SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 8
Winter 2005

Ignition

News from TRB's IDEA Programs

HIGH-SPEED RAIL
HIGHWAY SYSTEMS
TRANSIT &
TRANSPORTATION SAFETY

INSIDE:

- New Idea for RR bridges
- Funding Sources for Innovation

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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/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: Norfolk Southern Research site in Flat Rock, Kentucky where safety IDEA project 6 is being tested. See page 7.

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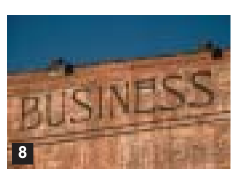
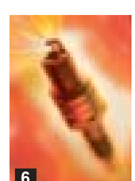




From the **Editor's** Desk

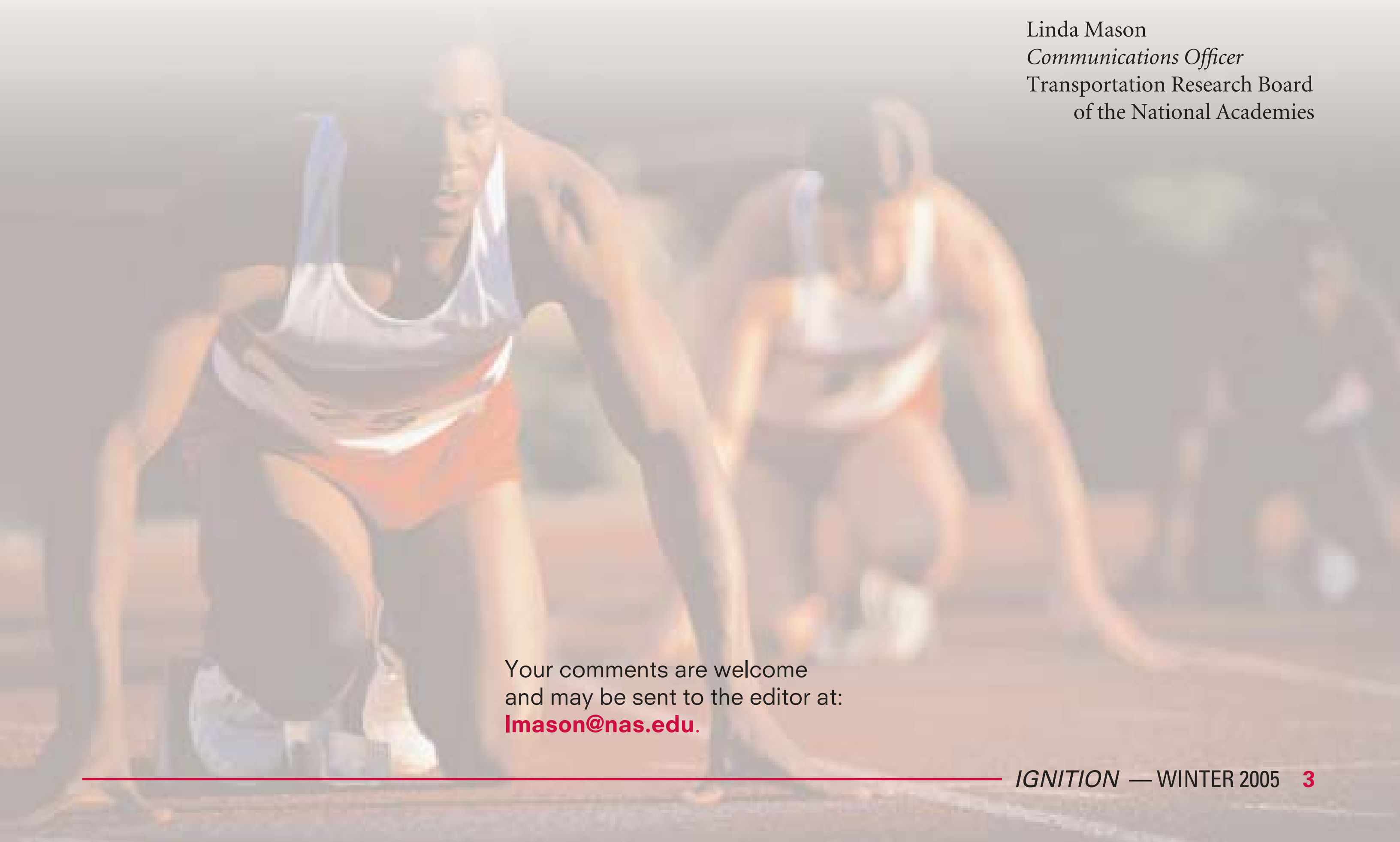
Champions Among Us

This issue features champions of differing sorts. Some win awards, others select award winners and both deserve recognition and support. Our interview is with an award-winning bridge engineer whose IDEA project looks like a winner itself. John Hillman, PE, is testing a bridge beam system that combines the benefits of composite materials with the strengths of conventional components. We visit the Composite Materials Lab at the University of Delaware to get the story.

The need to characterize what can't easily be seen is a complication inherent in many transportation projects. Three interesting approaches to this problem were awarded funding through IDEA programs and they are described in the New Ideas section.

In the Business section, we salute two agencies that have taken on the challenge of championing the potential for innovative solutions by funding high-risk research. Programs like these magnify the value of programs like ours and bring the benefits of research closer to us all.

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.

John R. Hillman, PE

A BRIDGE PURE *and* Simple

Ivory tower research this was not. The Center for Composite Materials may be housed in the halls of academe on the campus of the University of Delaware, but the materials lab is where ideas meet up with elbow grease. It's a space designed for heavy lifting, with muscular equipment and no apparent restriction on making too much noise or too big a mess. It's not instantly clear why anything weighing five tons would need to be raised three stories, but if you needed to, you could do it here. John Hillman was here on a bone-chilling January day to build a bridge beam and find out how many times a locomotive can travel across the beam before it fails.

The locomotive wasn't actually in the lab, but two hydraulic actuators were set up to deliver 2 million cycles of the full live load of the rail industry's bridge design requirements (Cooper E-80). In an earlier test, the single beam being tested exceeded the factor of demand in railroad safety codes by a factor of three.

Hillman is an award-winning Senior Structural Engineer with Teng Associates, a design, construction, and project management firm headquartered in Chicago. In January, Chicago's DOT announced that Hillman's design for a pedestrian bridge across Lake Shore Drive was the winning entry in an international competition that attracted 67 design proposals. In 2000, the High-Speed Rail IDEA program selected his proposal for a hybrid bridge beam system as a concept exploration project and in 2003 the NCHRP IDEA program joined with HSR in funding a follow-on project to help with the testing phase. Now, 30-foot beams are being constructed for a full-size demonstration railroad bridge that will be installed for accelerated testing on a track at the Transportation Technology Center in Pueblo, Colorado.

We spoke with John by email from airports, by phone from Chicago, and in person at the University of Delaware's Center for Composite Materials.

The constituent parts of the Hybrid Composite Beam—fiber-reinforced polymers, concrete, and steel—are not new to bridge building. What is the innovation in your patented design?

The primary innovation resides in the combination of materials that creates a very efficient beam. Although the beam is encapsulated in a fiber-reinforced plastic (FRP) shell, it is much more analogous to a reinforced concrete beam than it is to a composite beam. The concrete used to resist compression loads is contained in the simple parabolic arch within the core of the beam. The thrust in this concrete arch is resisted by layers of small steel fibers that tie together the ends of the arch. The FRP shell serves as a stay-in-place form that also helps to transfer vertical loads and shear within the overall beam system. Each of the materials is used in the most efficient manner to take advantage of its strengths in performance. Concrete is in pure compression, steel is in pure tension, and the FRP primarily resists shear.

Other unique aspects of the beam result from the nature of the FRP materials. The corrosion-resistant qualities should contribute to lower life-cycle costs for these beams as compared with concrete and steel. And because the FRP shell is very light and the concrete in the arch can be placed in the field, there are distinct advantages with respect to shipping and erection costs. For example, prior to injecting the beams with concrete, a 30-foot Hybrid Composite Beam railroad bridge would weigh approximately 1/7 the weight of a conventional precast concrete bridge and approximately 1/3 what a conventional steel bridge of the same span might weigh.

What's more, this is the first attempt that I'm aware of to use FRPs in the main load-resisting system for a railroad bridge. Most FRP bridge applications to date have been limited to off-system lower-traffic bridges and golf courses.

Recognizing that your project is still in the testing phase, is it possible to quantify the benefits to transportation agencies and others who might use the Hybrid Composite Beam?

It is possible to quantify the savings both in initial construction costs and in the long-term benefits of the life-cycle costs. It's important to note, though, that selection of a structural system based on lower life-cycle costs is a luxury that few public or private clients can exploit. For the most part, any successful innovation must provide a distinct advantage on a first capital cost basis. This is where the Hybrid Composite Beams demonstrate benefits.

Pure FRP structural systems designed for the loads of a railroad bridge will be cost prohibitive when compared with conventional methods. Because the Hybrid Composite Beam uses less expensive materials to provide most of the strength and stiffness to the system, these girders can be designed and fabricated to support tremendous loads but still take advantage of the light weight and corrosion resistant attributes of FRPs. Calculations have shown that these girders can be cost competitive with concrete and steel on a first cost basis.

Review of technology transfer activities often shows that the perception of risk is an impediment to the implementation of new technologies. There also seems to be lore among engineers that bridge engineers are among the most conservative or risk-averse groups in the transportation community. How would you address this issue?

There is always a certain amount of risk in designing and constructing any structure. The transportation infrastructure market is inherently conservative, and rightly so. That being said, the simplicity of the Hybrid Composite Beam in terms of design, fabrication, and erection is a real benefit in educating potential designers and users as to the behavior of these beams. The objective for any technology in the transportation industry is to make the risk so small that it is of no consequence in the selection of materials or structural systems. The HCB is a real belt-and-suspenders system. Each element acts monolithically as a beam, so redundancies are built in and even more could be.

With promising results so far, have you considered what it will take to commercialize the HCB? You've attracted participation at this early developmental phase from suppliers. Do you foresee partnerships as part of your marketing strategy?

Ever since the inception of the Hybrid-Composite Beams, I have been cognizant of what it will take to get the product commercialized. The first step is to be cost competitive with conventional materials. The next step is to develop a procurement strategy that avoids the pitfalls of sole-source procurement. One way to do this would be to have multiple licensees with non-exclusive fabrication rights. This is a tough sell to almost any industry, but when you evaluate the billions of dollars spent annually on our nation's infrastructure, high volume with smaller profit margins will likely result in larger revenues over the long run than finding a handful of niche installations and charging excessively high margins.

It's difficult to predict what partnerships may evolve as we move toward commercialization. I will say that there have been several forward-thinking companies who have embraced the technology and been supportive of this research. I would also add that the companies that have taken part were generally contacted because their specific products brought distinct advantages to either the structural performance of the beams, the fabrication process, or both. In particular the FlowTex(tm) fabrics from Owens Corning and Hardwire(r) products from Hardwire, LLC have made it possible for us to conduct the closed-mold infusion without any proprietary transfer media.

One of the more lasting relationships that has evolved through the development of these beams is my working relationship with The University of Delaware-Center for Composite Materials. The staff at CCM has been invaluable in rolling up their sleeves and helping solve all of the fabrication issues necessary to make this a viable product.

Ideally, I look forward to a day when HCB are commonplace. Any bridge engineer will easily be able to design and specify a safe and durable structure. When bridges are built using these beams without any encouragement on my part, I will consider the endeavor a true success.

Beyond funding, has your experience with the IDEA programs been useful in developing your project?

The IDEA program has been an invaluable asset. The funding is no doubt critical, in that there just aren't many avenues for an independent inventor or small company to gain access to that kind of seed money to pursue the initial stages of research and development. However, beyond the funding, the IDEA program provides a level of credibility that helps gain access to individuals that can help make or break the success of the project. Whether it is potential customers, investors, or panel members who can provide valuable input, the reputation of the IDEA program is highly regarded in the transportation industry and needs no introduction. I would also credit HSR-IDEA Program Manager, Chuck Taylor, with helping me maintain my enthusiasm in pushing this project forward. In my mind, his optimism and encouragement characterize the intent of the IDEA Program. ❖

Red Hot Data for Bridge Decks

When subsurface layers of pavement in a bridge deck separate, deterioration of the bridge deck speeds up, causing traffic flow to slow down. This unseen delamination can be difficult and expensive to discover, and require prolonged lane closures that both highway workers and highway users want to avoid. An NCHRP IDEA project investigated by Infrasense, Inc., tested a combination of standard pavement heaters and infrared thermography equipment to detect temperature differentials that indicate subsurface deterioration of bridge decks. A laboratory test slab was built with simulated delaminations. The infrared data collected on the heated slab showed detectable temperature differentials at the delaminated locations, proving the feasibility of using an active infrared system for bridge decks.

Cost analysis shows that using infrared thermography to detect bridge deck deterioration on a standard overpass bridge costs less than half of the conventional chain-dragging method and requires only brief moving lane-closures. A number of state transportation agencies are expected to collaborate with field testing and demonstrations of the technology. ❖

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What Lies Beneath

Delays during highway construction projects are very often the result of subsurface surprises. Knowing what is belowground before breaking ground could reduce change orders, construction claims, schedule slippage, and cost overruns. Argus Technologies has developed mobile geophysical equipment they call EM3 that can acquire subsurface data for three depths or volumes simultaneously and can electromagnetically

map 140 lane-miles a day. The result is greater confidence in project decisions because they are based on far more data about what lies below the surface than can typically be acquired by other systems and methods.

Caltrans and the investigators of this NCHRP IDEA project are collaborating on two highway projects. Teams will meet with project and functional managers to establish needs and schedules. Surveying the area of potential effect will produce data along the road axes and sinusoidal lines will improve coverage as well as the ability to interpret linear features such as utility lines. Data will be analyzed through software that can be used to construct 2D contouring and 3D inversion models of both apparent conductivity and magnetic-susceptibility. Results of the EM3 data analysis will be evaluated through groundtruthing conducted by Caltrans. After the assessment to quantify cost and time savings and identify any added value, Caltrans will make the information available on its Web page. ❖

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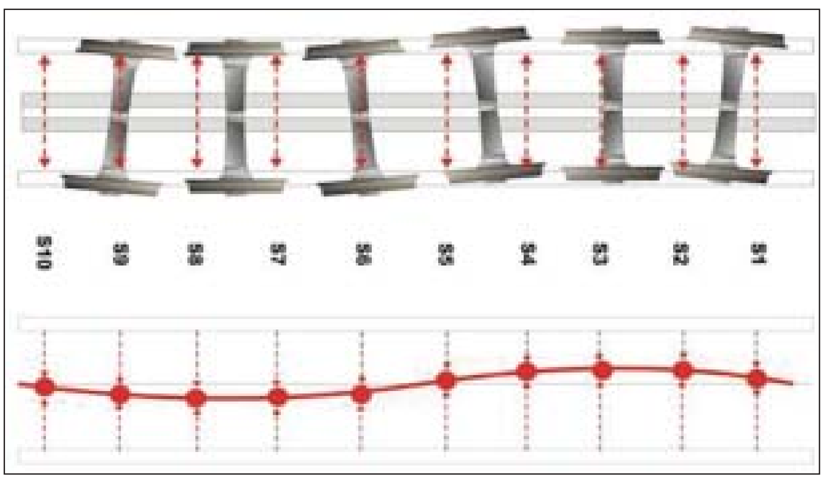
Truck Hunting

As rail car suspension systems and wheel sets, called trucks, degrade with use, rail cars can rock from side to side as the trucks "hunt" for secure position on the tracks. This lateral instability accelerates degradation of the component parts and can cause track damage and even train derailment. Onboard instrumentation has been used in some cases to detect hunting, but that solution has practical limitations. Another way to detect hunting is being tested in a Safety IDEA project. An array of non-contact displacement transducers is placed at intervals along a section of track on which trains operate at speed. A particular wheelset's path through the array is determined through various measurements and the data can be analyzed to identify a truck with lateral instability.



Investigators from the Transportation Technology Center, Inc., in Pueblo, Colorado, a subsidiary of the Association of American Railroads, are conducting tests to determine the viability of this modular and transportable system for identifying dangerous lateral instability. ❖

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Business

They are the Champions

Nearly everything that we can buy in a box—software or cell phones, for example—represents countless ideas and innovations that we as consumers do not see or know or particularly care about. Innovation in transportation can be even more obscure: we're just not likely to notice that advanced algorithm controlling the traffic signals on our way to work. That obscurity is an important factor in the perceived utility of research and a reason to applaud supporters of innovation.

It is a challenge to champion the invisible. Those who value the things that make things work and the possibilities inherent in serious investigations—even if the benefits are not immediate—have the vision to see the invisible. They invest in innovation because they believe that the price of not imagining the possible is too high. But these champions, and their contributions, are often obscure themselves.

The New York State Energy Research and Development Authority (NYSERDA) and the Ohio DOT are both champions for transportation research. Since 1975, NYSERDA has funded projects that span a wide range of transportation issues that challenge both New York State and the nation. Alternative fuels, advanced vehicles and vehicle components, infrastructure, rail, and transit are among the research areas funded. In fact, two projects funded by IDEA programs also received funding through NYSERDA for next-stage development. A hand-held device to detect rail wheel cracks developed by International Electronic Machines is now available after "graduating" from both NYSERDA and High-Speed Rail IDEA. TransTech's nonnuclear pavement quality indicator now sells on the international market in part because of its early partners in research, NCHRP IDEA and NYSERDA.

Ohio DOT's Office of Research and Development established the Partnered Research Exploration Program (OPREP) three years ago when Monique Evans, PE, became administrator. Based loosely on the IDEA programs, OPREP demonstrates a commitment to basic research and belief in the potential of innovative concepts to address long-range transportation goals. Annually, $100,000 is allocated to the program, and at least 50% of funds for each project must be from another source, which addresses the need to leverage research investments. ODOT's in-house research team programs its resources for much-needed applied research, but funding OPREP, which solicits proposals, is investing in the future. A slogan on the ODOT Office of R&D newsletter captures the idea: "He who does not look ahead, remains behind." ❖

Contact:
NYSERDA at: **www.nyserda.org**; information about OPREP is available at **www.dot.state.oh.us/divplan/research/manual**.

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