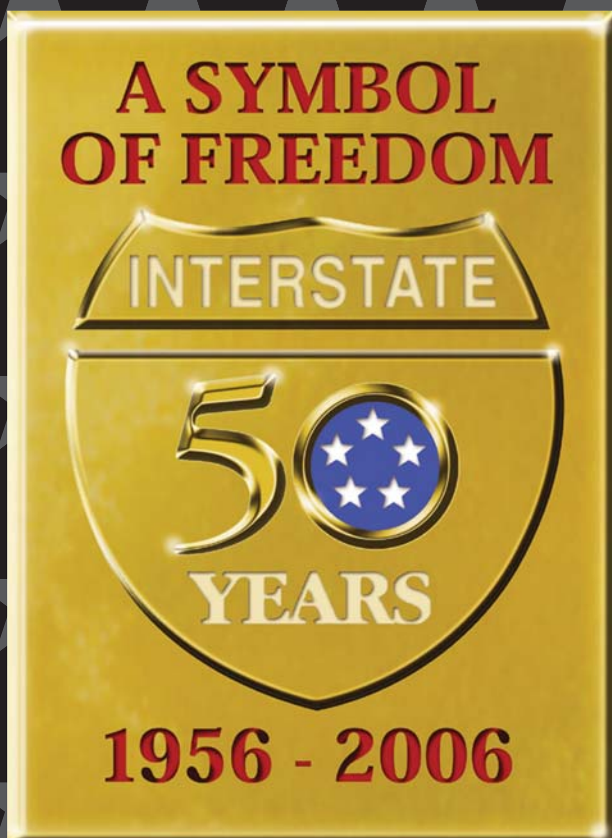
SPARKING INNOVATIVE TRANSPORTATION SOLUTIONS

Issue 10
Fall
2005

HIGH-SPEED RAIL
HIGHWAY SYSTEMS
TRANSIT &
TRANSPORTATION SAFETY

Ignition

News from TRB's IDEA Programs



INSIDE:

- Steve Andrle, Tom Bryer, and John Conrad consider what we need to know for the next 50 years

TRB
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

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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: Many events are planned to commemorate the 50th anniversary of the Interstate Highway System. Visit the AASHTO clearinghouse of Interstate events at: http://interstate50th.org

TRANSPORTATION RESEARCH BOARD
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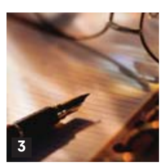
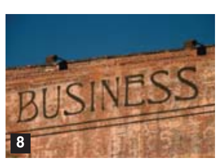


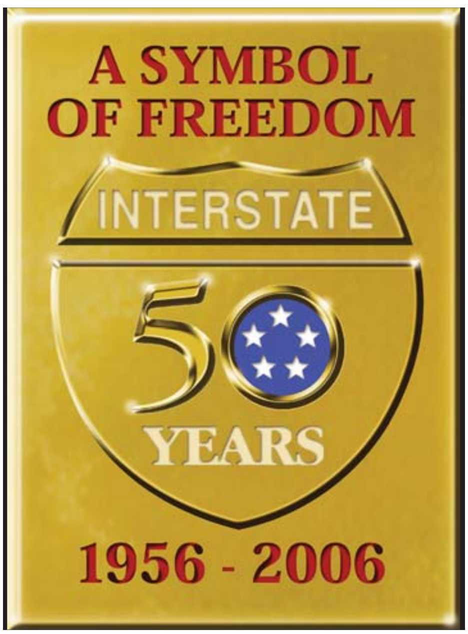


From the **Editor's** Desk

Since 1955, when 36,300 people lost their lives on our highways , head-on and angle crashes have virtually been eliminated on the Interstate system. Since 1975, it is estimated that seat belts, child restraints, air bags, helmet laws, and a higher age for legal drinking have saved more than 244,000 lives.* Research on roadway design, vehicle safety features, and all the related areas was in part the basis for these changes. In this issue of Ignition, Steve Andrle, Tom Bryer, and John Conrad, all leaders in the transportation community, share their thoughts on the research we need for the next 50 years. Each has different areas of expertise and a different perspective on the issue, so it's surprising—and encouraging—to find congruence among their recommendations.

It's hard to tell from the picture on page 6 what makes that direct current motor different from any other, but tests are showing that the differences in this innovative arrangement have real benefits. The New Ideas section describes this project, along with a test method for low-temperature limits of asphalt binders (this project might have received unfair advantage from Mother Nature), and two IDEA projects that are now on the market.

And please take a look at the Business section, both to celebrate the success of research that received early investment and to read—in 25 words or less—the secrets of that success.



Linda Mason
Communications Officer
Transportation Research Board
of the National Academies

Be sure to visit the IDEA exhibit at the TRB Annual Meeting in Washington, DC, January 23–25, 2006.

*From Table 2-30, *National Transportation Statistics*, Bureau of Transportation Statistics, 2005. On the Web at: www.bts.gov/publications/national_transportation_statistics/2005/html/table_02_03.html

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

What Do We Need to Know for the Next 50 Years?

When President Eisenhower signed the Federal-Aid Highway Act of 1956, establishing the Interstate Highway system of multilane roads that would connect the country from coast to coast, he had reached a primary goal of his term in office. As Lt. Colonel Eisenhower in July of 1919, he had been with the Transcontinental Motor Convoy when it left the zero milestone in Washington, DC, to determine how long it would take a military convoy to cross the country. Averaging a rate of 58 miles a day and arriving in San Francisco on September 6th, the answer turned out to be 62 days. As president, he put high priority on developing a national system of roads that would strengthen both the nation's economy and its security. And so began the largest peacetime construction project ever undertaken: more than 46,000 miles of Interstate highways.[1]

Now the Interstates have aged and deteriorated under a volume and weight of traffic that far exceeded what they were designed to carry. The number of vehicle miles traveled increased by 76% between 1980 and 1999. That number is expected to increase again by 50 % over the next 15 years. Rehabilitation alone will not provide the service and benefits we need from our transportation system. We'll need innovative thinking about how we design, equip, operate, and maintain the system to meet Eisenhower's goals in the 21st century.

These needs are driving plans for research at the federal level and among the states. IDEA program sponsors seek innovative technologies to advance safety, reliability, and security for rail transit and commercial viehicles as well as highways. A new strategic highway research program is structured around four identified transportation goals: renewal, reliability, capacity, and safety. Implicit in the goals are the problems that currently plague many of our highways: congestion resulting from recurring work zones and heavy traffic volume, unpredictable travel times because of incidents that cause delay, and the safety risks that accompany each of these. Other newly authorized programs will focus on methods for addressing specific problems, such as advanced and alternative materials, high-performance bridges, bus rapid transit, and advanced travel and freight forecasting.

Many of the nation's transportation leaders collaborated in developing these research programs, helping to define what we need to know to achieve the goals and solve the problems. We've asked several of those leaders to share their thoughts on the subject. Stephen Andrle, Center for Transportation Research and Education at Iowa State University, who invited contributions from Tom Maze, Reg Souleyrette, and Terry Wipf, all of Iowa State; Thomas Bryer, of SAIC; and John Conrad, Washington State DOT, have all participated in planning various aspects of a strategic highway research program and they have very generously responded to our questions with informed and thoughtful comments.

While those comments addressed a range of issues from infrastructure finance to freight management, two themes were common to all responders: that nontraditional partnerships are needed to spur innovative solutions and that integrating advanced technologies is the way to transcend incremental improvements.

Partnering For Progress

It is clear that our respondents aim for a reinvented approach to achieving goals in the coming years. All of them encourage alliances across many research areas, citing the synergy of shared knowledge and responsibility. Partnerships were considered essential to expanding finance options, deploying advanced technologies, accommodating environmental concerns, and encouraging innovation.

Steve Andrle identified finance as the number one issue for the next 50 years. "Because of our land use decisions, automobiles will continue to be the primary method of travel in the U.S. and options for paying for the roads they travel on are currently the same as they were in 1950—tolls, property tax, or fuel tax. Now we can collect tolls electronically, but we cannot reduce congestion or improve safety with funding schemes that consume a state's construction dollars in debt service. Rapid construction techniques have great potential for becoming standard practice, reducing hazards and congestion along with construction time. But these techniques will not be effective if we cannot finance multi-billion dollar reconstruction efforts over a few years. This means concentration of financial resources beyond the capability of state bonding, which will require a new social contract for highway funding."

Andrle points out that highway capacity would also benefit from technology partnerships. "While public investment will be needed for renewing and expanding the transportation infrastructure, partnerships among private- and public-sector parties will be needed to increase roadway capacity by improving efficiency. For example, congestion occurs when vehicles occupy only 18% of the road space; 82 % of the road space is between vehicles (headway). Technology that would allow vehicles to travel safely where headways consume only 65% of the roadway at current speeds could double the capacity of the system even where available right-of-way is limited."

John Conrad identified operations and system reliability as critical issues for the coming decades, in contrast with design and con-

[1] Highway Statistics, Federal Highway Administration, U. S. Department of Transportation, 2003.

struction, the focus of his early career. Technologies that integrate infrastructure and vehicles can advance safe and reliable travel on highway systems, he says, but deploying these emerging technologies will require new alliances and cooperative relationships between the automobile manufacturers and the builders and operators of the highway system.

Conrad sites a new major initiative of the US DOT as an example of such a relationship. The Vehicle-Infrastructure Integration (VII) initiative works through a coalition of federal, state, and local transportation agencies, automotive manufacturers, and national associations to deploy a communications system that supports vehicle-to-vehicle and vehicle-to-infrastructure communications. Potential benefits include crash avoidance and vehicle guidance systems, improved traffic flow where signal timing is based on real-time traffic counts, hazard detection, in-vehicle signing, and real-time schedule information for fleets, to name just a few.

IDENTIFIED RESEARCH NEEDS

Data and safety system integration

Electronic traffic law enforcement

Freight logistics systems

Fuel cells and electrical energy storage

Funding options

Rapid road and bridge reconstruction techniques

Vehicle guidance systems

Innovative technologies may offer the best advances in improving highway operations, Conrad says, but the lead time for bringing them into the marketplace requires a change from traditional program financing approaches. This too will require innovative thinking and nontraditional alliances.

Tom Bryer illustrated his point that partnering for safety will be the primary issue of the coming years with two telling statistics:

- Since 1955, more than 2 million people have lost their lives on our highways.
- The fatality rate per 100 million vehicle miles traveled plummeted from 6.5 in 1955 to slightly less than 1.5 in 2004.

"One may hypothesize," he writes, "that the safety advances made to the highway, vehicle, and driver have made travel over a specified distance a lot safer, but because we are driving more miles and there are more of us driving, the total number of highway deaths has not been impacted, particularly over the past 20 years.

"If we are to ultimately achieve a point where highway deaths are very rare events, two critical steps are needed. First, we must identify with some confidence those very promising mature technologies and inventions that have strong potential to meet [established] criteria. 'We' being a combination of government, automotive industry, representatives of the driving public, academia, affected industries, including health and insurance, and others. Second, when all rigorous quality requirements have been met and the concept's value accepted by all the members of this group, we must take an integrated approach to developing, assessing, validating, and deploying these innovations."

Data—both generated and collected by the various technologies that will integrate vehicles and highways—can also serve newly allied organizations as information becomes available through analysis. Such information can be a tool for asset managers, product manufacturers, freight movers, and others who could be collaborating on projects. Andrle points out that the private sector will increasingly equip cars with advanced electronics to improve safety, but access to public-sector intelligent transportation systems and road weather data will be required to make the equipment useful. Bryer emphasizes the importance of learning how to use data for safety improvements. He writes, "Progress in managing and analyzing massive amounts of data quickly and inexpensively, coupled with continued improvements in sensor reliability and sensitivity, may soon make safety goals achievable."

All this suggests that the synergy of invested partners will be the source of innovations that propel our progress. It's a concept that is central to agencies and innovators who partner through IDEA programs. ❖

New Motor Design Gains Traction

An innovative electric motor technology for railroad locomotives is being developed in a project funded by the High-Speed Rail IDEA program. This new motor is powered by direct current but does not need a commutator and carbon brushes, as do conventional DC motors, because permanent magnets in the rotor replace electromagnets. The most significant innovation in this technology is the solid state switching and control system that replaces the commutator and brushes. Such motors have the potential to be much lighter and to have superior speed-torque performance than both conventional DC and AC motors.

The railroad industry currently uses both commutator-type DC motors and the relatively new inverter-driven AC motors for locomotive propulsion. The AC motors, developed to circumvent some shortcomings of DC motors, have very high starting torque capacities and longer service life than DC motors. However, the AC motors must be driven at very high voltages to achieve high speeds and still are limited in speed as compared with commutator DC motors. An additional drawback is that AC motors generate substantial heat in their rotors, which forces designers to oversize them to provide for heat dissipation, making inverter-driven AC motors at least as heavy as DC motors and limited in speed and capacity.

The permanent-magnet DC motor has the potential for maximum torque at any speed and at less than half the weight of current motors. Superior service life and efficiency are also expected, benefits enhanced by lower operating temperatures. This new motor does not require driving voltage levels that increase with speed, and so can operate at constant voltage. A prototype motor now under construction is expected to be able to run at speeds of 65 mph with double the load capacity of the D77 traction motor used in GP 38 locomotives. The motor is designed to be capable of 80 mph with the same load capacity.

The prototype traction motor will be installed in the housing of a D77 traction motor used in a GP-38 locomotive. The new motor cores, including the integrated controller, will fit in the existing housing with space to spare. Once construction is completed, the motor will be installed on a dynamometer test stand and its performance recorded and compared with the conventional D77 motor. If these tests are successful, future development could include installing a full 4-motor complement under a locomotive for field testing and evaluation. ❖

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Recipe for Strength

A formula for reinforcing steel developed by researchers who received funding from the NCHRP IDEA program uses the inherent strength of the metal during one phase of processing (martensite) and the ductility of the soft ferrite phase to cook up steel that is both strong and resistant to corrosion. The microstructure formed during the patented process minimizes formation of microgalvanic cells, which contribute to the initiation and advancement of corrosion. The process is the basis for steel rebar that is now among the products offered by MMFX Steel Corporation.

Work on the low-alloy and low-carbon formulation developed by Gareth Thomas and David Trejo of the University of California at Berkeley continued after NCHRP IDEA Project 28 was completed and research results are showing up in bridge decks and piers, foundations, and similar underwater or corrosion-prone construction projects. More information is available on the company's Web site: ***www.mmfxsteel.com***. ❖

Signal Success

Where roadways cross rails, vehicles and trains can cross each other, too. The Federal Railroad Administration's Office of Safety Analysis has documented 1,863 incidents at highway/railroad crossings in the United States between January and August of this year (see: http://safetydata.fra.dot.gov). To the extent that driver behavior is influenced by information, this statistic would argue for enhanced warning systems that alert drivers of the approach of oncoming trains.

Early in the High-Speed Rail IDEA program, in April of 1997, the panel of rail experts that serves this program funded a project that could, if proven feasible, advance the options that railroads have for warning systems. O'Conner Engineering proposed to develop a system of microwaves, sensors, and Doppler radar to detect the presence of a train, determine its distance from the crossing and direction of movement, and activate a crossing signal at the appropriate time. The project was completed in May of 2000 when prototype systems were evaluated in a series of field tests.

Results of the tests showed that, while the concept proved feasible, additional development was needed to improve performance on various crossing and train configurations. In a perfect example of how the relatively small, early investment of IDEA funds can make a difference in public safety improvements and other areas of transportation, O'Conner Engineering was able to continue developing the system and overcome the limitations. Solar-powered and easy to install, the improved product is now industry approved and part of a range of rail crossing safety features developed and sold by the company. ❖

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270-838-1000
www.oconnerengineering.com

The Cracking Point

January 2004 turned out to be the perfect time for NCHRP IDEA investigator Simon Hesp to test the low-temperature limits of asphalt binders that had been used in seven side-by-side test sections in Ontario. The test sections were part of Highway 655 in far northern Ontario and, for eight history-making days that month, temperatures 5mm below the surface of the roadway were -30°C (-22°F). The air temperature was -47°C (-52.6°F). It was nature's own version of accelerated pavement testing.

Highway 655 pavement test site in northern Ontario just after construction and apparently before the cold spell

The point of the testing is to establish criteria for asphalt binder performance grade specifications based on low temperature and fractional mechanics. The project looks at the fracture behavior of binder and determines the temperature at which that behavior can be expected. Typical tests for establishing binder performance at low temperatures are based on rheology, how the binder flows. Characterizing binder behavior in a brittle state and studying how it fractures could improve reliability of performance predictions for asphalt pavements and in turn, improve actual pavement performance.

The proposed specification test method requires no new equipment and the investigator is working closely with the Material Engineering and Research Office of the Ministry of Transportation of Ontario, as well as with users and producers in the Canadian asphalt industry to include the specification in future hot mix contracts. ❖

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DriveCam in Top 100 of Fastest-Growing Companies

With a 3-year sales growth of 1,106 percent, former IDEA project DriveCam ranked 67th this year in the Inc. 500, a list of fastest-growing U.S. companies compiled each year by Inc. magazine. Eligible companies must be U.S.-based, independent and privately held, and have had at least $500,000 in net sales in the base year of 2001. Companies are ranked on cumulative 3-year sales growth from 2001 to 2004. Tax forms, audited financial statements from certified public accountants, and interviews with company officials are used to verify company information.

In 1999, DriveCam's inventor, Gary Rayner, received funding through the ITS IDEA program to test the viability of his concept for a video and data recorder for vehicles. (Gary describes those early days in an interview in Issue 2 of Ignition. See page 4: http://trb.org/publications/ignition/ignition_2.pdf .) Six years later, about 30,000 systems have been sold and 2005 sales are expected to double the previous year's figure as DriveCam systems are being implemented by larger utility and service/delivery fleets, according to CEO Bruce Moeller.

DriveCam started as a solution to a widespread problem, was developed with single-minded devotion, tested with partnering customers, and marketed by professionals. Now it seems those characteristics could be signs along the road to real commercial success for a transportation technology. You can learn about DriveCam at *www.drivecam.com.*

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