SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 12
Fall/Winter
2007

Ignition

News from **TRB's IDEA** Programs

RAIL
HIGHWAY SYSTEMS
TRANSIT &
TRANSPORTATION SAFETY

INSIDE:

TRB
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

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/CEO, Capital Metropolitan Transportation Authority in Austin, Texas. Harvey Berlin is the TRB program officer.

High-Speed Rail IDEA is funded by the FRA as part of its next-generation high-speed rail research. A committee chaired by Mike Franke, National Railroad Passenger Corporation, has oversight. Charles Taylor 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 Carol Murray, New Hampshire DOT; Inam Jawed is TRB program officer.

Safety IDEA is jointly funded by FMCSA and FRA. The committee is chaired by Ray Pethtel, Virginia Tech Transportation Institute. Harvey Berlin is TRB program officer.

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

On the cover: John Hillman demonstrates great confidence in his hard hat during a test of the composite bridge beams he developed. See the Business section for details. Photo by Michael Zicko.

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, NW
Washington, DC 20001

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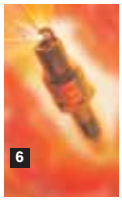

From the **Editor's** Desk

On November 7, 2007, under blue Colorado skies, the experimental bridge shown on our cover responded precisely as predicted when a locomotive rolled onto it—among bridge engineers that's cause for excitement. The 12 years leading up to that day are testament to the power of an idea that's backed up with energy and determination. The test itself is a credit to the railroads that were willing to suspend disbelief, form a coalition, and make it possible. Now further testing can be done, in both rail and highway installations, to determine if the Hillman Composite Beam will provide construction and cost benefits that could save us all time and money. The Business section provides some details.

The action of the five railroads that jointly funded the Colorado load tests demonstrates support for innovation at a time when the nation's economic vitality increasingly relies on advances in science and technology. Through thoughtful comments from IDEA committee members, the feature story in this issue helps us understand what is at risk if innovators have no help and to appreciate the surprising range of benefits that IDEA programs underwrite.

Projects highlighted in the New Ideas section also have quite a range. They include a new way to test pavement quality, a barrier system that prevents moisture damage to pavements, a driver alertness indicator, and a tool that integrates technologies so that transit agencies can generate dynamic timetables for both internal and public use.

Many IDEA investigators will present information on their projects during a poster session at the TRB Annual Meeting to be held January 13–17, 2008, in Washington. You can find a list of projects and presenters on the IDEA Web site: www.trb.org/idea.

Linda Mason
Communications Officer
Transportation Research Board
of the National Academies

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

To Weather the *Storm*, Shelter the Innovators

Whether the next transformational ideas in transportation thrive or die may depend on an individual inventor's ability to find financial support. It's an uncomfortable thought, but the problem comes up regularly in the IDEA programs. Take Nick Rivera, for example. After very promising test results, what may be a long-sought breakthrough in permanent magnet traction motors would be lost if Nick didn't have sound credit. If John Hillman can't keep up an exhausting and expensive scramble to build bridge beams in his spare time, a technology that may contribute to more reliable travel times for all of us may never be available.

Urgent calls come from many sectors of society for policies and programs to boost US achievement and innovation. Congress recently passed the America Competes Act to promote basic research in science, technology, engineering, and math as a necessary step in maintaining economic viability. A precursor to the act was a 2007 report of the National Academies entitled, *Rising Above the Gathering Storm*: *Energizing and Employing America for a Brighter Economic Future*. The report describes why science and technology are critical to the nation's prosperity and their role in addressing the challenges of a global market in which US advantages are eroding, the storm to which the title refers. "Today, much of everyday life in the United States and other industrialized nations…is the product of investments in research and in the education of scientists and engineers. Innovations based on scientific and technological advances have become a major contributor to our national well being." However, the report notes, "There is no simple formula for innovation. There is, instead, a multi-component 'environment' that collectively encourages, or discourages, innovation." That environment encompasses such factors as research funding, an educated work force, a culture that encourages risk taking, a financial system that provides patient capital for entrepreneurial activity and intellectual property protection. (pp. 41, 182)

> "The IDEA programs have given the nation access to small inventors and their talents."

An earlier report of the National Research Council (*Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, 2002) also acknowledged our reliance on these factors, stating: "There are few capabilities as important to our national life as those which allow us to generate, diffuse, and employ new technologies. Our standard of living is directly linked to productivity growth driven by technological innovation; both profits and higher wages depend on this growth."

That report's recommendations include several means of enhancing the national investment in innovation. They especially address the role of government in what had been seen as a "gray area" between basic scientific research that advances the nation as a whole and "need-driven, creative research on new kinds of materials, new processes or ways of exploring and measuring, and new ways of doing and making things. The consequence of leaving out this gray area between science and commercial development is that… a critical area may otherwise be unaddressed." Lewis Branscomb, professor emeritus of public policy and corporate management at Harvard and a co-author of this report, advises that government should be a "stable and reliable partner in a long-range national research effort. Research and development agencies should receive strong support for their investments in basic technology as well as in basic science. The test for government investment in basic technology should be the same as for government investment in basic science: Is it an effective, high-quality contribution to the nation's knowledge and innovation infrastructure?"

TRB's IDEA Programs do provide modest funding for early research in innovative technologies. Industry and public agencies are more likely to invest in innovative ideas, if they know that knowledgeable people have vetted the concept. The committees that review IDEA proposals bring depth of knowledge, practical experience, and insight into the value of

potential investments that provide a comfort factor for later investors that is hard to come by. Ideas that have won support from these committees have passed the scrutiny of people who ask tough questions and know if the answers make sense.

That support can be valuable both to innovators hoping to install a demonstration project or fund an implementation phase and to would-be champions in the public or private sectors. In transportation, where public safety is the first priority, cautious conservatism is the natural posture of decision makers. Researchers have often won the opportunity to move ahead in this environment because IDEA committees were behind them.

Members of the Transit IDEA committee listen to a progress report from an investigator.

Committee members themselves have much to say about the value of these programs that offer what few others do. Robert Wright, Manager of Research and Development at Alstom Transport, Inc., says this: "Innovative talent does not typically associate with money and power. For great things to happen, all three must come together. The IDEA programs have made this happen for a few who have been able to demonstrate they have a good idea. Without the IDEA programs, these ideas may never have matured enough to be noticed. The IDEA programs have given the nation access to small inventors and their talents."

Tom Smithberger, Senior Vice President and National Railroad Director for HDR Engineering, Inc., and a member of the Rail IDEA committee, notes that "the Rail IDEA program provides an avenue for considering practical (and even some seemingly impractical) research schemes by a broad panel of industry experts. This program has been a generator of many "great ideas" that are being further studied in the industry. A surprising benefit of the program is the ideas and technologies from other industries that otherwise would not have been known by the rail community. Bringing these ideas across industries has definite value and is a real asset of the IDEA programs."

State transportation agencies derive great benefit from the IDEA programs in the opinion of Joe Mahoney, Professor of Civil Engineering at University of Washington, a member of the NCHRP IDEA committee and a long-time TRB volunteer. DOTs are unlikely to undertake high-risk research through their traditional programs, which build on incremental advances in knowledge, but the scale of their work permits huge returns from implementing even one time- or money-saving innovation.

Ray Pethtel at Virginia Tech Transportation Institute and chair of the Safety IDEA program appreciates that the program helps address the deficiency in support for ideas that are inventive, creative, and innovative where transportation safety is concerned. Preventing and reducing highway collisions, transit mishaps, train breakdowns or derailments are tasks so daunting that they require innovative solutions. Apparently, benefits derived from research into new transportation technologies and innovative methods and materials ripple out far beyond the test lab to agencies, industries, and nations.

Early tests of high-risk innovations are an essential component of a balanced research program. Our sponsoring agencies find a way, year after year, to make a compelling case for that investment because people willing to champion these programs understand the inherent transformational power of ideas and value the contributions of creative work. But that's not all; in a very practical way, they acknowledge the direct link between a nation's support for its innovators and its ability to rise above challenges to its economic vitality. ❖

The IDEA Story in Numbers

$80K	average funding per project
$240K	additional investment per project generated through cost sharing
17	IDEA projects funded in 1997
15	IDEA projects funded in 2002
14	IDEA projects funded in 2007
$2M	Combined funding for all 4 programs

Rising Above the Gathering Storm and Making the Nation Safer are available from the National Academies Press Website: http://www.nap.edu/

DAISY–fresh Drivers

At least 25 percent of crashes in the United States result from driver inattentiveness or drowsiness, which puts the number of such crashes at more than 100,000 per year[1]. This serious problem was addressed in a Safety IDEA project with a light-hearted name. Developers at Sphericon, Ltd. hope that the driver alertness indication system, which they have dubbed DAISY, will become a standard safety feature offered by automakers to refocus drivers and prevent crashes.

DAISY is a 'software on a chip' product to assess driver attentiveness and issue a signal when attentiveness falls below a preset level. The challenge in developing this sort of detection device is in knowing why a driver's steering pattern changes. It's easy to detect a change in g-force, but was that slight swerve to avoid a bump in the road or was it because the driver's attention was elsewhere? DAISY integrates the variables of driver alertness and changing road conditions, making it possible to determine which one prompts changes in the driving pattern.

Building on earlier work, in the IDEA investigation Sphericon focused on developing and constructing a simulator to allow safe testing with inattentive drivers. The simulator integrated a real steering system with a computerized simulator, an elaborate set of sensors, and a data acquisition system. A computer-controlled load generator recreated in the virtual vehicle the dynamic behavior of an identical steering system installed in a real vehicle performing the same maneuvers. As a series of driving tests were conducted, algorithms were enhanced with the resulting data. Results of the driving tests were translated into an alertness indicator, which was then compared with an index produced by the subjective judgment of two investigators who independently reviewed video of the test subjects and graded their level of alertness. The comparative analysis indicated validity of the principles that govern DAISY. Sphericon, Ltd. has scheduled demonstrations of DAISY with a major automotive manufacturer to take place later in 2007.

The DAISY simulator could help drivers stay alert.

Contact:
Dr. Dan Omry, CEO, Sphericon, Ltd.
dan.omry@sphericon.co.il

1. The Role of Driver Inattention in Crashes; New Statistics from the 1995 Crashworthiness Data System http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/ll01!.pdf

Timetables You Can Trust

A recent Federal Transit Administration scan of the intelligent transportation systems (ITS) used in public transit found that the complexities of state-of-the-art technologies "exceed the transit community's current ability to deploy them" and that not being able to integrate technologies is a key obstacle to implementation. [1]

Transit IDEA project 39 developed the prototype for a tool that overcomes those issues for generating arrival and departure timetables based on real time information. The Dynamic Timetable Generator is being used by New York State DOT, Tri-Met in Portland, Oregon, and the Regional Transportation Authority in Chicago to help manage regional timetable displays. These agencies tested the DTG during the IDEA project and are now including it in their transit schedule data exchange architecture to quickly and efficiently update schedule data on their Web sites.

1. Advanced Public Transportation Systems: The State Of The Art Update 2006. FTA-NJ-26-7062-06.1. On the Web:http://www.fta.dot.gov/documents/APTS_State_of_the_Art.pdf

The DTG prototype application was built using multiple standards (e.g., TCIP, XSLT) and open source software (Apache Web Server, MySQL, Linux, and Tomcat) to ensure its compatibility with various formats. The DTG loads timetable data from databases as changes occur and delivers the information configured either for public presentation, with color schemes and accessible formats, or in formats specific to agency uses. The ability to assume different formats and integrate with existing technologies helps this IDEA product hurdle the obstacles to implementation.

Contact:
Paula Okunieff at
paula.okunieff@consystec.com
Consensus Systems Technologies Corp.
www.consystec.com

Probing for Quality Assurance

Roadbuilders have long sought easy and reliable ways to verify during construction that base and subgrade materials will support the roads above them and that pavements are uniformly compacted. A product being developed through NCHRP IDEA project 112 to measure stiffness and Poisson's ratio (a measure of the tendency of a material to get thinner in two directions when stretched in another) promises an automated, accurate, and economical system for controlling construction quality and evaluating the performance of pavement systems.

Using the project's cone penetrometers equipped with piezoelectric sensors, three indicators of soil stability—shear modulus, elastic modulus, and Poisson's ratio—can be measured to a depth of 4 feet. During tests of two soil types, results from the penetrometers compared favorably with results on the same soils from other methods. The technology will undergo further field testing through an agreement with the Ohio Department of Transportation, which has offered to perform validation testing at a new Superpave project site in Delaware County, Ohio. A provisional patent has been issued for this device and a formal patent is expected to be awarded soon. An engineering technology company has signed a memorandum of agreement to produce commercial units for sale, pending the outcome of the validation testing.

The cone penetrometer equipped with piezoelectric sensors.

Contact:
Xiangwu (David) Zeng at
Case Western Reserve University:
xxz16@cwru.edu

Drying Up the Source of Damage

Potholes, rutting, and other types of pavement failure are often caused by the effects of moisture in and under the pavement. Conventional drainage is designed for periods of saturated flow, when water is no longer absorbed by the soil in the constructed layers under the pavement. Saturation of the subgrade or the base layer or both causes the familiar—and costly—pavement damage. Investigators for NCHRP IDEA project 113 have developed a layered drainage system that drains the water before saturation occurs.

The geocomposite capillary barrier drain (GCBD) comprises three layers that (1) drain water from the soil of the base course by means of a special geotextile that transports more water as it becomes wetter, (2) prevent capillary rise of water (with a layer of geonet), and (3) separate the subgrade soils from the capillary barrier to prevent it from clogging. The system has been installed in a full-scale test section at the pavement test track operated by the Minnesota Department of Transportation.

Tying GCBD into edgedrain during installation in a Minnesota DOT test track (left), and covering the GCBD with base course aggregate in the test section (right).

Sensors are monitoring moisture and temperature changes in the GCBD test section and in an adjacent control section and the resulting data will allow for performance analysis. Design tools calibrated with the field data are under development so that the GCBD can be designed for specific climates, geometry, and soils. This technology is available for licensing and manufacturers of geosynthetic products have expressed interest.

Contact:
John Stormont at the University of New Mexico:
jcstorm@unm.edu or Karen Henry of the US Army Cold Regions and Research Engineering Laboratory:
Karen.S.Henry@erdc.usace.army.mil

This Could be History in the Making

A consortium of Class 1 railroads contributed the funds needed for a demonstration test of the Hillman Composite Beam in a rail test track at the Transportation Technology Center in Pueblo, Colorado. The shipping and installation costs, as well as the technical expertise needed during the installation, were provided by: Burlington Northern Santa Fe, Canadian Pacific, Canadian National, Norfolk Southern, and the Union Pacific.

One of eight 30-foot hybrid composite bridge beams is installed for load tests in a railroad test track.

John Hillman, who developed and patented the bridge design, clearly appreciates the help: "I am in awe of the support I have gotten from the Class 1 Railroads and the Class 1 Engineers who have helped me orchestrate this test. I would qualify them as pioneers and I think a couple of them are more excited about this test than I am."

Their support apparently was well-placed. As Hillman reports: "On November 7, 2007, on the FAST loop at TTCI, we load tested the first composite railroad bridge in the history of the world (to my knowledge). The bridge supporting the locomotive (see cover photo) is a 30-foot span comprised of eight hybrid-composite beams (a.k.a. Hillman-Composite Beams or HCB). The response of the bridge matched exactly the predicted strains and displacements calculated in accordance with the specified limits in the AREMA design codes. Despite the successful test, I don't mind telling you I was nervous given there was only one direction to point the finger."

The HCB will also be installed as highway bridges in two projects to be constructed during 2008, one in Illinois and one in New Jersey.

Information about the IDEA project, which was funded jointly by the NCHRP IDEA and the Rail IDEA programs, is available from Chuck Taylor, Rail IDEA Program Manager, who can be contacted by email at ctaylor@nas.edu, and from Hillman at HillmanJR@teng.com.

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