automobile; Henry Ford had the vision to create a global industry. Leif Ericson was the first European to discover America; Christopher Columbus had the vision to use that discovery to launch history's most ambitious market expansion plan. Xerox invented the PC; Bill Gates hadthe vision to realize the PC's possibilities.

"We must follow the example of leaders like ... Henry Ford and Christopher Columbus, whose success depended upon innovation rather than invention. The challenge we face as members of the transportation research community is to make sure we are investing our time and resources in technology with the potential to move beyond mere invention."

Conducting research in partnerships enables new technologies — such as new cars (concept cars with automated technologies) or new highway materials (such as Superpave) — to enter the marketplace more quickly.

Transportation Science and Technology Strategy

None of this would be possible without an unprecedented government-wide research coordinating body -- the National Science and Technology Council (NSTC). Secretary Slater belongs to this group, which sets overall directions and priorities for federal investments in research and development R&D).

The new vision for transportation innovation was first laid out in 1997 by NSTC's Committee on Transportation Research and Development, an interagency panel chaired by Deputy Secretary Downey. The committee's report, *Transportation Science and Technology Strategy*, is the foundation on which the redirected DOT research program has been built.[1]

When the report was issued, Dr. John H. Gibbons, assistant to the president for science and technology, observed that the report "responds to the greatest challenge facing the nation's transportation system and the federal community -- how to do more with less -- by identifying innovative ways to partner successfully with industry and academia to leverage scarce R&D dollars."

Next-generation vehicles — such as smart cars and vehicles that incorporate ITS technologies — are another partnership area the NSTC Committee on Transportation Research and Development identified.

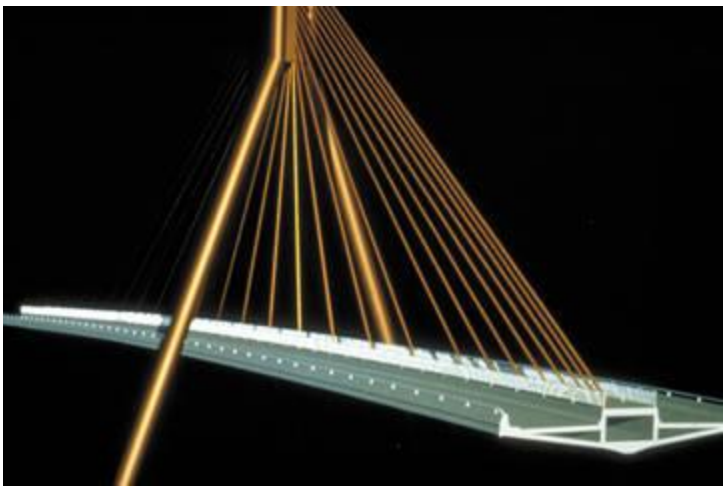
A year and a half later, in May 1999, Secretary Slater and Dr. Neal Lane, the new assistant to the president for science and technology, released a broader *National Transportation Science and Technology Strategy.*[2] This document builds on the 1997 strategy, but it includes broader participation by the transportation and research communities. The addition of the word "national" was a key indicator of the thinking of the members of what is now called the NSTC Subcommittee on Transportation Research and Development.

As Slater noted, the new national strategy now "goes beyond federal government activities and sets forth challenges for the entire transportation and technology community -- federal, state, local, and tribal governments; industry; academia; labor; and professional associations -- to address."

The national strategy sets out a vision and a mission for transportation science and technology. It cites the importance of transportation to economic growth and competitiveness, as well as the growing concerns about environmental impacts; congestion; highway fatalities; and access for the elderly, physically challenged, and the poor.

"The transportation system must be designed to meet the challenges that will reshape the globe during the next 25 years. Key among these changes are significant shifts in demographics, economic growth and globalization, growing urbanization and motorization, increasing concerns for safety and security, and changing technological trends," the subcommittee said. "The goal for transportation science and technology is to meet these challenges by providing the innovations that will enable us to balance the sometimes competing values of safety, mobility and access, economic growth, environmental quality, and national security. Through science and technology, America can achieve a transportation system that is fast, safe, efficient, accessible, and convenient."

"In the past, changing transportation needs have typically been met through innovations in three area: (1) transportation vehicles; (2) the physical infrastructure that supports their use; and (3) the people who plan, design, build, operate, use, and maintain the vehicles and infrastructure and who plan and manage the transportation enterprise. More and more, the burgeoning demands on the transportation system will be met through a fourth means: the development and deployment of an information infrastructure that underlies and will integrate these three areas," said the subcommittee.



One of the six enabling research areas that the committee recognized is tools for transportation modeling, design, and construction. By producing a computer-generated model, such as this model of a composite bridge, planners and designers can maximize the safety benefits of highway projects within the constraints of cost.

National Strategy - A Framework for Innovation in Transportation

Both the 1997 and 1999 strategies use a four-tiered approach to transportation science and technology as the framework for the innovation process.

The first tier is the strategic planning, policy research, and other activities to ensure that all transportation innovation, enabling research, and education and training activities support the national transportation goals and contribute to providing America with unprecedented transportation systems and services in the 21st century.

The second tier represents strategic public-private partnership initiatives that address recognized national needs; have a technology focus; and, if successful, could rely on existing market forces and the private sector for implementation. The 1997 strategy notes, "For agencies with transportation R&D responsibilities, strategic partnerships can expedite the research process and speed the introduction of much-needed new technologies into transportation systems and operations."

The 1999 national strategy identifies 13 transportation partnership initiatives that fall into three general categories. Initiatives in the transportation information infrastructure category include an intelligent vehicle initiative, national intelligent transportation infrastructure, next-generation global air transportation, enhanced transportation weather services, enhanced goods and freight movement at domestic and international gateways, accessibility for aging and transportation-disadvantaged populations, and local environmental assessment systems. Another category is next-generation vehicles, including next-generation transportation vehicles and the aviation safety research alliance. The third partnership area is transportation physical infrastructure, including monitoring, maintenance, and rapid renewal of the physical infrastructure; transportation and sustainable communities; and transportation infrastructure assurance.

Implementation activities for the partnerships identified in the 1997 strategy were set forth in the NSTC *Transportation Technology Plan*, which was also developed by the NSTC Subcommittee on Transportation R&D and was released in November 1998.[3]

The third tier is enabling research. Such basic, long-term research supports long-term national transportation goals whose benefits are too widely spread for any one company to recover its investment, whose cost or risk is too great for one company to bear, and whose benefits are too far in the future to meet private investment criteria. A separate NSTC *Transportation Strategic Research Plan*, published in May 1999, elaborates on six of the seven high-priority enabling research areas in the national strategy: human performance and behavior; advanced materials and structures; computer, information, and communications systems; energy, propulsion, and environmental engineering; sensing and measurement; and tools for transportation analysis, modeling, design, and construction.[4]

As the 1997 strategy states, "Innovations in transportation generally result from the application of a wide range of scientific and engineering disciplines not specific to transportation. Continual research in these areas is necessary to provide a solid foundation for the steady advances in transportation technology required to meet the demands of the 21st century."

But the report said the existing process does not lead to the necessary technological advances. "The long-term nature and often diffuse benefits of such research means that market forces may be insufficient to motivate private investment. Moreover, while many federal agencies conduct research in these

By repairing older bridges, PAIR can work toward one of their opjectives for the year 2000 — reducing the number of deficient bridges in the county.

really have to be innovative."

areas, R&D is typically focused on agencies' specific concerns -- not on broader national needs."

The fourth tier is transportation education and training, and it provides the base for technology development and application. "Transportation today is undergoing great change -- experiencing advances in technology, undergoing organizational transformation, and continuing globalization along with the world economy. These changes require that current and future generations of transportation professionals and workers be responsive to a more complex and dynamic environment," the 1999 national strategy states.

Both strategic documents recognize the need to build the professional capacity of the transportation work force, to create general public awareness of transportation benefits, to ensure a globally competitive work force, and to prepare the next generation of transportation professionals. They suggest that high priority should be given to vocational and technical training, international and multidisciplinary transportation degree programs, mid-career transportation training, and the introduction of transportation concepts in elementary and secondary schools.

Overall, the strategic documents "will ensure that the next generation of Americans enjoys an even greater level of transportation safety, efficiency, environmental protection, and mobility than we Americans enjoy today," the 1997 strategy states.

"The reports are outstanding," said Oliver McGee, the new DOT deputy assistant secretary for technology policy. "They articulate the details of what we need to be doing in applying technology to transportation. We are a medium-size department in relation to the large departments. We can be a fast-moving department. We can be agile, and we can be responsive and entrepreneurial. But more important, we

Public-Private Partnerships Matter

The national strategy affirms that public-private partnerships are vital to achieving the technological breakthroughs that lead to deployment. Partnerships are defined as "cooperative arrangements engaging companies, universities, and government agencies and laboratories in varying combinations to pool resources in pursuit of a shared R&D objective."

"The nation can best profit from its investments in research through the exchange of people and ideas among federal agencies, state and local governments, industry, academic institutions, private citizens, and other stakeholders," the report states.

The NSTC Transportation R&D Subcommittee conducted a detailed review of what contributes to successful technology partnerships. Its December 1998 report, *Public-Private Partnerships: Implications for Innovation in Transportation*, found that even though public-private partnerships have been successful in bringing the products of research in other fields to the market, "the conversion of research successes into viable commercial products and services can often be impeded by the absence of market forces sufficient to stimulate private sector investment in development and production. This is particularly true when benefits may not be realized for years, when technological uncertainties are present, or when the marketplace is fragmented. Increasing attention is now being given to explicit collaborations between governmental agencies (federal and non-federal) and the private sector, which may overcome the obstacles imposed by the failure of market mechanisms."[5]

In addition, "the success of [transportation] partnerships is limited by factors such as divergent motivations, limited resources, evolving legal constraints, and changing agendas among participants. Preventive strategies that minimize the impact of these challenges are needed."

The report further states, "In order for transportation-related partnerships to achieve a fuller potential, additional efforts are needed to leverage existing research and development investments and build new ones, possibly as part of the overall R&D investment environment."

To accomplish this, the *National Strategy* report identifies a series of needed transportation-related, public-private partnerships that "represent broad-based collaborative efforts in key technology areas."

Issues relating to global positioning systems are an area of enabling research that is best handled through broad partnerships.

"The partnerships focus on the innovation process -- getting technology into the marketplace cheaper, faster, safer, and in an environmentally friendly way. The federal role in these efforts includes strategic planning, reducing barriers, promoting national technical standards, fostering venture capital and private sector investments, and stimulating creative financing of technology deployment."

Prominent on the list of partnerships is the Partnership for the Advancement of Infrastructure and its Renewal (PAIR). (See "The PAIR Initiative: Repairing and Revitalizing Our Nation's Physical Infrastructure" in *Public Roads*, November/December 1999, page xx.)

PAIR partners include DOT, with the Federal Highway Administration (FHWA) and the Research and Special Programs Administration (RSPA) as the lead agencies; the departments of Commerce and Defense; the National Science Foundation; the Civil Engineering Research Foundation (CERF); state and local agencies; chemical, automotive, and material manufacturers; commercial freight, air transport, and insurance industries; infrastructure construction, planning, and management firms; utilities; universities; and industry and trade associations.

The goals of the partnership are to "accelerate the comprehensive renewal and advancement of the nation's aging transportation infrastructure, using stronger, cheaper, and environmentally superior materials and more cost-effective delivery systems [and] reduce waste, pollution, and emissions generated in the production of infrastructure materials."[2]

PAIR's objectives for the year 2000 include: (1) increase the portion of the National Highway System (NHS) that provides acceptable ride quality by about 1 percent (2,600 kilometers) up to 91.8 percent, and (2) reduce the percentage of deficient NHS bridges by about 1 percent (almost 6,000 bridges) down to 22.5 percent.[2]

Working with a broad range of partners to develop innovative technologies and to get the innovations into the market better, cheaper, faster is a major, major, major undertaking. To help remove some barriers, CERF has sponsored several workshops over the last several years, the most recent held in September 1999 focused on the procurement reform. A future workshop will examine risk and asset management.

"Increasing the viability of partnerships within the transportation community to address common R&T [research and technology] goals has been a priority for FHWA," said Dennis Judycki, FHWA's director of research, development, and technology.

"In cooperation with AASHTO [American Association of State Highway and Transportation Officials] and TRB [Transportation Research Board], FHWA has taken the initiative to establish a National R&T Partnership Forum. This work is aimed at establishing a new framework for coordinating highway R&T activities among research sponsors, practitioners, researchers, and other stakeholders in highway transportation.

"The main intent is to better coordinate investments among highway R&T programs and to do so in a manner that involves a diverse array of stakeholders and builds upon existing efforts. TRB, in line with its mission to serve as a forum for the coordination of transportation research, is facilitating the effort through the formation of working groups that address R&T program directions and needs in the areas of infrastructure renewal, safety, operations and mobility, planning and environment, and policy analysis and system monitoring," Judycki said.

Enabling Research Matters

Long-term research to produce significant advances in transportation technology is the third tier of the national transportation science and technology strategy. Generally, enabling research is not expected to produce operational implementation for at least five years.

In its May 1999 *Transportation Strategic Research Plan*, the NSTC Subcommittee on Transportation R&D said, "The long-term and often diffuse benefits of wide-ranging research are often such that market forces may be insufficient to motivate private investment. In these areas, enabling research performed or funded by the federal government can begin the way for future technological advances from the private sector."

"FHWA has a program to assure the development and widespread application of advanced technology and innovative approaches in ongoing operation, maintenance, and renewal of the nation's highway systems, as well as safety enhancement," said the subcommittee. It also cited the Intelligent Transportation Systems (ITS) Joint Program Office for "fostering and supporting application of advanced information technologies to improve surface transportation mobility, capacity, safety, and environmental compatibility."

The subcommittee found that almost half of the federal government's transportation-related enabling research is being conducted in the area of computer, information, and communications systems, and the council's report endorsed "the critical role [played by the federal government] in helping to develop uniform standards" in this area. Issues relating to the development of standards and protocols for ITS, the allocation of specific radio frequencies for ITS applications, global positioning systems, and software assurance are among the many aspects of this research area that must be worked by broad partnerships.

The subcommittee reported that advanced materials and structures research receives about one-fifth of the federal government funding for research and that research in energy, propulsion, and environmental engineering receives about the same. Less than 10 percent is devoted to the remaining three categories: analysis, modeling, design and construction tools; sensing and measurement; and human performance and behavior.

In a speech to the President's Committee of Advisors on Science and Technology, Secretary Slater said, "Our challenge is to find innovative ways to make the results of this research available to the private sector and to other units of government more quickly and cheaply. ... Our nation cannot afford to leave its research and technology unused."

Education and Training Matter

The final element of the science and technology strategy is education and training to ensure the continuing development of the skills and abilities needed by the transportation professionals who will be developing and applying new technologies.

For several years, Secretary Slater has championed DOT's Garrett A. Morgan Technology and Transportation Futures Program. This program brings information about careers in transportation to students of all ages and encourages them to improve their math, science, and technology skills. In the past few years, more than 1 million students have been reached by the Morgan program.

In addition, DOT is developing its first-ever University Research and Education Plan to develop a better integrated university research and education program across the department and the nation.

"In some respects, [education] may be the most important technology issue of all," Slater said. "We must act now to ensure that we have a trained work force to build our 21st century transportation system and to operate it after it's built."

Highway Research and Technology at DOT

FHWA has embraced, and is moving forward on, the strategic concepts.

"The thrusts highlighted in the NSTC and DOT R&D strategic planning documents form a strong framework for the efforts of the modal administrations within the department, and they are well-represented within FHWA's research and technology program. TEA-21 [Transportation Equity Act for the 21st Century] includes a robust set of authorities and emphasis areas for FHWA's R&T program, including the necessity for strategic focus in R&T efforts, advanced research, effective partnerships, and training and education to support advances in the development and implementation of innovation," Judycki said.

In May 1999, NSTC released the *Surface Transportation Research and Technology Assessment*.[6] The assessment noted that, "FHWA's current infrastructure-related R&T programs provide a platform on which to build a broader departmental effort." But the assessment also suggested that DOT examine its allocation of R&T resources.

"Approximately 90 percent of DOT R&T resources and most departmental technology development and technology partnership efforts are focused on transportation system operations. Less than 10 percent of DOT's R&T resources are allocated to

infrastructure preservation and renewal. ... It is difficult to determine just what the appropriate amount for infrastructure renewal might be, but it is important for DOT to consider that questionseriously," the assessment said.

Also in May, DOT released its first-ever *U.S. Department of Transportation's Research and Development Plan*, which emphasizes the need for a coordinated research program. "Much will be gained by assuring that the department's separate R&D programs occur within a common framework of goals and guidance and that their results are as widely disseminated as possible. It is equally as important that these activities be carefully coordinated with the needs of transportation users, as well as with the research efforts of others engaged in this common endeavor."[7]

The new DOT research strategy emphasizes a spirit of innovation, department-wide cooperation, and partnerships that will produce the technologies and systems that, as Secretary Slater said, "offer genuine promise for meeting the transportation challenges of the next century."

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