SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 19
Summer/Fall
2012

Ignition

News from **TRB's IDEA** Programs

HIGHWAY SYSTEMS
TRANSIT
TRANSPORTATION SAFETY

INSIDE:

TRB
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Sparking Innovative Transportation Solutions

Issue 19
Summer/Fall
2012

Highway Systems
Transit
Transportation Safety

Ignition

News from TRB's IDEA Programs

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), and the Federal Railroad Administration (FRA).

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.

The Safety IDEA program has been sponsored by the Federal Railroad Administration (FRA) and the Federal Motor Carrier Safety Administration (FMCSA). Since the program is currently funded only by the FRA, the Safety IDEA program is accepting new proposals only on innovative approaches to improve railroad safety or performance. The program committee is chaired by Bob Gallamore, a consultant and writer. Harvey Berlin is the TRB program officer.

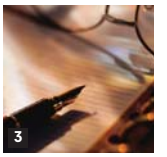
Visit the IDEA Web site:
www.TRB.org/IDEA

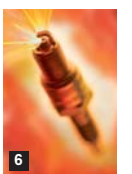
On the Cover: Mark Sheppard of Tampa's HART transit system explains the Travel Assistance Device, or TAD, to a traveler

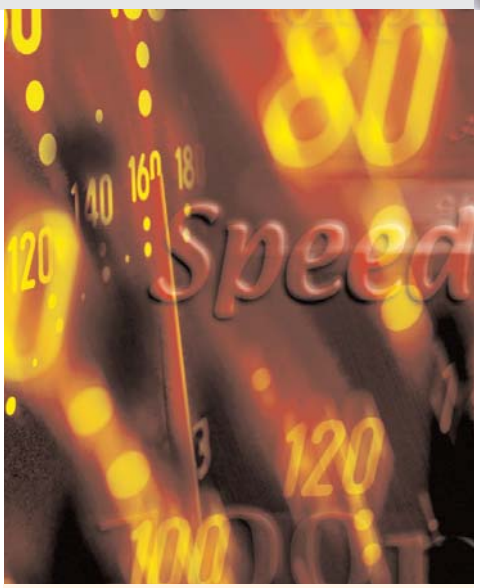
Photo courtesy of Sean Barbeau

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

Contents







Staying Alert, Staying Alive

Remember cocooning? A trend noticed in the 1990s, cocooning celebrates retreat from distractions of the outside world and cozying in at home. Modern communication technology both facilitates that option (with HDTV and wireless computing we can stay home from the movie theater, the office, and even the grocery store) and complicates it (with hard-to-ignore social media and those addictive word games!). This tension between the need both to connect with our world and to disconnect from it plays out even when we're on the road.

Consider, for example, the plight of truck drivers. Because the constant sounds of tires and engines and rushing wind induce stress and fatigue and cause distraction, modern truck cabs are often highly insulated. The result can be almost, well, a cocoon. Drivers can become too disconnected from what's happening outside their soundproof windows and miss cues that signal danger. An ingenious approach to increasing situational awareness for truck drivers is the subject of research described on page 6.

Drowsy driving is another danger for truck drivers and all road users. Alert systems to rouse drowsy drivers require reliable input, but detecting the physical indicators of drowsiness—without using electrodes—has been a challenge. A new approach to meeting the challenge is the subject of another IDEA project described in this issue.

Our feature article celebrates a technology that helps people stay alert while navigating public transportation. Especially useful for people with cognitive disabilities, the Travel Assistance Device is a smart phone app that provides alerts to prompt riders when an action is needed to complete their trip. A real boon to independent travel, this product can also reduce paratransit trips, which typically cost transit systems about 10 times what a fixed-route trip costs. Transit agencies in four Florida cities have participated in successful demonstrations of the device and commercialization is under way.

The Business section reports on another IDEA success story: a rail wheel inspection system, having proved its worth at home in the United States, is being installed in lands far away. Fortunately, everyone is on the alert for a good idea.

Linda Mason
Communications Officer
Transportation Research Board

Recently Released Reports from the NCHRP IDEA Program

NCHRP-139: Development of a Sensing Methodology for Intelligent and Reliable Work-Zone Hazard Awareness (Georgia Institute of Technology; Author: Yichang [James] Tsai)
http://www.trb.org/main/blurbs/167317.aspx

NCHRP-146: Advanced Methods for Mobile Retroreflectivity Measurement on Pavement Marking (Leetron Vision, Concord, New Hampshire; Author: Terry Lee)
http://www.trb.org/main/blurbs/167371.aspx

NCHRP-150: Automated Laser Spectrographic Pattern Matching for Aggregate Identification (Chesner Engineering, P.C., Long Beach, New York/New Mexico State University; Authors: Warren Chesner and Nancy McMillan)
http://www.trb.org/main/blurbs/167373.aspx

NCHRP-152: Bridge Cable Inspection with Long-Range Ultrasound (WaveinSolids, LLC, State College, Pennsylvania; Author: Thomas R. Hay)
http://www.trb.org/Main/Blurbs/167392.aspx

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

Want to Reduce Expensive Paratransit Trips? There's an *App* for That.

About 14 million Americans have cognitive disabilities, and for many of these people, using public transportation without personal assistance can be challenging. They often have to rely on expensive paratransit systems. Now, with the help of a tool developed in the Transit IDEA program, riders with cognitive disabilities can use fixed-route buses and transit agencies can reduce expensive paratransit trips.

Philip Winters and a project team at the University of South Florida developed the Travel Assistance Device, or TAD, which is a GPS-enabled mobile phone application that integrates communication with a transit system's automatic vehicle location (AVL) system. TAD delivers information prompts to riders with a just-in-time method that triggers the phone to vibrate and to deliver audio and visual messages when the rider needs to pull the stop cord and exit the bus. If the rider deviates from his or her planned route, automated alarms can alert the travel trainer or the parent/guardian of the traveler. And although the primary demographic for TAD is riders with cognitive disabilities, it can benefit anyone who is not familiar with the transit system.

The TAD System

The TAD system comprises four individual software components:

1. a mobile phone application;
2. a web application, which interacts with the mobile phone software;
3. a webpage for end-user interaction; and
4. a toolkit application, which handles the importing, exporting, and processing of transit data.

TAD interacts with two components of an agency's transit system: the database server containing AVL data; and a web service that provides estimated time of arrival (ETA) information for a particular bus, stop, and route. The mobile phone app can display real-time ETA information to users waiting for their bus at the stop. Additionally, the TAD web page can show the real-time bus locations for all buses relative to the active user. Based on the ETA, TAD alerts the user when a set number of minutes remain before the bus is to arrive, and then it notifies the user as the bus is actually arriving at the stop.

How TAD Works

When the TAD mobile phone application software starts, it prompts users to select a trip that was previously planned on the TAD website by a travel trainer, parent, guardian, or the transit rider. The mobile app retrieves the estimated arrival time of the next available bus from the transit agency's real-time AVL system. The phone application counts down in real time until the vehicle arrives. If the arrival time changes due to an unscheduled delay, the phone application will retrieve this information from the AVL system and update the display for the transit rider. The phone vibrates when the bus is five minutes away, and it announces "Now Arriving…" when the bus is within two minutes of the stop.

After the rider boards a bus and the bus begins to move, the phone will display the distance to the destination stop, which decreases as the bus approaches the rider's destination. The phone vibrates and announces "Get Ready…" when the destination is a few bus stops away. When it is time to request the stop, the phone vibrates and announces "Pull the Cord Now!" via visual and auditory messages.

Transit IDEA Project 52

TAD came to the IDEA programs as a prototype. The initial TAD prototype was designed to use commercially available cell phones with GPS to aid transit riders by triggering the phone to vibrate and to deliver audio and visual messages when the rider should pull the cord and exit the bus. In Transit IDEA Project 52, the project team was able to work with Hillsborough Area Regional Transit (HART) in Tampa, Florida, to integrate communication between TAD and HART's AVL system.

Mark Sheppard of HART demonstrating TAD to a traveler

This enhanced communication supported the development of new features that were based on the real-time location of transit vehicles in relationship to the real-time location of each rider. This allowed TAD to provide personalized notices of the estimated time remaining for the bus to arrive, to notify riders when their bus arrives, and to provide identifying information so riders can correctly identify their bus if multiple buses are present. It also enabled the TAD website to show the real-time bus locations for all buses relative to the user.

At HART, six people with special needs participated in a series of pilot tests. Observers accompanied the participants and recorded the details of each trip. The link between TAD and the AVL system worked successfully in most of the tests. A few issues were found and resolved after further testing.

Post-IDEA Tests

After Transit IDEA Project 52 ended, the research team received follow-on funds to test TAD with four other transit agencies in four other cities in Florida—all of which were successful. Also, an independent human behavior analysis study of TAD provided supporting evidence that TAD has a positive effect on the ability of individuals with cognitive disabilities to travel independently using public transportation. The University of South Florida has since obtained two patents on this system. In 2010, the university licensed a company called DAJUTA to refine and deploy the system to other transit agencies, and DAJUTA has since worked with a number of transit agencies. The TAD app currently works on Blackberry 9930 phones on Sprint; apps for additional phones and carriers are in development.

How Do Transit Agencies Use TAD?

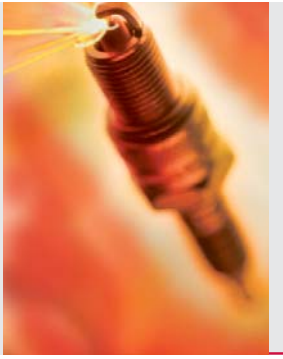
For an agency to implement TAD, the costs are relatively low. Some up-front work is required to make sure the agency's fixed-route bus schedule information is in the General Transit Feed Specification (GTFS) format, which TAD uses to import and update schedule information from agencies. The TAD smart phone app and mobile technology platform, on the other hand, are completely self-supportive; those two parts of the system require no integration into an agency's system. DAJUTA sets up accounts for the transit agency and uses the agency's current costs to create a customized "savings calculator" for TAD trips. The agency also selects a TAD champion who will be trained on how to use the TAD app and the trip-planning/rider-tracking website. The final step is a two-week test, which is conducted before TAD is available to the general public.

Minimal time is required to teach trainers and riders how to use the TAD system. Trainers learn how to plan a trip on the website, how to demonstrate the app to caregivers and riders, and how to track riders and read their TAD trips dashboard. Experience with Mark Sheppard, the travel trainer for HART, has shown that trainers can learn how to use the TAD system in less than two hours. The system is also easy for riders to learn. Because the TAD mobile app was developed with a highly intuitive user interface, a rider can learn the complete intent and functionality of the system in about five minutes.

Benefit to Transit Agencies

TAD has three major benefits. First, it can reduce the number of paratransit trips; the average paratransit trip costs $17 compared to $1.70 for a fixed-route bus trip, which is an average savings of $15.30 per trip. Second, a rider who uses TAD to travel on fixed-route buses has more travel independence than a rider who depends on paratransit trips. The third benefit is increased ridership on fixed-route buses.

Contact: Philip L. Winters, winters@cutr.usf.edu



Measuring Bridges with Lasers

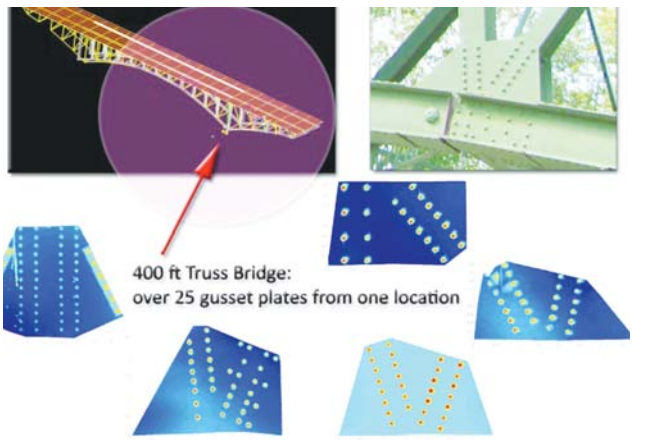
Damage to bridges can occur in many places, including girders (which can be damaged by over-height loads) and gusset plates (which can be susceptible to corrosion or warping, as in the I-35W bridge collapse in Minneapolis, Minnesota). In preparation for the necessary repair work, measurements are traditionally made by hand using measuring tape and string lines. A worker must be within arm's length of the bridge to measure it; this requires ladders, scaffolds, bucket trucks, or lifts to access the bridge. Putting people in place to perform these measurements can sometimes require lane closures, and taking measurements over rail lines can be difficult or even impossible. Traffic control and access equipment add extra time and expenses to the project. Moreover, it can be very difficult to make the measurements accurately even after putting someone in the right place.

To make bridge repair and rehabilitation work easier, a project team led by Paul Fuchs developed a laser metrology instrumentation system in NCHRP IDEA project 153. The laser-based system sets up quickly on site and makes measurements that are difficult or impossible to make with string lines, measuring tape, or other more advanced measurement systems. It can measure the shape, position, and dimension of bridge members. The laser measurements are then turned into CAD drawings of retrofit parts. This system can save time and improve measurement quality.

Project 153 built on the success of NCHRP IDEA project 127, which developed laser metrology instrumentation to improve the fabrication process of steel bridges. The need for this technology is illustrated by a problem that a state department of transportation (DOT) faced when erecting a bridge in 2001: an incorrectly fabricated girder was not identified until most of the structure was erected and some components did not fit together; this incident resulted in millions of dollars in legal expenses, refabrication expenses, and delays in construction. If the laser metrology system had been used, this situation could have been prevented. A Transportation Pooled-Fund study was established to further develop the laser metrology system, following project 127, because several DOTs believed it had a clear cost-saving benefit. To improve the field measurements of bridges, specifically for retrofit and repair work, project 153 adapted the laser metrology system for field use.

To discuss implementation, the project team has been meeting with various DOTs. They are currently coordinating field tests to demonstrate the capabilities of the system; one such demonstration project is being planned with the help of Virginia DOT. The team hopes to implement this technology as a standard tool that will be used on a routine basis within the conventional retrofit process.

Contact: Paul Fuchs,
paul.fuchs@fuchsconsultinginc.com



The laser metrology instrumentation system can measure *many* bridge details from one laser position.

Monitoring Driver Drowsiness

Drowsy driving is dangerous driving, but how can you tell if someone is drowsy? Electrocardiography (ECG) and electroencephalography (EEG) have been used for years in studies of drowsiness and sleep disorders. These technologies use electrodes, which are put in contact with the human body with coupling gel, to measure physiological signals. Wiring up drivers is not likely to be a popular tactic and in fact would introduce its own safety issues. Therefore, Xiong (Bill) Yu of Case Western Reserve University has adapted this technology to be useful to truck drivers, bus drivers, and railroad operators in Safety IDEA project 17.

Yu developed a prototype sensing platform that can detect driver drowsiness without physical contact. The prototype is housed in a shielding box and includes a metal detector, which

is placed in front of the left side of the driver's chest. Digital signal processing algorithms decimate the signal noise and automate signal analysis. The prototype was able to detect physiological signals including heart rate, heart rate variability, breath frequency, and eye blinking; and it was fully functional at distances up to one foot from the subject's chest. Using parameters of the physiological signals, Yu created a highly reliable drowsiness indicator.

In addition to monitoring the physiological signals and detecting driver drowsiness, this device could be used to monitor the health of truck drivers. Information collected from the physiological sensors can be integrated with a wireless data transmission module that allows for remote diagnostics of a driver's health conditions. Warning systems could also be developed and integrated with this system to alert drivers when they are drowsy. This could result in increased driver safety.

Based on work in the completed IDEA project, additional steps have been taken to further advance the prototype. A provisional patent application was filed through the Office of Technology Transfer of Case Western Reserve University. As part of the National Science Foundation's Partnership for Innovation, the system was evaluated by a commercialization specialist. The project team has engaged in dialogue with a business to develop bio-

The sensor (left) monitoring a driver in a simulated vehicle cab.

compatible polymeric detectors that can replace the current metallic based sensor; this upgrade could reduce the size of the sensors from a large box to the size of a button. Further testing of the system has also been planned.

Contact: Xiong (Bill) Yu, xxy21@case.edu

Beeps, Bells, and Vroom-Vrooms: Audio Cues to Help Truck Drivers Stay Alert

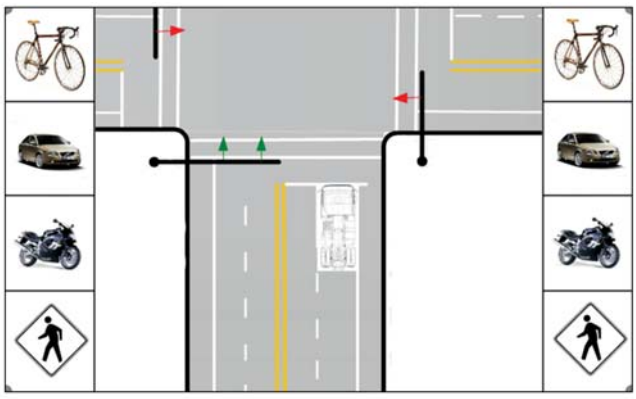
Inside the cab of a truck, sounds from wind, cooling fans, road surfaces, the engine, vibration, tires, and exhaust can be a driver's enemy. These high noise levels can lead to distractions, stress, and fatigue, which erode driver performance and safety. To combat these effects, commercial vehicle manufacturers insulate truck cabs to reduce noise, vibration, and harshness. But when coupled with the limited visibility from inside a truck cab, this can reduce a driver's situational awareness and increase risk to road users in the truck's vicinity. To improve a truck driver's situational awareness, a team led by Dominic Paul Piamonte of Volvo Technology of America developed a 3-D sound system to assist truck drivers in Safety IDEA project 19.

This project tested whether 3-D sounds could increase a driver's situational awareness by providing traffic cues of other vehicles near the truck. 3-D sounds are auditory icons that indicate what is making the sound, where the sound source is located, and the direction it is moving. In this project, auditory icons represent simulated traffic situations with four road users: cars, bicyclists, pedestrians, and motorcycles.

Tests were conducted with nine participants in a laboratory. In these tests, the participants heard sounds from one of the four road users coming from their left or right, and the participant had to indicate the type of sound and location of the sound on a tablet. In analyzing their recognition, auditory icons resulted in high accuracy rates, which indicate their intuitiveness and high degree of association to the intended object. The results indicated that spatial movement, along with the context of a traffic scenario where a critical safety event could occur between a truck and other road-users, tended to increase the accuracy to assess situational awareness.

In the next stage of the project, a 3-D sound system is being installed in a fully operational truck and modified to let the project team safely evaluate how effective the auditory icons are during real driving scenarios. Further improvements will also be made to the audio icons to improve their recognition potential and evaluate the effectiveness of those improvements during the field tests.

Contact: Dominic Paul Piamonte, paul.piamonte@volvo.com



Tablet screen presented to participants during clinical testing.

TRB

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

www.TRB.org/IDEA

Non-Profit Org
US Postage
PAID
Washington, DC
Permit No. 8970

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

The nation turns to the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—for independent, objective advice on issues that affect people's lives worldwide.
www.national-academies.org

Inspecting Rail Wheels Around the World

The wheels keep on turning. In Transit IDEA project 17, an automatic, in-ground rail wheel-gauge inspection system was developed by International Electronic Machines Corporation (IEM). The device—which uses 3-D laser imaging technology, trackside cameras, and ultrasonic sensors—scans the entire cross-section of the wheel to create a complete digital profile. The profile is then processed by software, which checks for wheel cracks, flange angle, wheel diameter changes, hollow tread, and other signs of wear.

Because of the system's benefits to overall performance and safety, the prototype developed in the IDEA project attracted additional funding to support refinements and redesigns that resulted in a commercial product. Several transit agencies and railroads have purchased the system, and others have expressed interest in it. The in-ground wheel inspection system was purchased by CSX and installed at its rail maintenance yard in Selkirk, New York, in 2006. The system has inspected millions of rail wheels at this location alone. CSX subsequently purchased additional wheel inspection systems from IEM to be installed at other rail yards. New Jersey Transit has also purchased this system to inspect the wheels of its rail transit vehicles.

As part of a consortium for Australian rail transit projects, IEM built and installed a system for the CityRail transit system in Sydney during 2009 and 2010. The system has also been installed in Izmir, Turkey. In both international cases, IEM manufactured the system in the United States before transporting it to and installing it in the other countries. IEM will provide continued maintenance for the system in all of its locations. This has created jobs for U.S. workers.

Information about this project, which was funded by the Transit IDEA program, is available from Zihad Mian, the Principal Investigator, at zack786@nycap.rr.com, and from Harvey Berlin, Transit IDEA program manager, at hberlin@nas.edu.

TRB Accepting IDEA Proposals for Railroad Safety or Performance

The Safety IDEA program is now accepting proposals for funding investigations of promising but unproven innovations that could improve railroad safety or performance. The innovations can be applicable to high-speed rail, intercity and passenger rail, or freight railroads.

Instructions for preparing and submitting IDEA proposals are in the *IDEA Program Announcement*, which is available on the IDEA website (www.TRB.org/IDEA). Safety IDEA proposals are due by September 7, 2012. Earlier submissions are encouraged.

The Safety IDEA program is currently funded by the Federal Railroad Administration (FRA) and managed by TRB. Have questions about preparing your proposal? Contact Harvey Berlin of TRB by e-mail at hberlin@nas.edu.