SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 18
Fall/Winter
2011

HIGHWAY SYSTEMS
RELIABILITY
TRANSIT
TRANSPORTATION SAFETY

Ignition

News from TRB's IDEA Programs

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TRB
TRANSPORTATION RESEARCH BOARD
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THE IDEA PROGRAMS

Innovations Deserving Exploratory Analysis

IDEA programs provide start-up funding for promising but unproven innovations in surface transportation systems. The programs' goal is to foster ingenious solutions that are unlikely to be funded through traditional programs.

Managed by the Transportation Research Board, IDEA programs are supported by the member state departments of transportation of the American Association of State Highway and Transportation Officials (AASHTO), the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), and the Federal Motor Carrier Safety Administration (FMCSA).

The Transit IDEA program, which receives funding from FTA as part of the Transit Cooperative Research Program, is guided by a panel chaired by Fred Gilliam, President, Gilliam and Associates, Austin, Texas. Harvey Berlin is the TRB program officer.

The NCHRP Highway IDEA program is supported by the member state departments of transportation of AASHTO through the National Cooperative Highway Research Program (NCHRP). It is guided by a panel chaired by Sandra Q. Larson, Director of Research and Technology, Iowa State DOT. Inam Jawed is the TRB program officer.

Safety IDEA is jointly funded by FMCSA and FRA. The committee is chaired by Bob Gallamore, a consultant. The program focuses on innovations to improve railroad inter-city bus, and truck safety. Harvey Berlin is the TRB program officer.

Reliability IDEA is funded throught the second Strategic Highway Research Program to encourage innovation in techniques and tools to reduce congestion and delay caused by unexpected events. The program's goal is to improve travel time reliability. The committee is chaired by Leslie Spenser Fowler, ITS Program Manager for Kansas Department of Transportation. Inam Jawed is the TRB program officer. This program is no longer accepting proposals. It will discontinue after the active projects are completed.

Visit the IDEA Web site:
www.TRB.org/IDEA

On the Cover: A traffic signal that has been equipped with a signal head vibration absorber. This device can reduce fatigue in cantilevered traffic signal support structures. Story on page 4.

Photo courtesy of Richard Christenson

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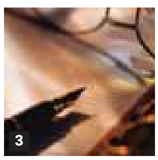
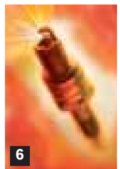




From the **Editor's** Desk

Risk at The Right Time

Oh, go ahead—take a chance!

In my experience, if this advice is given by a six-year-old to his four-year-old brother, bad things will follow. But where would we be if no one took risks? No astronauts, no deep-sea divers, no maps of the coral reefs or mountain ranges. Risk at the right time can propel innovation, boost the state of the art, and provide important benefits to many people. Our feature article describes a most useful example.

The article follows two IDEA projects as they negotiate the rigorous process of testing and vetting required before any new method or material can be included in the AASHTO standards of practice. Accomplishing this feat provides coveted credibility for new products and reduces the risk for transportation professionals who want to incorporate innovation into their practice. Reasonable risk taken early by the IDEA programs to support an unproven concept pays off for everyone when transportation agencies can advance their practice with assurance.

Some risks, however, should be limited. Be Safe, DRIVE-SMART explores a device that can reduce the impact of the primary risk factors that cause highway crashes. In Not-So-Good Vibrations, investigators developed a tool that can reduce fatigue in cantilevered traffic support structures. Helping Small Transit Agencies Reach the Mobile Market describes an application that gives small transit agencies the opportunity to make their transit information accessible from smart phones, laptops, and other mobile devices.

In the business section, we receive an update on the ultraviolet germicidal irradiation system that was developed in Transit IDEA project 53. Houston Metro took a chance by testing and evaluating the system, and it paid off. The system was proven to reduce costs, and several more transit agencies have since adopted the technology.

Linda Mason
Communications Officer
Transportation Research Board of the National Academies

Recently Released Reports from the NCHRP IDEA Program

NCHRP-129: Developing Embedded Wireless Strain/Stress/Temperature Sensor Platform for Highway Applications (Louisiana State University; Author: Kun Lian)
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2436

NCHRP-141: Reducing Fatigue in Wind-Excited Traffic Signal Support Structures using Smart Damping Technologies (University of Connecticut; Author: Richard Christenson)
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2701

NCHRP-148: Cleaning Device to Remove Debris and Chemicals for Crack/Joint Sealing (University of Nebraska- Lincoln; Author: Yong K. Cho)
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2857

Your comments are welcome and may be sent to the editor at **lmason@nas.edu**

High-Risk Investments Yield *Low-Risk* Innovations for Transportation Agencies

Transportation agencies rely on innovations to advance their practices and improve the materials and methods available for the work at hand. While new products enter the market all the time, agencies need a reliable way to distinguish what works from what doesn't. That is why professional organizations, such as the American Association of State Highway and Transportation Officials (AASHTO), issue standard specifications. Because of the rigorous acceptance process, standards reduce the risk of trying something new.

In an interesting twist, two products of the deliberately high-risk IDEA programs have recently made the transition from an IDEA project's typical beginning as unproven but promising concept to acceptance as standard specifications. This is the story of how two NCHRP IDEA projects—the Automated Computer Controlled Image Analysis Systems (AIMS) and the Asphalt Binder Cracking Device (ABCD)—came to be included in AASHTO's *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* (Materials Book).

AASHTO Standards

All products listed in AASHTO's Materials Book meet a certain level of quality and consistency. The Materials Book, which is updated every year, includes only standards and specifications that are approved by AASHTO's committees of experts. The vetting practice gives practitioners a reason to trust these products. "AASHTO material specifications are an easy place for the engineering community to go to be sure that materials and products meet a baseline set of criteria for proper use. The specifications provide a standard method for determining if a product meets the needs of the agency" states Jim McDonnell, Program Director for Engineering at AASHTO.

Along with the assurance of the product comes a level of exposure that it may not have received otherwise. "It's a big deal to become an AASHTO standard," says Keith Platte, Associate Program Director for Project Delivery at AASHTO, "because the product then gets exposure to the entire transportation community." Moreover, state departments of transportation (DOTs) become actively involved with the materials and products that are in AASHTO standards. "When a proposed specification becomes an AASHTO standard, the state DOTs are charged with maintaining it to ensure that the standard stays up-to-date. Thus, it gets more attention from the members who maintain the document. A product only becomes a standard when AASHTO's members have thoroughly reviewed it and decide to include it in the Materials Book. The members believe the products have value and are important."

The Products

The AIMS technique is used to characterize the shape properties of aggregates used in asphalt pavements. To do this, AIMS captures digital images of aggregate samples and analyzes the images to determine the shape characteristics of the material. These characteristics can then be used to classify the aggregates. The shape characteristics of aggregates used in asphalt mix, portland cement concrete, and unbound aggregate pavement layers are known to affect the structural integrity and durability of pavement as well as its skid resistance. The AIMS technique is rapid, convenient, accurate, and free from operator's influence and bias as compared to other methods that can be tedious, time-consuming, and often result in inconsistencies in measurements.

The ABCD simulates cracking in the field as it monitors thermal stress induced by a lowering of temperature in an asphalt specimen molded onto an Invar ring. ABCD is a laboratory test that is more practical and meaningful than other industry standard specifications. Low-temperature thermal cracking is a major type of asphalt pavement failure requiring state departments of transportation to allocate significant financial resources to fix cracked pavements. The ABCD directly reads cracking temperature without elaborate assumptions and calculations and allows simultaneous testing of multiple specimens, saving time and money.

Developing AIMS

Dr. Eyad Masad, who was a professor at Washington State University at the time, first brought AIMS to the IDEA programs as a proof-of-concept project in NCHRP IDEA Project 77. In this project, the hardware and software were developed and integrated to produce a prototype. The prototype was tested on a range of fine and coarse aggregates. It was able to provide detailed information on shape properties of aggregates in a relatively short time, and the shape measurements showed a good correlation with the resistance of asphalt mixes to permanent deformation measured in the laboratory using different wheel tracking devices.

After project 77, Pine Instrument Company obtained the technology from Dr. Masad. Pine constructed several AIMS systems that were used by various organizations that were investigating the relationship of aggregate shape properties to pavement structural and frictional performance, including objectively quantifying aggregate degradation. The purpose of these investigations was to further refine the technique. "The positive results showed the technology had promise in several areas of aggregate shape property characterization," according to Roger Pyle of Pine Instruments Company. "Some refinements of the analysis software were done but the equipment remained essentially unchanged."

AIMS

Dr. Masad then brought AIMS back to the IDEA programs in NCRHP IDEA Project 114, which supported further refinement.

AIMS was used in a new method to measure the aggregate texture of asphalt and its relationship to pavement skid resistance. The Micro-Deval test was used to polish aggregates and AIMS was used to quantify the change in texture due to polishing. The AIMS texture analysis was proven to rapidly and accurately quantify the influence that polishing has on texture.

"user-friendly and more convenient"

Because of the achievements made in the IDEA projects, Pine Instrument Company submitted a proposal to the Federal Highway Administration's (FHWA's) Highways for Life (HfL) program for the development of refined equipment that would encompass an implementation-ready system. In the HfL project, Pine partnered with Texas A&M University and the Texas DOT, as they had been using the research-grade equipment for investigating aggregate properties and were interested in improving the technology.

Several organizations now use the refined system to study aggregate shape performances. AIMS went through many changes since it first came to the IDEA programs. Pyle elaborated: "Today's investigations are still related to pavement structural and frictional performance. However, the frictional performance information, which can be obtained by using the AIMS2 system in conjunction with aggregate degradation tests, is generating renewed interest in the system in agencies wishing to understand an aggregate source's ability to retain skid resistance properties over a pavement's design life. Texas Transportation Institute in conjunction with Texas A&M University and the Texas DOT has recently developed a skid resistance predictive model utilizing inputs from the AIMS2 system as well as other pavement design parameters. Objective characterization of aggregate shape properties continues to be of interest. Research with the AIMS2 system and the application of the information it provides for current and forthcoming applications continues—such as pavement frictional properties, warm-mix asphalt applications, and recycled pavement material characterizations."

Developing ABCD

The ABCD was, similarly, brought to the IDEA programs as a high-risk proof-of-concept project by a college professor, Dr. Sang-Soo Kim of Ohio University. In this project a prototype of the ABCD was developed to determine the thermal cracking temperatures of asphalt binders. In the initial experiments, cracking temperatures were determined by using ABCD with aluminum molds and rings. The results were not accurate enough, so the specimen geometry was changed by using silicone molds and invar rings. This setup produced more accurate and repeatable results. By the end of the project, the ABCD included a ring with a biaxial strain gauge, a temperature sensor, and a Ni-chrome spot-welded connector bracket. The test results convinced the project advisory panel that this device had potential.

ABCD

As with AIMS, the ABCD went to FHWA's HfL program after the IDEA project, but this required some guidance from Dr. Inam Jawed, Program Officer for the NCHRP IDEA Program. "When Dr. Jawed first mentioned the Highways for Life program to me," Dr. Kim said, "I didn't know about it. I had never even heard of the program before. But because of Dr. Jawed, I read their guidelines and thought that it fit well. I submitted a proposal. Fortunately, it was selected. The program gave me an opportunity to make a lot of refinements to make it user-friendly and more convenient."

And after the HfL project, the ABCD still had to be developed further, but the FHWA continued to play an active role. "The units were sent to different parts of the country," according to Dr. Kim, "mostly FHWA labs. Because of this, I received quite a few inquiries from parties interested in purchasing the equipment for research use."

New Standards

Thanks to the IDEA programs and FHWA's HfL program, AASHTO provisional standards based on AIMS and the ABCD were included in AASHTO's Materials Book. Though important, a provisional standard is a little different from other AASHTO standards. "A provisional standard is a new standard which may need to be modified based on the experiences of and feedback from the initial implementers before it becomes a full standard," said Mr. Platte. "It's a way for DOTs to evaluate new materials, knowing that the specifications may change in the next two to three years. Provisional standards give newly developed products and materials national exposure, so people who want to try something new can try it."

AIMS actually had two provisional standards that were first published in 2010—test method TP81: *Standard Method of Test for Determining Aggregate Shape Properties by Means of Digital Image Analysis* and practice specification PP64: *Standard Practice for Determining Aggregate Source Shape Values from Digital Image Shape Properties.* TP81 is a procedure for collecting the data, and PP64 is a procedure for calculating source properties from the data.

Pine Instruments' Roger Pyles believes that HfL played an integral role in getting AIMS included in the Materials Book: "The development of the standards was at the heart of the HfL project from its initiation. It was recognized that for the technology to be utilized effectively, standard specifications would be required. Phase I of the HfL project refined the equipment and developed draft documents outlining the test procedures. . . . Phase II was an Inter-Laboratory Study (ILS) designed to evaluate the precision (repeatability and reproducibility) of the test method. . . . At the completion of the HfL work, the procedures were submitted to the AASHTO Subcommittee on Materials for consideration. The AASHTO Subcommittee accepted the procedures with some minor changes and published them as provisional specifications in 2010. The ILS provided the data used to establish the precision statement included in the specifications."

The ABCD, meanwhile, was added to AASHTO's Materials Book in 2011, with the inclusion of provisional standard TP92: *Determining the Crack Temperature of Asphalt Binder Using the Asphalt Binder Cracking Device ABCD.* FHWA and the IDEA project advisory panel for ABCD both suggested that Dr. Kim apply to have ABCD become an AASHTO standard. In field tests, ABCD cracking temperatures correlated consistently better with the crack severities of test pavements than existing standards, and it was found to be more accurate than the current Bending Beam Rheometer (BBR) test. It may even replace the BBR test one day.

Risks

When an innovation shows promise, such as ABCD or AIMS, a graduated process of acceptance lets transportation agencies know that it is safe to try these provisional standards; and, based on their experience, the products can become full standards and be implemented as standard practices. For innovators, that acceptance helps bridge the gap between concept and commercialization. For the agencies that support the IDEA programs as a way to encourage innovative advances in delivering transportation services, it's a nice pay-off from a high-risk investment.

Not-So-Good Vibrations

We have all seen cantilevered traffic signal support structures blowing in the wind. These structures comprise 62 percent of all traffic signal support structures because they are less expensive and safer than most other support structures. However, they are flexible and very susceptible to wind-induced vibrations, which can cause damage. In NCHRP IDEA project 141, Richard Christenson of the University of Connecticut is developing an innovative signal head vibration absorber (SHVA) to reduce fatigue in cantilevered traffic signal support structures that experience excessive wind-induced vibration.

Designed as a low-cost, low-technology solution to a widespread problem, the SHVA is a modified signal head that acts as a tuned mass damper. It incorporates a reliable and robust spring and damper inside the signal housing to allow the signal head to move vertically relative to the mast arm. Other dampers have been tested for cantilevered traffic signal support structures, but they each have their own pitfalls. Most achieve a low critical damping ratio below 2 percent. Some have a critical damping ratio between 6 and 8 percent, but these are costly, require separate tuning, and add additional weight to the end of traffic signal support structures. Laboratory tests on a prototype SHVA achieved a critical damping ratio of 10.1 percent. This corresponds to a reduction in the steady state vibration by more than a factor of 50—from displacements of 10 inches, for example, to less than 0.2 inches. Additionally, the SHVA tuned to a specific structure can be applied to a wide range of other signal support structures. Current research is testing a new SHVA unit that locates the spring and damper outside of the signal head and requires no modification to the signal head itself. The laboratory testing at the University of Connecticut of two signal support structures 35 feet and 55 feet long is now ready to be supplemented by field tests. Future research will focus on testing the SHVA on traffic signal support structures in the field; state and federal funds are being sought to support this next phase. Additionally, signal structures exhibiting frequent wind-induced vibration are needed for testing.

Reducing the wind-induced vibrations of traffic signal support structures can reduce fatigue and increase service life, so signal owners may save money by spending less on repairing and replacing fatigued structures. The SHVA serves as an effective vibration mitigation device that allows for new traffic support structures to be designed in the AASHTO code without fatigue design for galloping or truck-induced wind excitation, thus resulting in lighter, less expensive structures. The SHVA also enables existing signal structures that need improvements, such as additional lights or signs, to meet current codes, thereby reducing project costs. The Connecticut Technology Transfer Center is working with Vibration Mitigation Technologies Inc. to help disseminate the SHVA when it is ready for market.

Contact: Richard Christenson, rchriste@engr.uconn.edu

Be Safe, DRIVE-SMART

The National Highway Traffic Safety Administration estimates that there were almost 11 million vehicle crashes in the US in 2010. Most of them involved at least one of five primary risk factors: alcohol impairment, failure to use safety belts, driver drowsiness, aggressive driving, and driver distraction. A system to reduce the impact of those five factors is the focus of Safety IDEA project 18.

The research team is developing a crash-risk mitigation system, DRIVE-SMART, that combines cameras, sensors, machine vision technology, and data from the vehicle's internal network to reliably calculate risk levels and provide real-time warnings. The system is being designed to be relatively inexpensive, unobtrusive, easily connected, and most importantly, not subject to false alarms.

Systems currently available to warn drivers of crash risk most often rely on one sensor to measure risk indicators, which often results in unreliable assessments and false alarms. Drivers may ignore or disable the available systems because they can become distractions in themselves.

In the DRIVE-SMART system, cameras, sensors, all electronics, and audio and visual driver notification systems would be integrated into a single, small unit mounted on the windshield or dash area so that views of the forward roadway and the driver's face are available. The size of the unit depends on whether it is configured to continuously record data or to collect epoch-based data that can be stored on a memory card; in that case, the unit would be only slightly larger than a deck of cards.

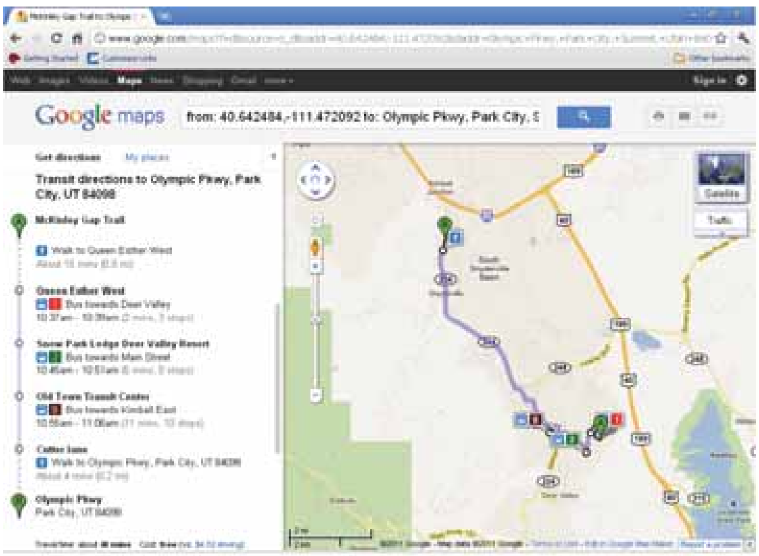
The project includes two stages: hardware and software development, and system implementation and testing.

Principal Investigator is Thomas A. Dingus, PhD, Virginia Polytechnic Institute and State University. Contact: tdingus@vt.edu

Photo courtesy of Ed Brown

Helping Small Transit Agencies Reach the Mobile Market

With the Google Transit tool, transit users can access online transit information from their smart phones, laptops, and other mobile devices. Because of this, Google Transit Feed Specifications (GTFS) formatted data became one of the most widely used formats for public transportation geographic and schedule data in the world. Many transit agencies use GTFS, Google Transit, and online transit trip itinerary planners that integrate with Google Maps. However, because significant resources are required to create and maintain transit data in the GTFS format, many small transit agencies have previously not been able to enter and publish the agency's transit information through the Google Transit process. That capability has generally only been available to large- or medium-sized transit agencies.



Example of a Google Transit result for Park City Transit Municipal Corporation

To help transit agencies with limited resources and limited technical expertise build GTFS data from the agency's transit information, the project team in Transit IDEA project 58 created the Transit Data Feeder (TDF) application. TDF gives small transit agencies the opportunity to use the Google Transit online trip planner with Google Maps as well as other online transit scheduling applications. TDF is available in two alternative configurations: (1) a hosted configuration, which minimizes the equipment requirements for the transit agency to a personal computer with internet access; and (2) a local web application, which allows an agency to load TDF into its production environment. TDF includes two components: (1) a database to store and access geographic and schedule data; and (2) Java software to create, manipulate, and export geographic and schedule data in a web-based interface.

Pilot tests were conducted by four small transit agencies: Park City Municipal Corporation in Park City, Utah; Southern Ute Community Action Programs in Ignacio, Colorado; Chatham Area Transit in Savannah, Georgia; and Santee Wateree Regional Transportation Authority in Sumter, South Carolina. The test results proved that TDF can create the data streams necessary to provide agency transit information to riders and potential riders of a small- or medium-sized transit system. TDF is currently available as open-source software at no charge to users. For agencies choosing to download and internally host the application in their production environment, the tool can be downloaded from the TransitDataFeeder project website (http://code.google.com/p/transitdatafeeder/). Agencies will need subversion client software to download the code.

Principal Investigator: Prescott Sherrod; PEMCCO, Inc.; Prescott.Sherrod@pemcco.com

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Business

Cleaner Air for More Transit Buses

Transit agencies can't get enough clean air. In 2009 early adopters in Forth Worth, Tampa, Jacksonville, and West Palm Beach were the first transit agencies to install a technology that helps transit bus drivers and passengers breathe easier. Since then, several more agencies have installed the ultraviolet germicidal irradiation (UVGI) system into transit bus air conditioning units. The Chicago Transit Authority has written this system into its specifications for new articulated transit buses. Dallas Area Rapid Transit has written it into its specifications for purchasing 400 new transit buses to be delivered next year and more scheduled for the following year. The system is also being put in rubber-tired trolleys in Orlando. Some transit agencies are also considering the UVGI system for rail cars on their transit systems.

The system was tested and evaluated on transit buses at Houston Metro in Transit IDEA project 53. The UVGI system was proven to reduce 95–99% of mold, bacteria, fungi, and harmful viruses in buses, which can affect passengers and drivers. It also provides protection against bioterrorist contaminants and generates savings by reducing the maintenance costs of air conditioners.

Information about this project, which was funded by the Transit IDEA program, is available from Lee Huston, the Principal Investigator, at th@gte.net, and from Harvey Berlin, Transit IDEA program manager, at hberlin@nas.edu.