



# A Legacy Of Innovations & Partnerships

## The Second Strategic Highway Research Program



# 2018

## IMPLEMENTATION HIGHLIGHTS

# Lives. Money. Time.

# SAVE



## **SAVE LIVES**

SHRP2 Solutions make our roads safer by helping to reduce worker and driver exposure to dangerous construction zones, incident scenes, and congestion.



## **SAVE MONEY**

SHRP2 Solutions decrease construction and maintenance costs with innovations that lead to longer-lasting infrastructure, provide for more efficient project planning, and speed project delivery.



## **SAVE TIME**

SHRP2 Solutions speed project delivery, decrease congestion on the highway system, and make travel times more reliable, saving everyone time on the nation's roadways.



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# SHRP2

## overview



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The second Strategic Highway Research Program (SHRP2) was created to help the transportation community save lives, money, and time. This effort took the form of a seminal partnership among the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB).

The unique nature of this program enabled each partner to play to its strengths: TRB tapped into its network of practitioner and research experts to design the program and deliver the solutions, while FHWA and AASHTO leveraged their reach and reputation within the transportation community to encourage and support the states' implementation of the resulting SHRP2 solutions. These solutions are now being widely adopted among the states, helping transportation agencies increase safety,

enhance productivity, boost efficiency, and improve the reliability of the nation's highway system. In this report, you will see how SHRP2 has been a catalyst for change across the country – from helping agencies eliminate internal silos to advancing innovative program delivery to supporting events that help practitioners learn from their peers across the country.

In the pages that follow, each of the partner organizations (FHWA, AASHTO, and TRB) will illustrate how the SHRP2 experience has changed the way they do business and how they interact with states and other organizations. Each will share the benefits of SHRP2 from their unique vantage point. Four state departments of transportation illustrate real-world examples of their SHRP2 experience, highlighting the versatility and usefulness of SHRP2 Solutions and of the partnerships that are at its foundation.



### **Innovation and Partnership In Michigan**

provides perspective from a state that was involved in SHRP2 from the very beginning of the research phase.

### **SHRP2 Brings Improved Relationships and a Culture of Innovation to Maine**

is an example of how a state's engagement with SHRP2 began from the ground up with practitioners eager to start using SHRP2 Solutions after having been exposed to them during the research phase.



### **SHRP2 Ushers in New Perspectives and Institutional Change in Tennessee**

shows how a state seeking a significant overhaul used a top-down approach to adopt several SHRP2 Solutions that transformed the agency and then shared its experience with several other states.



### **Innovative Renewal Technologies Open New Partnering Opportunities at Caltrans**

shows how a state leveraged one SHRP2 Solution to adopt several others.

### **SHRP2 by the Numbers**

has the data behind the SHRP2 story. These figures help explain where the time and financial investments made into SHRP2 went. Finally, **"The SHRP2 Legacy Continues"** shows how we are working to ensure SHRP2 has a lasting impact well into the future.



Source: Getty Images

# PARTNER

# SUCCESSES

## AASHTO

### States Reap Benefits of Strong Partnerships Built through SHRP2

Source: Shutterstock

SHRP2 has always been about innovation and sharing. While the development, testing, and implementation of innovations is important, the most vital piece of SHRP2 comes from the partnerships that were created and fostered along the SHRP2 journey.

SHRP2 was funded to find innovative and strategic solutions to some of the major challenges impacting our nation's transportation infrastructure: improving safety, reducing congestion, and improving methods for renewing roads and bridges. These concerns are big—too big for one organization to tackle on its own. That's where this idea of partnership started.

Significantly, the partnership of the Federal Highway Administration, the members of AASHTO, and TRB has supported SHRP2's unique approach to innovation and problem-solving. Each of these industry partners brought a different perspective and offered its strengths, allowing the program to flourish. From research to implementation to evaluation, SHRP2 benefited from the relationship to help transportation agencies save lives, save money, and save time along the nation's transportation infrastructure.

State departments of transportation (DOTs) were at the forefront of SHRP2's research phase and framed the idea that research for SHRP2 products must be completed with practical implementation in mind. After all, the goal of the program was to find real-world solutions to very serious and common transportation challenges. Those ultimate solutions had to be easy for state DOTs to implement. By working through various committees (including many within AASHTO), research was done through this lens provided by state partners.

At an implementation level, partnerships were of utmost value. Transportation departments in all 50 states, the District of Columbia, and Puerto Rico participated in SHRP2's Implementation Assistance Program (IAP), a tremendous show of participation. The IAP provided support to organizations for the deployment of SHRP2 products in the form of funding or technical assistance. After all, state DOTs are in the field every day dealing with the challenges that SHRP2 set out to alleviate. Even more, SHRP2 connected state DOTs in new ways. When a state was awarded assistance through the IAP for a particular SHRP2 product, for example, that state was then linked to other states testing out and utilizing that same product. The peer-to-peer connection provided greater understanding of the tools and innovations and fostered deeper discussions on solutions to challenges.

SHRP2 fostered relationships through implementation planning workshops, peer exchanges, communities of interest, and other opportunities to collaborate. Product webinars on various topics allowed state DOTs not only the opportunity to connect, but also to present to one another on their own experiences. The relationships created through SHRP2 between states and FHWA and TRB have been invaluable.

Although the formal program will be complete in May 2019, we know for certain that the legacy of the program will live far longer. Whether through the adoption of innovations or the partnerships created and fostered over the program's long and impactful run, SHRP2 has helped states in their quest to deliver a safe, efficient, and strong transportation system.





# TRB

## SHRP2: TRB's Role in Advancing Innovation

Source: Shutterstock

For nearly a century TRB has pursued its mission of advancing the knowledge and practice of transportation. One way that TRB carries out this mission is through managing research and development (R&D) programs in partnership with state DOTs and other members of the transportation community.

SHRP2 represents another stage in this legacy of advancing transportation practice through rigorous, peer-reviewed research. The success of SHRP2 implementation began from the very inception of the program. From the beginning, TRB knew the key would be to engage and encourage stakeholder involvement at each step of the journey and to establish a strong, research-based foundation that would support widespread adoption of innovative technologies and methods throughout the transportation discipline.

As a result, hundreds of stakeholders from the public, private, and academic sectors contributed to ensuring that SHRP2 research was focused on objectives that were strategically important to state DOTs, other transportation agencies, and to the customers they collectively serve. Because the program focused on strategic, high-level goals developed through broad stakeholder input, the SHRP2 initiative itself was an unprecedented innovation in that it was neither structured around nor driven by particular disciplines. This innovative framework made it possible for SHRP2 to encompass a comprehensive progression of activities spanning research through implementation

preparation. The framework drew together multi-disciplinary teams from engineering, planning, environmental sciences, psychology, business, economics, sleep research, information technology, data science, and more.

### Identifying Needs

In 1999, having been charged by Congress with conducting “a study to determine the goals, purposes, research agenda and projects, administrative structure, and fiscal needs for a new strategic highway research program” (Transportation Equity Act for the 21st Century, Section 5112), a committee of state DOT and industry leaders decided that the broadest possible input from the transportation community and users of the highway system was imperative for identifying those needs that were of the greatest strategic importance. As a result, TRB undertook a broad-based initiative to survey and study highway user preferences; engage speakers from throughout the transportation industry, including agencies, contractors, metropolitan planning organizations, and an array of interest and advocacy groups; convene stakeholder meetings; and review research needs statements from internal TRB standing committees. TRB took a structured approach to each step of the program development and research process.

## Strategic Program Design

As the committee identified gaps in knowledge, technology, and procedures, they were compared against existing research programs to determine which needs were not being adequately addressed. Consulting with experts and researchers about the viability of addressing identified needs through research, the leadership committee used an iterative process to consider all the input, prioritize needs, request more input, and refine the priorities until four clear strategic goals were articulated.



**SAFETY:** Make a significant improvement in highway safety through more accurate knowledge of driver behavior and other crash factors.



**RENEWAL:** Accelerate the renewal of America's highways by developing a consistent, systematic approach to performing highway renewal that is rapid, causes minimal disruption, and produces long-lived facilities.



**RELIABILITY:** Provide a highway system with reliable travel times by preventing and reducing the impact of nonrecurring incidents.



**CAPACITY:** Provide highway capacity in support of the nation's economic, environmental, and social goals by developing approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity.

These goals hit the “sweet spot” of being high-level and long-term enough to endure and remain important over the program's time horizon, while also being specific enough to drive R&D decisions.

### Conducting the Program

An Oversight Committee of state DOT, industry, and academic leaders established strategic priorities, made program-wide budget allocations, and approved contract awards. Four Technical Coordinating Committees oversaw four integrated R&D programs aligned with SHRP2's four strategic goals. Dozens of Expert Task Groups wrote requests for proposals, reviewed proposals, oversaw R&D activities, and reviewed and approved reports and products.

### Implementation Planning

At the request of Congress, TRB convened a committee to develop an implementation plan. The plan was published as *Special Report 296 Implementing the Results of the Second Strategic Highway Research Program*, which identified the most promising results of SHRP2, the most likely users, incentives for implementation, and potential impediments. Published in 2009, this document laid out the framework for successful implementation far enough in advance to allow for effective planning.

### Transition to Implementation

All the stakeholder input and guidance that led to the design, development, and delivery of SHRP2 Solutions was only the beginning; much wider stakeholder involvement was necessary for widespread deployment of innovative results. AASHTO, FHWA, and TRB, contributed to this transition by conducting face-to-face visits with 40 state DOTs to provide tailored briefings on the potential benefits of SHRP2 products for each agency. The organization also conducted a two-year, comprehensive initiative that resulted in a knowledge transfer from the TRB committees, contractors, and staff to the implementation teams at FHWA and AASHTO who carried out the direct implementation support functions.

TRB's role in SHRP2 was to leverage its unique reputation and capacity for conducting world-class research with its independent oversight capabilities to create a foundation upon which the multi-year SHRP2 initiative could be built. TRB's role in convening experts and managing R&D activities generated the innovative approach to collaboration that has become the hallmark of SHRP2.



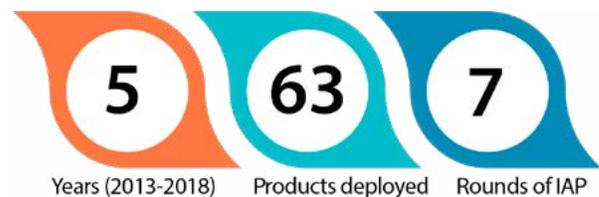
# FHWA



Source: Massachusetts DOT

## The Road to Success

Deployment of the first SHRP2 Solutions began in early 2013 with the first round of the SHRP2 IAP. A total of 63 products were deployed, and, after five years and seven rounds of the IAP, many of the SHRP2 Solutions have become institutionalized within the day-to-day operations of transportation agencies across the nation. Numerous states—including those highlighted in this year's report—have reported that specific products have had marked impacts on the way they do business. But beyond the innovations themselves, SHRP2 has built a legacy of partnered success. The strategic partnership between and among AASHTO, FHWA, and TRB not only led to the successful implementation of the SHRP2 products among state agencies, it has established a durable model for successful partnerships in future transportation programs.



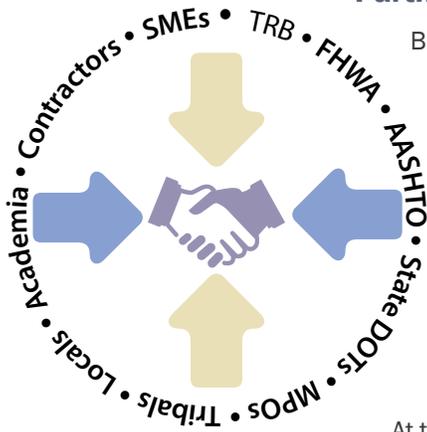
By its very nature, the SHRP2 implementation efforts also created unique and lasting partnerships at the state and local level, which in many cases led to new and improved business practices in all facets of the transportation industry. This report highlights several key aspects of SHRP2's overall success, from both the state and national agency perspectives. The successes and lessons learned are a testament to the hard work and collaboration of hundreds of parties who worked to ensure that success for one means success for all.

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### From FHWA's Perspective...

In 2018, FHWA conducted an assessment of the overall SHRP2 implementation program by interviewing key stakeholders from AASHTO, FHWA, and TRB, as well as from state and local agencies that implemented SHRP2 products. This evaluation identified several areas where FHWA and AASHTO employed new processes that differentiated SHRP2 from traditional technology deployment programs and contributed to the overall program's success. Here are some of the key elements:

## Partnership made it happen



Beginning in the research phase, AASHTO, FHWA, and TRB collaborated to plan for implementation. This partnership continued throughout the lifecycle, with AASHTO and FHWA leading the implementation. Throughout the entire SHRP2 continuum, stakeholders from transportation agencies were included on committees that steered the success of the product development and the overall program.

This collaboration happened at all levels of the partners' organizations. FHWA and AASHTO's leadership both prioritized the research products based on their readiness for implementation and established product implementation budgets. At the program level, the IAP provided a managed approach to encouraging state and local agency interest in the products, and supported that interest with funding and direct technical assistance.

At the product level, the technical leads worked directly with the states to train, assist, and support states' implementation. In addition, the technical leads regularly shared their product implementation successes and methods with other product leads to advance product implementation within the same focus area and across the entire program.

## Everyone contributed for the benefit of all

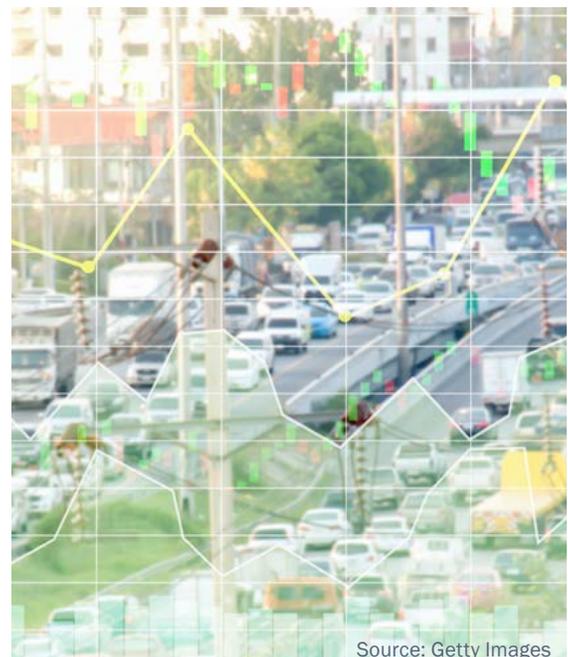
The SHRP2 IAP was funded by a unique arrangement with the states. Through an AASHTO-conducted vote in 2012, the states agreed to contribute four percent of their fiscal year 2013 and 2014 State Planning and Research dollars to the SHRP2 implementation program. This effort provided \$60 million for implementation. FHWA provided additional funding from its Technology and Innovation Deployment Program. These funds supported product deployment and made it possible for the agency to hire full-time staff for SHRP2 implementation. These combined funds ultimately went back to the states through the IAP program's financial and technical assistance, netting states a 2-to-1 return on their investment.

## Dedicated SHRP2 staff and contractors kept the focus

Staffing was a unique aspect of SHRP2's success. This was the first time a program of this size hired full-time employees who could devote all of their time to a single effort. FHWA hired employees for several roles in SHRP2 implementation, including technical leads for product deployment and focus area coordinators. FHWA and AASHTO also relied heavily on contractor assistance to augment their staffs, including subject matter experts who directly supported products.

## Results were documented and successes shared

Finally, the extensive opportunities to share program successes via product showcases, peer exchanges, and webinars led states to try using additional SHRP2 products on their own. Some of these activities are still ongoing, indicating that SHRP2 has already begun to leave a lasting legacy.



Source: Getty Images

# STATE

# SUCCESSSES



Source: Shutterstock

## Michigan



### INNOVATION AND PARTNERSHIP IN MICHIGAN

The Michigan Department of Transportation (MDOT) has been a strong supporter of SHRP2 and a willing adopter of multiple solutions since the program's inception in 2005. This is due in part to MDOT's culture, which embraces partnership and encourages staff to look at new ways of doing things, to think outside the box, and to reach out to peers at other transportation agencies to learn about their experiences with new technologies, processes, or approaches. But this culture, which is steadily expanding across the nation, hasn't always been present at MDOT or among other state transportation agencies.

"While the desire to learn from peer experiences existed in some DOTs to a limited extent before SHRP2, what SHRP2 did was explicitly share that there are really good solutions out there," said MDOT Director Kirk Steudle. Steudle has a rare historical perspective on SHRP2 and its continuing impact on how transportation agencies and practitioners view themselves and their roles. He was a member of AASHTO's Board of Directors from 2006 to 2018 and has served in several leadership roles pertaining to SHRP2, including chairman of TRB's SHRP2 Oversight Committee, chairman of AASHTO's SHRP2 Implementation Task Force, and director of a state DOT that implemented several SHRP2 Solutions.

Although some agency decision makers encouraged innovative business approaches or were open to trying successful practices other agencies had pioneered, prior

*"SHRP2 gave us better tools to build roads and bridges, but it also dove into safety and reliability – who even knew what 'reliability' was [at that time]? SHRP2 changed people's mindset."*

—Kirk Steudle, Former Director  
Michigan Department of Transportation

to SHRP2 many agencies were firmly focused on the traditional responsibilities of building and maintaining roads and bridges.

In addition to helping practitioners accept and share new techniques and learn from each other's experiences, SHRP2 became a vehicle for creating wholesale change in agencies' business practices, policies and standards, and approaches to working with external agencies and stakeholders, both public and private. This was due to the program's foundation in practical research and the deep knowledge and expertise among the partnering agencies and subject matter specialists who contributed to the program in its earliest days.

"At my first SHRP2 meeting," Steudle recalls, "I saw a number of peers and colleagues from the other states, consultants, universities, and industry. Then, as I looked at the makeup of the Technical Coordinating Committees, I saw a depth of knowledge I'd never seen before. SHRP2 was an unparalleled partnership among academia, consultants, state DOT practitioners, and of course AASHTO, FHWA, and TRB—we were all working together to resolve these issues."

For the staff at MDOT, getting involved with SHRP2 was easy because of his role on the committee, Steudle acknowledged, clarifying that he did not direct staff to use any particular products. “I left it to the experts to determine which tool could help us out, where we could best use this national expertise that was collected within SHRP2,” he said. “They quickly came back with several solutions they thought would benefit us, including the **Implementing Eco-Logical (C06)** solution.”

## **BUILDING NEW PARTNERSHIPS LEADS TO LONG-TERM IMPACTS**

In 2015, MDOT began reconstructing a 20-mile segment on Interstate 75 (I-75) along Lake Erie. This stretch is the busiest freight corridor in the state, and the project has the potential to negatively impact 40 acres of wetlands, threatened and endangered species, and water quality. For this large, complex project, MDOT would need to work closely with planning agencies, environmental resource agencies, and other stakeholders in order to complete the project.

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### **Lasting Bonds – Ongoing Partnership with First Responders Improves Safety and Mobility in Michigan**

*“The SHRP2 product that was probably the most impactful in Michigan was the National Traffic Incident Management Responder Training Program (L12/L32A/L32B). Our staff gravitated toward those workshops, and we expanded them as much as we could, including as many public agencies as we could get in the room. That training really got people excited—both our DOT staff and first responders.*”

*“From a partnership perspective, we are a lot closer than we had been with the police and other emergency response agencies. That was due to the SHRP2 program.”*

—Kirk Steudle, Former Director  
Michigan Department of Transportation

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I-75 in southeast Michigan near Lake Erie.  
Source: Michigan Department of Transportation

To ensure that the needs of all stakeholders were considered without delaying the project, MDOT used the **Implementing Eco-Logical (C06)** solution, which maps the steps needed to apply FHWA’s ecological approach to highway planning. For the I-75 project, this involved developing collaborative working relationships among the DOT and several of the state’s environmental and community agencies in order to prioritize ecological concerns within the region. Applying the methodology outlined in the nine-step Integrated Ecological Framework process, MDOT formed a technical advisory committee composed of staff from MDOT, FHWA, the Southeast Michigan Council of Governments, Michigan Natural Features Inventory, The Nature Conservancy, and other community and resource groups to review the project scope and solicit input to ensure that environmental concerns were addressed early and on an ongoing basis to ensure continuous engagement.

This extensive stakeholder outreach and partnering resulted in a conservation plan with broad-based stakeholder concurrence. The plan identified conservation priorities within the corridor as well as agreed-upon action items to address those priority concerns. The plan also led to a partnership with the Michigan Department of Natural Resources (MDNR) to transplant rare native plants to a state park and to use a state game area for wetland mitigation. In the end, MDOT saved over \$1 million in property acquisition costs for mitigation sites and developed solid relationships with environmental agencies and interest groups.

**“Without the tools from SHRP2 and the without the whole philosophy of managing those projects at a high level, we wouldn’t have been able to finish them in the time we had.”**

— Sue Datta  
MDOT I-75 Project Manager

“While the MDNR is a sister agency, we had only worked in parallel, not together,” Steudle recalls of the days prior to **Implementing Eco-Logical**. “For the I-75 project, we brought them to the table early so their issues, as well as the federal agencies’ issues, could be aired up front. What they found was that our designers were more than willing to accommodate their needs; the designers just needed to understand what those needs were,” he said.

Steudle attributes the resulting partnership with the MDNR directly to the SHRP2 **Implementing Eco-Logical** process. Since the completion of the I-75 project, this relationship has continued and even extended, leading to reviews of other wetland mitigation opportunities that may be mutually beneficial, coordination of invasive species control efforts, and improved access to MDNR geographic information system data.

“Nowadays, we work a lot more closely with MDNR,” Steudle acknowledged. This partnership has already proven valuable not just to the I-75 modernization project, but also to the more recent Interstate 94 (I-94) rehabilitation, for which the second-phase, design-build piece has just been completed. “I don’t think the I-94 project would have been as successful without the partnerships we built from our experience using the Eco-Logical solution,” Steudle said.

### Fostering a Culture of Innovation

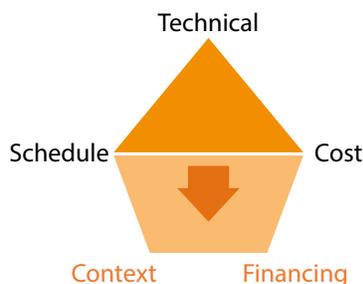
The I-94 reconstruction project is a complex, three-phase mega-project that involves completely reconstructing a seven-mile section of the interstate, widening the facility

from three lanes to four lanes in each direction—including the installation of the first-ever high occupancy vehicle lanes in the state—construction of continuous service roads along the mainline, new major interchanges, new bridges over I-94, and a new drainage system designed to hold a five-mile storage facility underground that will retain storm water to be repurposed during dry weather.

The project area is highly developed and includes two major freeway-to-freeway interchanges and eight interchanges with local streets, equating to 10 interchanges in less than seven miles. Further, more than 66 bridges cross I-94 within the project area, and a discontinuous series of service roads provide linkage to local streets.

In light of the size and many challenges associated with this large project, MDOT is using the SHRP2 **Innovative Strategies for Managing Complex Projects (R10)** solution to increase the effectiveness of its overall project management approach. The agency recognized that this large, multi-year, complex project would be far different than a typical project that a transportation agency usually undertakes, which involves schedule, cost, and technical components; a standard organizational structure; and standard development processes. Due to the many moving parts inherent in mega-projects, MDOT was looking for innovative approaches to help the project team handle these multiple overlapping activities. The project team turned to the five-dimensional project management (5DPM) approach SHRP2 developed for the R10 solution for answers.

Through a SHRP2 workshop, the MDOT I-94 project team was introduced to the concepts behind 5DPM and learned how all the components are interrelated and can influence each other. The workshop then suggested strategies, planning methods, and execution tools, which allowed the project team to identify issues and “house them together” to better address needs for stakeholders. An example includes education and communications—contextual solutions that are typically not identified for smaller projects.



*SHRP2 researchers expanded the traditional three-dimensional project management approach to one with five dimensions in order to address factors common to mega-projects, such as the need to avert major traffic disruptions and, in some cases, infrastructure failure.*

## The Benefits of the 5DPM Approach

The 5DPM approach represents an evolution in current transportation project management practices. A project management team can apply this approach to highway projects of varying sizes and types to help identify, plan, and manage projects proactively, thereby reducing the schedule and cost impacts. This approach:

- is scalable and adaptable to projects of all sizes and types—a complex project does not need to fit into the “mega” project genre to apply this approach;
- changes the context for projects from linear to dynamic by encouraging innovation and relational partnering and by emphasizing that each complex project has its own distinct set of critical success factors; and
- guides managers through a process to fully integrate teams across the entire complex-project life cycle, a practice that was determined to be a foundation for complex-project success.

Adapted from SHRP2 Solutions materials

“MDOT has seen almost immediate results from applying the SHRP2 methodology and guidance,” said Steudle. Due to a range of factors—from agency- and community-related concerns to shifting legislative priorities—the agency was under pressure to complete phase 2 of the project before 2020. The phase 2 design-build effort was anticipated to take nearly 2.5 years, said Steudle, but it was completed in less than 1.5 years.

“Had it not been for the **Complex Projects (R10)** product, I don’t know that we would have been able to deliver this \$1.5 billion project in a year and a half. It was directly because of SHRP2,” Steudle said.

### SHRP2 Safety Data and Speed

Michigan was one of 10 states that were awarded IAP grants to conduct research using the SHRP2 Naturalistic Driving Study (NDS) and Roadway Information Database (RID). The

study, entitled “The Interrelationship between Speed Limits, Geometry, and Driver Behavior,” was conducted by the University of Michigan Transportation Research Institute over three phases to examine how driver, vehicle, and roadway factors affect speed and crash risk. The integration of data from the NDS and RID allowed for a detailed examination of these issues, which was generally impractical through alternative study designs. Two specific research questions were addressed as part of Michigan’s research:

1. How does speed selection vary for a specific driver, as well as across different drivers?
2. How does the risk of traffic crash or near-crash events change with respect to speed?

Steudle remarked, “From the beginning the SHRP2 Oversight committee knew investing in the safety data was high dollar, high reward, and high risk. In Michigan, we were directed by the legislature to look at raising speed limits on some country roadways. Staff came across the



information about that NDS database when we were figuring out what to do about speed limits. None were in the database, but the database could help us evaluate what could happen in the car from a human factors perspective as part of evaluating whether the speeds should be raised or not.”

This research provided critical insights regarding the setting of maximum speed limits, the use of advisory sign location and designs, and important differences among drivers.

### A New Direction

The Michigan experience with SHRP2 over the past decade and more has contributed to and supported profound changes, not just in the way practitioners approach and execute technical tasks, but also in the way they perceive and work with other transportation agencies, other public agencies in general, and stakeholder and interest groups within the state.

“The SHRP2 products and innovations are really embedded in the agency and are now a part of the culture,” said Steudle. “We expect that this is how we’re going to work going forward. It would be harder for our staff to stop doing things the way they are doing them because this is how they think now. They think about innovations and how they can use them as opposed to just ‘get these projects done.’”



Source: Shutterstock

## Maine

### SHRP2 BRINGS IMPROVED RELATIONSHIPS AND A CULTURE OF INNOVATION TO MAINE

Having completed IAP projects for seven unique SHRP2 products -- and five of those as a Lead Adopter -- the State of Maine has seen profound improvements in the way it does business, due to the new approaches and lessons learned from its SHRP2 experience. Both technical staff and decision makers have benefitted significantly, leading to a noticeable cultural shift within the agency as a whole.

“Our experience with SHRP2 has met our expectations every single time,” said Maine Department of Transportation (MaineDOT) Chief Engineer Joyce Taylor. “In some cases, we’ve gotten even more than we expected, by far,” she added.



Source: Finn Hubbard, Jacobs

From the very beginning, MaineDOT staff wanted to get involved with the SHRP2 products. “I had staff coming and asking me if they could do this,” Taylor recalls. “Usually involvement in this kind of program comes from the top down, but our staff was excited to be a part of SHRP2,” she added, pointing to such draws as the ability to work with FHWA subject

The **Innovative Design for Bridges (R04)** product provided MaineDOT with new tools that enabled the agency to completely replace the Kittery overpass on I-95 within 20 days, improving safety and mobility for the traveling public.

matter experts and the opportunity for increased peer interactions with other states, which led to a variety of innovations throughout the agency.

For example, the SHRP2 **National Traffic Incident Management (TIM) Responder Training Program (L12/L32A/L32B)** enabled the MaineDOT staff to train and work with first responders for the first time. Maine now has five different TIM groups, including one that coordinates with New Hampshire DOT, and Maine's state police department now requires all troopers to receive TIM Responder Training.

Taylor also noted that much of SHRP2's value stemmed from the fact that the states were involved from the very beginning of SHRP2, designing the research around their biggest challenges. "That meant the topics in SHRP2 were issues we cared about – bridges, the environment, and pavements. The focus was on day-to-day work."

SHRP2 innovations in pavement renewal and longevity are of particular interest to Maine, which has had ongoing problems with pavement segregation (i.e., the separation of coarse aggregate particles in asphalt from the rest of the mass) due to the freeze-thaw cycle common in northern states. Through its adoption of the **Technologies to Enhance Quality Control on Asphalt Pavements (R06C)** and **Advanced Methods to Identify Pavement Delamination (R06D)** products, MaineDOT has embraced the use of infrared (IR) imaging and ground-penetrating radar (GPR) to measure uniformity and potential defect areas in asphalt pavements during construction, enabling on-the-fly correction that improves the quality of the pavement without extending the time needed for the work to be completed. Maine is now using IR and GPR on additional projects and has a long-term goal of requiring the use of IR on all projects by 2020.

In addition to its focus on pavements, bridges, and incident management, MaineDOT also maintains a strong focus on mitigating potential environmental impacts resulting from building and maintaining the state's transportation infrastructure. Maine is home to the only remaining native population of Atlantic salmon in the United States, making ecological concerns a top priority. With nearly half the land in the state touching waterways that are vital to salmon migration and breeding, as many as 50 maintenance and construction projects each year are subject to Section 7 of the Endangered Species Act (ESA), which requires consultation with the U.S. Fish and Wildlife Service (USFWS)



In 2015, AASHTO and FHWA facilitated an **Implementing Eco-Logical** workshop with Maine DOT, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, the National Marine Fisheries Service, and the Maine Department for Marine Resources. Source: Carolyn Washburn, Jacobs

when any action the agency carries out, funds, or authorizes may affect a listed endangered or threatened species. However, the continual flow of new research findings on the habitat needs and health of the species was causing confusion about USFWS requirements, leading to significant project delays. "The ecological review process was really delaying virtually all of our culvert and bridge projects. Our consultations were only 8 percent on time," noted Taylor, adding that the agency's relationship with the USFWS was characterized by frustration and a lack of trust.

In an attempt to improve and streamline the consultation process, MaineDOT opted to apply the **Implementing Eco-Logical (C06)** solution. The Eco-Logical approach enables agencies to achieve better environmental outcomes through a more efficient transportation planning process, which is achieved by using a step-by-step process for engaging in early collaboration and establishing joint environmental priorities for transportation projects.

Through a collaborative effort with the FHWA Resource Center and the USFWS, MaineDOT received a Programmatic Biological Opinion on the Atlantic Salmon Programmatic Biological Assessment (PBA) from USFWS. The PBA outlined the commitment of the MaineDOT, USFWS, FHWA, and the U.S. Army Corps of Engineers to jointly aid in the recovery of Atlantic salmon by responsibly implementing specific avoidance and minimization measures during

### **The Maine Experience with SHRP2 Resulted in Positive, Measurable Successes**

- **Environmental permitting document lengths, which previously ranged from 50-100 pages, are now 1 page.**
- **USFWS review periods went from an average of 26 weeks to 1 to 2 weeks.**
- **Consultations are now 100 percent on time, and with no design changes, as opposed to 8 percent previously.**

clearly identified types of activities, ranging from culvert end resets and extensions to underwater grout repair on bridges. The PBA also streamlined the Section 7 consultation process so that routine transportation projects could be executed in a timelier manner, resulting in a dramatic improvement in the effectiveness of Maine DOT's internal process for ESA consultations. The agency now anticipates that 60 percent of projects that touch on designated habitats will be approved within 30 days of submittal — a significant improvement over previous years. In addition, processes for projects that clearly meet defined impact criteria in critical habitat areas have been agreed upon and established, giving staff clear-cut guidelines for project implementation. MaineDOT has also instituted a requirement for a one-week training program with the agency's hydrologist and DOT designers to explain the agency's process; only consultants who have completed this training are permitted to work on projects in these critical habitat areas.

Taylor added that this streamlined process has also led to earlier coordination, which has helped MaineDOT select candidate projects that have a higher priority among fishery and environmental agencies. This makes it possible for the agency to budget for the most critical projects at the candidate stage and obtain the right level of funding at the right time. "Now we can prioritize at an earlier stage because we have a better understanding of what they want and need from us," she explained.

Another benefit of implementing the Eco-Logical approach and working more closely with the USFWS is that MaineDOT has significantly improved its relationships with the

relevant federal agencies. "An important change in our business practices relates to how we interact with USFWS," said Taylor. "Our relationship with them has improved due to working together on our consultations, and others have noticed. Our partners at the local level have noticed, and now they want to know how we're doing it and whether they can participate. This has strengthened our relationships with other agencies. Key partnerships now exist with the USFWS and many in the environmental community, and the agency anticipates these relationships will continue and strengthen going forward."

Looking back, Taylor believes that the SHRP2 program has been vital both to Maine and to other state transportation agencies involved in fielding these innovative solutions throughout the nation. "When it comes to our investment dollars, we got our money back and then some in terms of what we learned and the time we've saved. When you can get longer life, even a year or two, out of pavements and bridges, that's hundreds of millions of dollars saved over time. Moving bridge construction faster, getting in and getting out, that's time you save the public from disruptions. Then there's the time you save in terms of environmental reviews. Saving time is saving money," she said. "I just wish that the SHRP2 program could continue—it has a lot of value."

## Tennessee



### **SHRP2 USHERS IN NEW PERSPECTIVES AND INSTITUTIONAL CHANGE IN TENNESSEE**

Prior to SHRP2, the Tennessee Department of Transportation (TDOT), like many other state transportation agencies, was primarily focused on large construction projects. Both elected officials and TDOT management were convinced that the capital construction program was all that the department should be concerned with. With the advent of SHRP2, however, perspectives began to change. Not only did TDOT's focus on "concrete and steel" shift to a more operations-oriented perspective, the agency began to recognize that successful practices were out there and waiting to be adopted.

"SHRP2 gave us what we needed to look at the experiences other states have had and what the best practices are. We reorganized our agency to become more focused on

maintaining and operating the highway system, because that is what our customers' expectations are," said TDOT's Deputy Commissioner and Chief Engineer Paul Degges.

"Back in the day, it was 'pave it black and don't look back,'" Degges said, contrasting the old culture to the new. "We would build a facility and turn it over to maintenance, and then it was their responsibility. But we had our eyes opened," he added, pointing to a catastrophic incident on Interstate 40 outside of Lebanon, TN, in which an overturned tractor trailer closed the interstate for nearly 12 hours, trapping traffic overnight between two interchanges - including a bus filled with school children.

This event galvanized the agency to take a much closer look not only at what had occurred, but how such operational crises could be handled by the DOT and emergency responders more quickly and effectively in the future.

"To quote the adage, 'Change occurs when the pain of the status quo outweighs the pain of change.' This incident was painful for us, and it showed us that we had

a lack of communication between our DOT resources and the highway patrol. So, we sat down with the Department of Safety and developed a memorandum of understanding with our Highway Safety Patrol that talks about how we're going to work together. That's when we started looking at what we can do to be better organized," said Degges.

This need to improve the agency's response to incidents was an early step in its quest to meet the growing need to include transportation systems management and operations activities into its day-to-day business functions. TDOT turned to the SHRP2 **Organizing for Reliability Tools (L06/L01/L31/L34)** to assist and guide both management and staff in completely restructuring the organization—a step that was required to achieve the goal of more responsive and effective transportation operations.

As early as 2009, Tennessee began participating in an FHWA-sponsored pilot study of the Capability Maturity Model to assess the agency's systems operation and management capabilities. This program ultimately folded into the SHRP2 **Organizing for Reliability Tools** offering in Round 1 of the SHRP2 IAP. "We saw an opportunity to use



TIM Training Facility  
Source: National Operations Center of Excellence

the IAP and SHRP2's Reliability products to jump start what we were already trying to do," Degges explained.

This led to the development of an action plan that created a completely new Traffic Operations Division within the DOT. Formed in January 2013, the division comprises:

- The Traffic Management Office, which combines the Traffic Incident Management Program and the Transportation Management Center Program.
- The Intelligent Transportation Systems Design Office, which focuses on developing and deploying intelligent transportation systems tools.
- The Headquarters Traffic Engineering Office, which includes four regional traffic operations centers and is responsible for traffic signals operation and design, as well as adding new safety products and conducting simulations and modeling activities.

"As the result of the work we've done with SHRP2, we've reorganized our agency and created a traffic operations division that examines how we deal with incidents on our system, with the goal of streamlining our response to issues and keeping traffic lanes open. Every day in Tennessee, an 18-wheeler rolls over and blocks the road, with significant impact to our transportation system. SHRP2 has helped us evaluate how we're organized and how to be proactive in planning our response. How we operate is a critical issue that our customers are asking us to look at," Degges said.

"Being organized for operations allows us to effectively communicate to the media regarding what we're doing and why so that the word gets out to our customers," he added. "We get a lot of requests from communities for more operations solutions to problems. We're at the point to where not only are they accustomed to it, they have high expectations that we can get incidents cleared and roads opened quickly."

TDOT is also using the **Reliability Data and Analysis Tools (L02/L05/L07/L08/C11)** to develop performance tools that will monitor the system and help the agency address the National Performance Management Measures to Assess Performance of the National Highway System, otherwise known as Map-21 PM3. The agency has developed an automated tool and is even working with the University of Tennessee at Knoxville to develop an



On October 30, 2014, the Tennessee Department of Safety and Homeland Security and the Tennessee Department of Transportation celebrated the opening of the Tennessee Traffic Incident Management Training Facility.

Source: Tennessee Department of Transportation

"Automated Data Performance Visualization Tool," which it plans to use to monitor the performance of the High Occupancy Vehicle system.

In terms of better managing traffic incidents, which was what prompted the agency to consider SHRP2 in the first place, TDOT has worked hard to collaborate with the State Highway Patrol and other responder agencies. Under state law in Tennessee, volunteer fire departments have control of the incident scene on an interstate, and historically, they often opted to close the road to clear the incident. The **National Traffic Incident Management (TIM) Responder Training Program (L12/L32A/L32B)** changed all that.

"The partnerships we've developed with the emergency responder community through the TIM training have been some of the most important outcomes of our work with SHRP2," said Degges. "One of the big things we saw was that when we pulled the emergency response community in and asked them to take this training, we started seeing real improvements in safety, and it got people excited. It got our highway patrol and local police departments really interested in how we can come in and make it safer for not only the motorists but for the responders out on the highway."

As a result of TDOT's experience with the SHRP2 TIM Solution, the agency constructed a Traffic Incident Management Training Facility, the first of its kind in the

nation, which is used to train all types of emergency responders. The agency has also worked with the emergency response community to develop an Advanced TIM Training Curriculum that includes hands-on modules to help train incident responders in how to safely manage and clear an incident. As a result, 98 percent of incidents are cleared in 90 minutes or less, secondary incidents have been reduced by approximately 40 percent, and the agency has adopted an innovative “Protect the Queue” Program, which positions work vehicles with warning lights and message boards on the road in advance of the queue to warn drivers about slow-moving traffic due to incidents or work zones.



### Improving the Basics – Installing Longer Lasting Pavements

While TDOT has successfully expanded its focus on transportation systems operations and management with its new Traffic Operations Division, the agency has not forgotten that it still needs to maintain its existing roadways, and the SHRP2 products that help agencies increase the lifespan of assets remains important as the national infrastructure ages.

TDOT is one of many agencies interested in extending the life of high-traffic roadways and was a lead adopter of the **New Composite Pavement Systems (R21)** product, which is focused on the design and construction of sustainable, renewable composite pavements using either a hot-mix asphalt (HMA) or Portland cement concrete (PCC) wearing course over a structural concrete layer (i.e., HMA/PCC or PCC/PCC) to achieve longer life. Tennessee wanted to explore the viability of constructing a more cost-competitive concrete pavement and move towards the use of more high-quality aggregates in response to a change to the state's specifications. That the R21 method has proven itself able to be constructed rapidly and rehabilitated with minimal disruption to the traveling public was an added benefit. After completing post-application testing and field reviews, TDOT found that the application met or exceeded all test criteria, and contractors are now permitted to use this method in addition to standard approved application techniques.

To streamline construction materials testing for quality assurance, TDOT is also implementing the **Techniques to Fingerprint Construction Materials (R06B)** solution, which is advancing adoption of technologies to verify the quality of construction materials in the field before they

are installed at project sites. TDOT is using X-Ray Fluorescence Spectroscopy—a nondestructive tool for determining the presence and concentration of chemical elements in a material—to evaluate thermoplastics, glass beads, and aggregates both in labs and in the field. This technology has been extremely beneficial, replacing hours-long tests with tests that only take a few minutes and can be performed on site, saving time, money, and ensuring that the materials meet quality standards before they are used to construct or renew roadways.

### Constructing the Future in Tennessee

Although SHRP2 has had a significant impact on TDOT, contributing to a restructured internal organization that is better geared to meet the operational needs of travelers, Degges reiterated the overarching value of the products that have been developed through SHRP2. However, an equal—or perhaps greater—value has come from watching other states adopt innovations and share their implementation lessons.

“The support that we get through FHWA and working with TRB and AASHTO gives us high-quality products to help us better do our jobs,” he said, “but the big advantage is that, even though we can’t participate in each of the SHRP2 product implementations, we get a benefit from all the other states that do. We have a lot of colleagues in other agencies, and when we hear folks talk about their successes with a SHRP2 project, we’ll pick those up and use them.”

One example of this is the **Nondestructive Testing for Bridge Decks (R06A)** product. After hearing about the successes of the IAP states, TDOT purchased a handheld ground-penetrating radar device to verify the quality of a new concrete bridge deck and the precast elements the agency is constructing. The agency is also looking at the **Precast Concrete Pavement (R05)** product for use in some areas where the pavement is nearing 20 years old and may require extensive renovation. TDOT is hoping this solution will reduce the need for long-duration work zones.

Degges further explained that if each individual state had to figure out how to develop all the SHRP2 products by itself, the states would spend much more money on research and would likely waste money on assets that were not as long lived, high quality, or safe. “I think if you talk to most DOTs, they will tell you that SHRP2 has been a bargain from the financial perspective,” Degges said. “Collectively, states spend about \$60 billion in state and local dollars per year just in highway programs, not to

mention transit, aviation, rail, etc., so in the scheme of things, our contributions to research and implementation of the SHRP2 products is a relatively small amount of money, and the return on that investment is manifold.”



## California

### INNOVATIVE RENEWAL TECHNOLOGIES OPEN NEW PARTNERING OPPORTUNITIES AT CALTRANS

California is the third largest state in the Union by land area and is host to more than 15,000 miles of public roads. Within this large state are many diverse stakeholder groups, public agencies, and

environmental considerations that factor into project planning, design, and implementation. As such, the agency faces two important challenges: 1) ensuring that the interests and needs of these stakeholders are identified and taken into account during project identification and implementation, and 2) making sure that the California Department of Transportation (Caltrans) is able to carry out its infrastructure construction, operation, and maintenance responsibilities as efficiently and effectively as possible in order to meet the public’s need for a robust transportation system.

With these dual factors in mind, Caltrans turned to a variety of SHRP2 Solutions in search of cost-effective solutions that would result in improved safety and mobility outcomes.

### New Approaches to Bridge Construction Mitigate Environmental Impacts, Win Stakeholder Approval

In 2014, Caltrans formed a multi-disciplinary, accelerated bridge construction (ABC) team in the agency to examine new technologies, starting with those endorsed by the SHRP2, Every Day Counts (EDC), and Highways for Life programs. The team used these initiatives to address the agency’s immediate bridge project needs, particularly the EDC initiative on slide-in bridge construction and prefabricated bridge systems and elements, which are also part of SHRP2’s **Innovative Bridge Designs for Rapid Renewal (R04)** toolkit. The team focused mainly on the



Caltrans used *Innovative Bridge Designs for Rapid Renewal (R04)* in the renewal of the Fort Goff Creek Bridge.

Source: Accelerated Bridge Construction Center at Florida International University

prefabricated bridge element system and precast abutment elements.

Caltrans, with FHWA assistance, installed precast concrete abutments during the replacement of the Fort Goff Creek Bridge along the SR-95 corridor in Siskiyou County, located in northern California. This product consists of:

- A design toolkit to assist state and local jurisdictions in developing accelerated bridge construction techniques and approaches.
- Standardized approaches to streamline the activities required to design, fabricate, and rapidly construct bridge replacement systems. Rapid replacement is desirable because it both minimizes safety risks to travelers and contractors and reduces environmental disruptions.
- Standard design plans for foundation systems, substructure and superstructure systems, subsystems, and components.
- Design detail standards and design examples for complete prefabricated bridge systems.

The Fort Goff Creek Bridge renewal was a streambed restoration project. This bridge had originally been installed as a 15-ft-wide corrugated metal culvert below Route 96, creating a barrier to salmon and steelhead migration into upstream breeding areas. Because California state law requires remediation of such locations to restore fish habitats, this location was a top priority project for Caltrans.



Fort Goff Creek Bridge – placement of 85-kip abutment segments  
Source: Accelerated Bridge Construction Center at Florida International University

Due to the environmentally sensitive nature of the area, the project focused on replacing the culvert with a single-span bridge. The goals of the project were to restore fish passage, complete single-season construction, reduce environmental impacts, use quality concrete, minimize traffic disruptions, and ensure that the interests and concerns of a variety of local and environmental stakeholders were addressed.

Caltrans considered the pre-fabricated aspects of the Accelerated Bridge Construction (ABC) method to be the best approach for this project, because it would reduce construction time and allow work to be scheduled around crucial times for plant growth and animal activities. It eliminates the need for falsework, which keeps construction activities out of the waterway, and it enables many construction activities to be conducted offsite, lessening environmental impacts and reducing the need for wetland mitigation. The ABC option also offered another advantage: Since the bridge site was in a severe climate area characterized by frequent freeze-thaw cycles, there were concerns about the quality and

durability of cast-in-place concrete. As a result, the prefabricated ABC implementation was estimated to be the most cost effective.

Other benefits learned from the implementation include the development of a suite of standard, single-span pre-cast bridge designs that Caltrans plans to use in other fish passage remediation projects throughout the state. In addition, since the Fort Goff Creek Bridge was completed in 2014, Caltrans has pursued ABC construction on a larger scale by institutionalizing the approach laid out in the SHRP2 R04 toolkit.

Caltrans suggested that, going forward in partnership with their contractors, the R04 solution could help agencies establish new expectations for the length of construction projects, potentially shortening standard timelines and leading to greater mobility and safer conditions for drivers.

### **Institutionalizing Innovative Subsurface Engineering Technologies Brings New Intra-Agency Partnerships to Caltrans**



Fort Goff Creek Bridge – stream bed restoration project  
Source: Accelerated Bridge Construction Center at Florida International University

As one of the few agencies in the country with a geophysics and geology branch, Caltrans has a long history of working with innovative technologies related to subsurface engineering that improve the durability of the state's infrastructure. In fact, Caltrans has more than 15 years of experience in the use of ground penetrating radar (GPR), which is useful for investigating very shallow features, such as underground utilities and pipelines, pavements, rebar, and detecting voids in concrete.

“Since we had been working in these avenues for quite some time, we had an idea of how well the methods would work,” said Bill Owen, chief of the Geophysics and Geology Branch at Caltrans. “When we saw the SHRP2 products coming out, they fit in with some work we’d already been doing, so it created an avenue to bring those technologies in-house and start rolling them out more broadly in the state,” he added.

Prior to 2016, Caltrans had evaluated multi-channel GPR (MCGPR) applications under the SHRP2 Solution, **Utility Investigation Technologies (R01B)** solutions for

subsurface utilities. The agency had also investigated the performance of the technology in bridge deck investigations and tunnel lining inspection. Recognizing that MCGPR has cross-application potential for utility locating as well as health monitoring for bridge decks and tunnel linings, Caltrans proposed to leverage funding for the R06D IAP with implementation funding other SHRP2 products, **Nondestructive Testing for Concrete Bridge Decks (R06A)**, **Nondestructive Testing for Tunnel Linings (R06G)**, and **Utility Investigation Technologies (R01B)**. By pooling its funding, Caltrans was able to purchase a GPR device and pursue its goal of institutionalizing these new technologies and using them for project work on a daily basis.

“Caltrans’ goal is to integrate these technologies so that they are used on a daily basis for active projects. We’ve been focusing on GPR because that’s the technology that has required the most effort to roll out,” Owen said, noting that the process of working with SHRP2 has also brought about an internal cultural shift. The need to communicate and coordinate with other internal divisions highlighted gaps in

information sharing processes that staff had not been aware of previously. As a result, not only did the process of working with SHRP2 products result in identification of these communications challenges, it also enabled staff to identify collaborative means for overcoming them.

“This [involvement with SHRP2] has made us rethink how different groups should interact and got us talking more so we are not working at cross-purposes. It’s helped us to recognize we have common goals. Once that recognition kicked in—an understanding that we are augmenting our capabilities and enhancing our ability to deliver information to the people who need it most—it changed the tone,” Owen explained, adding that the agency’s organizational structure has become more flexible. It is now common for ad hoc working groups to form in response to different needs. “Using the SHRP2 program has created the ability for us to do more collaborative work with our geotechnical services, and testing labs, and by tapping into different groups and utilizing our resources more effectively.”

### **A Positive SHRP2 Experience Sets the Stage for a More Successful Future**

Michael Kever, chief of the Division of Engineering Services at Caltrans, agreed that the agency’s experience with SHRP2 products has had a positive impact on the agency’s daily practices. “Implementing a range of SHRP2 products—from the **Non-destructive Testing Toolbox (R06)** to the **Utility Bundle (R01A, R01B, R15B)** to the **Innovative Bridge Designs for Rapid Renewal (R04)**, among others—has given Caltrans the opportunity to improve our existing business practices. We have integrated geophysical services for utility location into project design, and our acquisition of impact-echo and thermal imaging testing technologies will allow us to begin incorporating geophysical testing as a routine component

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*“I think probably the biggest benefit of working with SHRP2 was that it opened up our eyes. It’s allowed our internal organizations to think beyond their own structure and made us look around to see what other groups we can collaborate with. This wasn’t a primary goal for getting involved with SHRP2, but it was an unexpected benefit.”*

— Bill Owen  
Chief, Geophysics and Geology, Caltrans

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for bridge deck and tunnel inspection,” he said.

The SHRP2 experience has also enhanced the agency’s relationship with the other states that have been awarded Round 7 IAP assistance.

“We have developed new relationships with other implementing states due to our SHRP2 experience,” Owen said. “We knew other states were working with these technologies, but we never really talked to them about it. SHRP2 let us physically get face-to-face with other people at the implementation workshops to talk about our experiences. This is part of what SHRP2 has enabled us to do that we weren’t necessarily able to do before. We were able to get together with colleagues in other states and talk about the kinds of details that come up during the course of an in-person conversation. Right now, our interactions with other implementing states are informal, but we’ve maintained contact, and we are continuing to discuss our experiences and share information and lessons learned.”

## **ONE TECHNOLOGY, MANY USES**

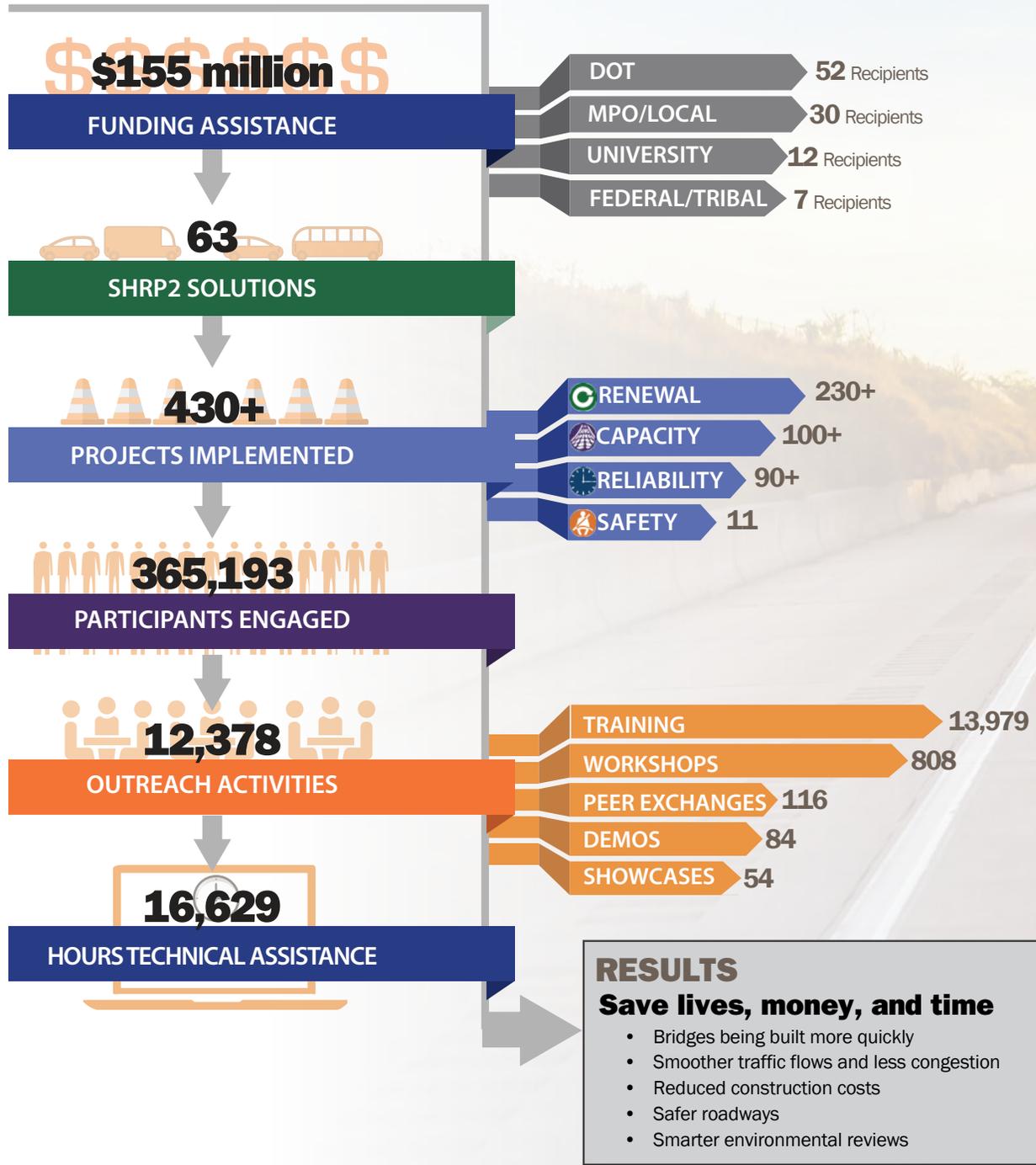
### **Caltrans has spent several years exploring the different uses of ground-penetrating radar.**

“We quickly found that [GPR] has some very good applications,” noted Owen. “One is for the state’s recycled-in-place-program, where the GPR technology has been helpful in providing volume estimates to assist Caltrans in assessing the amount of pavement available for re-use on roads that needs to be repaved. Accurately estimating the total volume of the available material that can be recycled helps the agency plan for how much new material will be needed as well as cut down on materials-related project costs.”



# SHRP2 by the Numbers

From Research into Practice: SHRP2's Implementation Progress





Source: Getty Images

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## THE SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

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