Field Notes

The newsletter of the Infrastructure Technology Institute at Northwestern University

The Infrastructure Technology Institute is a National University Transportation Center supported under a grant from the U.S. Department of Transportation’s Research and Innovative Technology Administration (RITA).
Much energy and debate is focused on crafting our nation’s economic recovery program. Infrastructure investments will be a large part of the program, an essential and logical action since the restoration and expansion needs are great and the employment and economic multiplier effects generated by infrastructure projects are substantial.

But infrastructure revitalization should not be a once-and-done program. There is a need for a revised long-term infrastructure management strategy to assure that the United States remains secure, economically competitive, and environmentally sound.

This is particularly important for our surface transportation infrastructure – highways, bridges, railroads, and intermodal facilities – where important changes are needed, and some are already underway. Among these important changes are:

- **NEW FUNDING BASIS**
  Supporting the highway and mass transit systems with user fees, primarily in the form of motor fuel taxes (18.4¢ per gallon at the Federal level, and similar state fees), has worked well for more than half a century, but times have changed. These fees are based on fuel consumption, not fuel costs, yet transportation maintenance and construction costs inflate proportionally to market costs of energy and other resources. This means that the funds to manage the transportation network are lagging behind the costs.

  At the same time, vehicles are becoming more fuel efficient in response to policies and prices. A growing proportion of vehicles are not fully dependent on oil, instead using mixes of biofuels, hybrid power, and, most likely in the future, electric power from various sources. Yet the current financing system allows the same amount of travel to generate less revenue to support to road network. While total travel, measured in vehicle miles of travel (VMT), continues to increase, the rate of growth has been slowing. When oil prices spiked in the fall of 2008, year-over-year VMT actually decline by nearly 5%. This means declining fuel sales and reduced revenue for the road system.

  The most promising financing alternative is a road pricing scheme that charges users by VMT, location, and time of day – congestion pricing. Beyond serving as a revenue collection scheme, congestion pricing has the added advantage of allocating scarce network capacity in proportion to value, as manifested through in willingness-to-pay. Both the effectiveness and technical feasibility of congestion pricing have been proven in major applications around the world and a few in the U.S., though important obstacles remain, including convincing the public that the road system really isn’t free, resolving important concerns about income equity and privacy, and designing a transition process to move to a new funding basis.

- **STREAMLINED IMPLEMENTATION PROCESS**
  It takes too long to implement significant changes to the surface transportation system. Major projects can take a decade or more from plans to pavement. While time is necessary for thoughtful analysis and deliberation, long implementation times boost costs: construction costs continue to rise, and valuable, often essential services are delayed. Rapid implementation can be particularly critical when the task is to restore service after unexpected interruptions, e.g., the I-35W bridge in Minneapolis or the I-580 ramp in Oakland.

  The challenges are to find ways to reduce implementation times without sacrificing careful consideration of stakeholder concerns and social and environmental impacts, and while including the best available system and service designs.

  Fortunately, there is a growing set of examples of project acceleration strategies that meet these challenges. One of the keys is early engagement
of stakeholders and efforts to address and resolve contentious issues, including impact mitigation through design and collaborative efforts among public agencies. Incentive contracting and design-build strategies can also reduce delays. A clearer assessment and better understanding of the economic and social value of proposed transportation facilities may also provide a more objective basis for reaching agreements on project implementation more quickly.

**INTEGRATED SYSTEMS VERSUS SILOS**

Transportation is a highly integrated network system. People and goods usually have a variety of mode and path choices for journeys; modes are both complementary and competitive. Congestion or service disruptions on one mode can cause – and are a motivation to encourage – diversions to another. Yet government programs to invest in, and to regulate, transportation services and facilities tend to keep modes and programs in separate “silos.”

For the nation to get the best transportation service – in terms of capacity, performance, and environmental impacts - it is important to plan and implement integrated systems and services, taking advantage of modal synergies. This suggests, for example, the importance of integrated planning and funding for metropolitan and intercity passenger services. The old terminology was balanced transportation systems. Today there are more outcomes to balance, including environmental consequences, energy and climate change, and equity considerations.

In the freight realm, it has become important to integrate planning for rail and highway facilities and services. Logically viewed as competitive, rail, relying on private infrastructure, and trucks, which now use public highways, are also highly complementary. Container freight, which moves freely between road and rail, illustrates this complementarity. Today, planners and decision-makers in several busy corridors are looking at road-to-rail diversion from the point of view of public policy as a way to decongest the roads and reduce damage to infrastructure.

System integration is not new, but the job is not done. There are needs to address analysis methods, program design and policies, and funding structures that recognize intermodal synergies, including the public benefits of private transportation services.
• **DATA-DRIVEN DECISION PROCESSES**

In the race to advance the economic recovery, and in the steady state that follows, it is important to get the most value for investment dollars through data-driven decision processes. This means investing in transportation infrastructure on the basis of objective measures of need, particularly physical condition and operational performance, and value – that is, function and level of utilization, now and in the future.

This presents special opportunities for development and deployment of new and better tools for assessment of structural health and operational performance in real time, the assembly and integration of data to produce useful information for decision support, and the delivery of that information in forms that work for decision makers. Embedded sensors and remote, continuous monitoring – the core activities of ITI – must become the standard for new construction and rehabilitation. Data analysis, forecasting models, and creative reporting will be essential to assure the usefulness to decision makers of the massive data streams these technologies generate.

Change is needed, and change is coming in transportation systems planning and management. The report of the National Surface Transportation Policy and Revenue Study Commission (December, 2007) defines a roadmap for long-term change. There are critical roles and opportunities for research, policy development, and organizational change. It is important to look beyond the recovery to build a more robust and sustainable integrated transportation system for the nation’s future.
The ITI Research Engineering Group (REG) continues to be a leader in the area of practical applications of acoustic emission (AE) testing to steel highway bridges. AE testing employs special transducers to detect ultrasonic noises emitted by engineering materials under stress. In the experience of the REG, acoustic emission is particularly useful as a means to locate and characterize cracks and other defects in steel bridge details. By deploying an array of transducers around a known defect, or in a high-stress, fracture critical, or other area where a defect might be suspected, it is possible to locate an active crack or quantitatively determine whether a crack is actively growing or has been extinguished.

In October, 2008, members of the REG attended the 51st meeting of the Acoustic Emission Working Group, held in Memphis, Tennessee. ITI researcher David Kosnik presented his award-winning extended abstract, “A New Approach to Acoustic Emission Testing of Difficult-to-Reach Steel Bridge Details,” which documented the REG’s experience in AE evaluation of a crack in a fracture-critical steel bridge member. Previous AE work on highway bridges has been contingent on favorable field conditions – particularly access, weather, and power. To overcome these limitations, the REG developed a weatherproof enclosure and robust communication and control schemes to allow the collection of many hours of data from a detail that was accessible only by lift bucket during limited lane closure windows. The data showed that the crack was not growing; corroborating results were obtained from other, more traditional non-destructive evaluation techniques. In addition, the AE data indicated an additional defect near the crack. The presence of this defect, which is believed to be a slag inclusion, was confirmed by radiography, further validating the utility of AE testing of steel bridge details.
NEW DATA GIVES INSIGHT INTO BRIDGE COLLAPSE

The 790-foot main span of the Koror-Babeldaob (KB) Bridge, completed in 1977, connected the islands of Koror and Babeldaob in the Republic of Palau. The KB bridge set the world record for length of a prestressed concrete box girder bridge. While it is normal for bridges of this type to sag slightly as they age, the observed sag at the midpoint of the bridge after only 18 years in service was double what the designers predicted. A remedial repair was performed in 1996; however, the bridge suddenly collapsed three months later.

In late 2008, ITI researcher Professor Zdenek Bažant, after taking part in a successful campaign to gain public release of the engineering data that had been sealed by litigation since the incident, completed the first of two analyses of the degradation and collapse of the KB Bridge. In this first analysis, Bažant addressed the cause of the sagging that eventually prompted remedial action that accelerated the collapse of the bridge.

Because it is impractical to build a full-sized bridge in a laboratory to test and measure how it will perform, engineers must combine small-scale experiments with mathematical models to determine to the safest ways to design a structure. Bažant’s analysis concluded that the excessive movement at the middle of the bridge was not caused by any error in fabrication or construction but by the design models that failed to predict the performance of the structure once it was built.

All models used in today’s engineering practice underestimate the degree of structural degradation that affected the KB Bridge over 18 years of service. By contrast, Bažant’s new model, which is not currently part of the standard by which structures of this type must be designed, accurately predicts the performance of the bridge. Bažant hopes to incorporate this new model into the standard design practices of concrete structures to prevent this type of incident in the future.

WEB SITE EVALUATES PAVEMENT PERFORMANCE

Mathematical modeling of the performance of highway transportation infrastructure plays a crucial role in decision making for maintenance and rehabilitation. Using these models, which incorporate factors such as traffic loads, environmental conditions, and pavement maintenance history, engineers can better predict when pavement will need rehabilitation, how much that rehabilitation will cost, and when the pavement must be replaced. This information can then be used in setting maintenance and operating policies.

In late 2007, ITI researcher Professor Pablo Durango-Cohen launched the Pavement Analysis Comparison (PAC) web site dedicated to the mathematical modeling of pavement performance. The PAC web site, hosted by ITI, contributes to the theory and practice of performance modeling by serving as an authoritative repository of modeling information and by providing online access to a test bed that allows researchers to evaluate the capabilities of their own models against both established benchmarks and state-of-the-art models from recently published literature.

Because of the interactive nature of the PAC web site, it supports development and testing of more sophisticated pavement performance models that, in turn, improve the overall performance of the nation’s highways.

During the last quarter of 2008, the PAC web site received over 500 visitors from over 100 unique addresses, with the majority originating from universities and corporations in the United States and Taiwan.

VISIT THE PAC WEB SITE: modelingpavements.iti.northwestern.edu
On November 13th, 2008, policy makers, transportation professionals, faculty, and students assembled at Northwestern for the Second Annual William O. Lipinski Symposium on Transportation Policy.

The Symposium brings together transportation leaders to discuss innovative approaches for planning, financing, and constructing transportation infrastructure. Using the 100th anniversary of Daniel H. Burnham’s 1909 Plan of Chicago as a vantage point, speakers and participants at the Symposium envisioned a future transportation system for the Chicago region to meet the accessibility, capacity, quality, and sustainability needs of our society and economy for the next century. The series of presentations and panel discussions identified current challenges facing transportation systems locally and nationally and explored avenues for change.

After former U.S. Representative William O. Lipinski opened the forum named in his honor, U.S. Representative John L. Mica (R-FL), Ranking Member of the House Committee on Transportation and Infrastructure, discussed the need for a national strategic infrastructure plan. Rep. Mica emphasized the importance of using targeted infrastructure investments to stimulate economic recovery, and he advocated a clear financial plan and the use of objective project selection criteria. Finally, Rep. Mica spoke of the need to make project implementation processes more efficient, citing the rapid replacement of the I-35W bridge in Minneapolis.

The theme address was given by Carl Smith, Franklyn Bliss Snyder Professor of English, History and American Studies at Northwestern University. The author of The Plan of Chicago: Daniel Burnham and the Remaking of the American City (U. of Chicago Press, 2006), Prof. Smith provided an illustrated
Dr. Michael Toman of Johns Hopkins University spoke next, outlining the global energy picture, its relationship to the environment, climate, and national security, and the implications for transportation. Discussing global warming, Dr. Toman pointed out that one-third of U.S. CO₂ emissions come from transportation, and that pricing options are likely to show earlier effects than technologies on reducing both energy consumption and greenhouse gas emissions.

Observing that energy simply can not be left out of future transportation planning, Toman noted that the global market is affected by exploding demand for energy from China and India, as witnessed by the 2008 jump in oil prices and the continuing escalation of the costs of construction materials.

Dr. Martin Wachs of the RAND Corporation was the last speaker of the morning session. He discussed critical policy and financial issues facing transportation, key among which were congestion mitigation, efficiency of overall transport, fiscal sufficiency, and equity. He contrasted the Burnham era, when solutions were found in infrastructure investments, with contemporary approaches that emphasize financial instruments to influence behavior and provide sustainable support.

Wachs described the highway transportation finance crunch in terms of increasing needs and costs contrasted with decreased user-tax revenues due to increasing fuel economy and use of biofuels. He stated that user-based financing was the key to transportation infrastructure investment, and he made a strong case for use-based pricing, including time-of-day (congestion) pricing, cordon pricing (as in London and Stockholm), and mileage charges using vehicle tracking technologies. He cited examples of the effectiveness of use-based pricing in reducing congestion and roadway damage and underscored the political challenges of implementing such financing and demand-management schemes.

A panel discussion concluded the morning session, extending the earlier talks and their implications for Chicago. Larry Johnson of Argonne National Laboratory predicted changes in vehicle technologies, saying the hybrids would become standard, taking advantage of advanced batteries and regenerative braking. Professor Joseph Schwieterman of DePaul University discussed key issues for the Chicago region, including assuring the efficiency of freight transportation and reinvigorating public transit.

ITI Director Joseph Schofer made closing remarks, urging that Chicago recapture a leadership role in transportation innovation. He emphasized that challenges ahead revolve around sustainability of key resources – energy, climate, and funding and the road ahead will be paved with a mixture of capital investments and operational improvements built on advanced communications and computing technologies. Schofer closed with a call to increase
collaboration among industry, government, and the several universities in the region that have strength in transportation.

At the lunch break, William O. Lipinski presented U.S. Representative James Oberstar (DFL-MN), Chairman of the U.S. House Transportation and Infrastructure Committee, with the inaugural David F. Schulz Award for Outstanding Public Service in Transportation and Infrastructure Policy. Present during the ceremony were Jo Ann and Bobby Schulz, the widow and son of David Schulz, the late founding director of Northwestern’s Infrastructure Technology Institute. In his acceptance speech, Rep. Oberstar called for action to restore our rapidly deteriorating infrastructure.

At the start of the afternoon session, Frank Kruesi, Director of the City of Chicago’s Washington, D.C. Office of Intergovernmental Relations, emphasized the centrality of Chicago in the nation’s transportation system. He described some of the important transportation initiatives underway in the City and the region, including re-establishing the importance of transit by expanding the Chicago Transit Authority rail lines; the O’Hare Airport Modernization Program; the Midwest High Speed Rail Initiative; and the transportation elements of Chicago’s 2016 Olympic bid. Paraphrasing Daniel Burnham, Kruesi observed that “…it takes money to stir men’s blood.”

The afternoon continued with a panel of members of the House Transportation and Infrastructure Committee: Rep. Jerry F. Costello (D-IL), Rep. John J. Duncan, Jr. (R-TN), Rep. Daniel Lipinski (D-IL), and Rep. Thomas E. Petri (R-WI). The Members shared their views of future transportation needs and issues, as well as the expected and essential elements of the forthcoming surface transportation reauthorization act.

Rep. Petri argued that transportation is not high enough on the national agenda; he noted that President Eisenhower believed that the real strength of the country was in productivity, not in arms. He called for a renewed national commitment to bridges and public transit.

Rep. Petri spoke in support of project CREATE – the Chicago Regional Environmental and Transportation Efficiency Program, the public private partnership to enhance rail freight efficiency in Chicago, because of the benefits it will produce for the nation. He observed that the U.S. now spends about 2% of GDP on transportation, while China spends 9%. Rep. Duncan expressed concern over the state of the Highway Trust Fund (HTF), reminding the group that Congress appropriated $8 billion from the general fund in 2008 to keep the HTF solvent. To make the best use of these funds, it will be important to streamline the project implementation process. This will cut costs and speed project delivery.
Rep. Costello joined in support of the need for and value of reinvesting in surface transportation infrastructure as a part of the recovery program. He said that every $1 billion invested in transportation infrastructure generates 34,000 person-years of employment and an overall return of $6 billion.

Rep. Costello noted that we cannot promise to do more and to cut taxes at the same time. To get support for additional funds it is necessary to make it clear what benefits will be produced; this should take the form of a national plan for transportation.

Rep. Lipinski underscored the value of megaprojects, large-scale public infrastructure investments of true national significance. Such initiatives require the support of broad coalitions. He predicted that the surface transportation reauthorization bill would begin with a clean slate, offering great opportunities for moving forward.

He declared 2009 as the Year for Transportation, noting the need to reauthorize highway, aviation and transit programs. Directing his remarks more specifically to Chicago, Rep. Lipinski noted the need for more federal support to deal with at-grade railroad crossings, since Illinois has the second largest number of these crossings among the states.

In an interchange among panelist about successes with large projects in Europe, Rep. Lipinski observed that Europeans have higher expectations for service quality and greater willingness to pay for it. Rep. Petri said that in the U.S., infrastructure investment is a hard sell, but Americans expect projects to be done well.

The afternoon ended with a panel discussion by state and local leaders. John McCarron, former editorial writer for the Chicago Tribune and adjunct lecturer in Northwestern’s Medill School of Journalism, suggested the need for more communication with journalists to explain the need for and value of infrastructure to the public; citizens and decision makers need to know why transportation projects are so costly, and what value they produce.

State Representative Elaine Nekritz, chair of the Illinois House Railroad Subcommittee, observed that we have neither a state nor a national plan for transportation. She contrasted that with public-private collaborations elsewhere that seem to produce results. She argued for making freight transportation a key issue because of its importance for economic competitiveness, and she supported expansion of transportation infrastructure to increase capacity.

Milton R. Sees, Illinois Secretary of Transportation, stated that while infrastructure costs money, it generates benefits that produce more money for the economy. Without additional funds, there are severe limits on what the state can do today to improve the condition of transportation infrastructure. Under the current budget situation in Illinois, bridge maintenance is necessarily the main priority.

The legacy of Daniel Burnham and his Plan of Chicago was the underlying theme for this Second Annual Lipinski Symposium. Like Burnham, participants agreed on the critical importance of efficient transportation infrastructure and service to ensure the success of our economy and society. There was broad support for plans – grand plans – for transportation at the regional, state, and national levels. Those plans must be based on a system-wide perspective that balances needs, values and impacts. To justify the costs and secure funds to meet them, it will be essential to help decision makers and their constituents understand the links among transportation, economic competitiveness, and social success.
The latest meeting of the ITI-sponsored Midwest Bridge Working Group (MBWG) was held in December 2008 in Louisville, Kentucky. The forum attracted over 120 bridge professionals from state highway agencies, consulting firms, vendors, and universities for one and a half days of discussion of best practices and technical, political, and financial issues in the field of bridge maintenance and inspection.

The day-long first session included a wide variety of talks on new technology and methodology for bridge inspection and maintenance. One notable presentation was an extensive explanation of Missouri’s Follow-Up Action Required procedure by Ken Foster, who recently joined the staff of the Federal Highway Administration after a long career with the Missouri DOT. Mr. Foster explained that the procedure enables inspectors to report bridge problems or deficiencies which require immediate investigation or corrective action.

The development of the process in 2003 was prompted by a group of inspectors who found that certain potentially critical bridge problems never seemed to be remedied in spite of inspectors’ reporting them after every inspection. Under the Follow-Up Action Required procedure, inspectors submit a form documenting an issue of particular concern (including photographs and other documentation) along with a recommended plan of action for review by an engineer. If the issue is deemed a Critical Inspection Finding (CIF) in need of immediate attention, inspectors and engineers then work together to develop a response plan. Because the new procedure ensures timely and thorough response to inspection results,
the number of CIFs in the first year of the program dropped from 15 to 2, and there have been no more than four CIFs in each of the subsequent years.

Another highlight of the day was a discussion on fracture critical bridge inspection timetables delivered by Professor Rob Connor of Purdue University. Prof. Connor discussed H.R. 3999, the National Highway Bridge Reconstruction and Inspection Act of 2008, which will require engineers to perform a hands-on inspection of fracture critical bridges at the same time every year. He argued that this method is both inefficient and inadequate for ensuring the safety and serviceability of critical structures, particularly since it may result in some structures being over-inspected due to strict calendar requirements while others are under-inspected due to lack of resources. Prof. Connor suggested that the calendar-based inspection schedule currently mandated by federal law should be replaced with performance-based inspection scheduling with an engineering approach similar to that used in aerospace and other industries, allowing engineers to allocate resources where they are most needed.

Two ITI researchers gave presentations in the afternoon. Chief Research Engineer Daniel Marron spoke about noise localization on a new rolling-bascule lift bridge. Mr. Marron’s talk drew on ITI’s years of experience and pioneering work in the application of acoustic emission (AE) testing – a non-destructive evaluation technique which employs special transducers to “listen” to ultrasonic noises made by engineering materials under stress - to large civil structures, particularly steel highway bridges. In this case, the ITI team was able to locate the source of loud banging noises that occurred during movement of the bridge. David Corr, Clinical Associate Professor of Civil Engineering and the newest member of the ITI team, discussed lessons learned from the collapse of the Marcy Bridge in upstate New York during construction. Prof. Corr’s presentation concentrated on the application of finite element models to investigate the collapse.

The morning-long second session of the working group meeting was a two-part discussion for all participants, including an open discussion of general inspection and maintenance issues and a forum in which participants shared agency successes and best practices. Scott Stotlemeyer of Missouri DOT moderated the early session and began the dialogue with talk of the effect of funding shortages in the current economic climate. David Steele of the Kentucky Transportation Cabinet moderated the late morning session, beginning with a success story about the emergency replacement of a small bridge in the coal mining region of southeast Kentucky.

MBWG, which has been supported by the Infrastructure Technology Institute since 1996, continues to be a successful forum for the interchange of information between participating state highway agencies on issues related to bridge inspection and maintenance. ITI works closely with the Kentucky Transportation Center (KTC) and the University of Kentucky (UK) Civil Engineering Department to facilitate Working Group activities.
In September 2008, members of the ITI Research Engineering Group (REG) attended the American Society for Nondestructive Testing’s “Structural Materials Technology Conference 2008: NDE/NDT for Highways and Bridges” conference in Oakland, California. The conference explored the role of non-destructive evaluation and testing throughout the life cycle of transportation infrastructure. ITI researcher David Kosnik presented “Monitoring of In-Situ Strains in Bearing Assembly Anchor Bolts on a Large Through-Truss Bridge,” which summarized testing and structural health monitoring work done by ITI and University of Kentucky researchers on a major Interstate highway bridge.

The paper covered the response to the failure of an uplift bearing anchor bolt on a the John F. Kennedy Memorial Bridge, a large cantilever truss structure which carries Interstate 65 over the Ohio River at Louisville, Kentucky. Analysis of the failed bolt showed that corrosion fatigue was the likely cause; additional inspections revealed significant corrosion damage to the remaining anchor bolts securing the bearing to the pier. The entire bearing assembly was observed to be moving relative to the pier cap as a result of the reduced restraint. The three remaining anchor bolts and the bearing were instrumented to quantify strains and bearing movement under live traffic. Similar measurements were performed on the other three uplift bearings on the truss. When the failed anchor bolt was replaced with a threaded rod, the rod was instrumented and tightened to a specified pre-load to secure the bearing. The axial strain was measured by instrumentation as a securing nut was tightened. Changes in strains on the other bearing anchor bolts were simultaneously measured. Dynamic strains in the retrofitted rod and other bearing anchor bolts were monitored under traffic for 17 hours. Continuous remote monitoring of live strains is being employed to evaluate the long-term performance of the temporary retrofit and aid future decision-making.

When not attending conference sessions, ITI personnel staffed an exhibit booth describing ITI’s work to potential deployment partners and others.
In September of 2008, the ITI Research Engineering Group hosted a short course in acoustic emission (AE) technology to provide the most current training to experienced users, and an introduction to engineers with interest but no previous experience.

AE is a naturally occurring phenomenon whereby a material under stress produces sounds. These sounds, though usually imperceptible to a human ear, can be observed with the use of special equipment; furthermore the location and intensity of these sounds can be used to measure degradation in a material. This technology, though under continuing development, has already proven useful across many engineering disciplines. AE can be used to measure the performance of medical implants, the integrity of pressure vessels, the health of steel bridges, the condition of wind turbines, or the strength of new materials.

Professor Richard Nordstrom of Portland State University, an expert in AE technology and practice, conducted lectures and tutorials on basic AE principles, then provided hands-on demonstrations and lessons using the equipment in the ITI laboratory. Students were encouraged to ask questions about their specific applications of AE technology.

The two-day short course was attended by members of the ITI team, graduate and undergraduate students in civil engineering and materials science, and a few members of private engineering firms. The course was well-received and will likely be offered again in 2010.

ITI HOSTS TRAINING FOR ACOUSTIC EMISSION TECHNOLOGY
Tell us a little about your college career. Where did you go to school? Did you like it?

I got my undergraduate education at Notre Dame, and received a BS from the Department of Civil Engineering and Geological Sciences. I subsequently went to the University of California at Berkeley for graduate school. In a lot of ways, Notre Dame is similar in size and atmosphere to Northwestern. It draws students from around the world and is excellent in research — yet a great place to be an undergraduate without feeling like “just a number.” I think that my recent experiences at Notre Dame helped to prepare me for a career in education and to connect with the students at Northwestern. Berkeley was a great place to be a graduate student in structural engineering, as the opportunities were endless in terms of courses and research.

What is the most interesting thing that happened to you at Berkeley?

Well, the obvious answer is meeting my future wife [Karen Smilowitz, now a professor in Northwestern’s Department of Industrial Engineering and Management Science], but there were also tons of exciting professional things I did at Berkeley. One of my favorite experiences was taking a course in microscale heat transfer from Berkeley’s former Chancellor, Chang-Lin Tien. His course incorporated a broad perspective that was very unique among engineering courses, and he really made us think beyond the specifics of the material to get at what was really important about the topics we studied. But my favorite moment came shortly after the course ended, I was on the elevator with my thesis advisor and Chancellor Tien got on with us and said, “Hello David, how are you?” My advisor was quite impressed!

Before you came to Northwestern (and ITI), you worked at Exponent, a forensic engineering company. What drew you to forensic engineering?

Forensic engineering is very exciting because your activities lie at the intersection of several fundamental components of society: engineering, the law, and economics. You have to learn to think like an engineer while operating and communicating in the legal and economic worlds. And from a practical standpoint, consulting as a forensic engineer exposes you to many different topics, so you are always working on something new and it never gets boring. It was a fantastic way to broaden my perspectives as an engineer.

What is the most interesting project you worked on while there?

The most technically interesting projects I worked on were the Marcy Bridge Collapse (a pedestrian bridge that collapsed during construction) near Utica, NY and the Quad Graphics Collapse (an automated industrial facility that collapsed and burned for several days) in Lomira, WI. What made both of these cases great was that they were perfect examples of applying the scientific method: collect data, hypothesize, perform analysis, and evaluate your hypotheses.

Profile: David Corr

David Corr joined Northwestern’s faculty as Clinical Associate Professor of Civil Engineering in September, 2008. Before coming to NU/ITI, Dr. Corr worked with Exponent, an engineering and scientific consulting firm, where he specialized in forensic engineering, analyzing structure failures. At Northwestern, he teaches structural analysis and design as well as forensic engineering. He works closely with the ITI Research Engineering Group, bringing expertise on structural analysis to the design, deployment, and interpretation of field tests of major transportation infrastructure components.
to reach a conclusion or form an opinion. In both cases, our investigative teams were unclear about the answers we would find upon performing our investigation. The results were enlightening and sometimes surprising, and the uncertainty in the result made all of the hard work worth it.

**WHAT WAS THE MOST VALUABLE EXPERIENCE YOU HAD AT EXPONENT THAT YOU NOW BRING TO ITI AND NORTHWESTERN?**

From a technical standpoint, my skills as a structural analyst were finely tuned at Exponent. I had been trained in graduate school in theoretical structural and finite element analyses, but at Exponent I learned to identify specific questions beforehand and then analyze and construct models to answer these specifics. The ITI Research Engineering Group (REG) performs instrumentation studies in the same focused way, so I look forward to melding my skills with their existing expertise.

**WHAT ARE YOU WORKING ON RIGHT NOW FOR ITI? WHAT IS YOUR VISION FOR THE FUTURE OF YOUR WORK AT ITI?**

Right now, we are preparing for a new field deployment on a highway bridge in Wisconsin. This exciting project will give us the opportunity to measure inputs (truck loads, speeds, ambient temperature) and observe the responses (strains, displacements, accelerations). In addition, we are constructing finite element models which allow us to predict the responses. Comparing the theoretical and measured responses of the bridge will be interesting, and I look forward to the results – I expect to be surprised!

My vision for future work at ITI is to use the information that the REG is currently able to collect, and take it to the next step which is logically to use it to aid in infrastructure decision-making. At first I intend this to answer specific questions about a structure, for example our Wisconsin bridge: if we observe certain displacements, accelerations, or strains, should we be concerned? And then later, I hope we will be able to advise infrastructure management professionals based on the information we collect and analyze. In my short experience in the world of infrastructure management and preservation, there appears to be a lot of inefficiency in the system. If we can help the management professionals to make more scientifically-based decisions that maximize the impact of their available resources, I will be very proud of the work we do.

**WHAT ARE THE POTENTIAL IMPLICATIONS FOR THE WORK THE REG IS DOING RIGHT NOW IN THIS FIELD?**

Obviously, the collapse of the I-35W Mississippi River Bridge in Minneapolis highlights the fragility of our infrastructure. An ambitious goal of the REG would be to develop monitoring systems where such a catastrophe could be detected in time to issue a warning before collapse. Unfortunately, an intractable amount of information would be needed to achieve this goal, unless a focused instrumentation and modeling plan can be developed. The REG is an innovative leader in developing these types of focused, long-term infrastructure monitoring systems, and I’m excited to bring my experience in analyzing and evaluating structures to the group.
Ivan Vlahinich is a Ph.D. candidate in the Department of Civil and Environmental Engineering at Northwestern University. His studies and research focus on the behavior of cement-based and other heterogeneous materials, and he works with ITI researchers Professors Hamlin Jennings and Jeffrey Thomas on the chemical and microstructural properties of cement.

Ivan earned his B.S. in civil engineering at Columbia University, graduating magna cum laude in 2003. During and after his undergraduate studies, he worked as a civil engineer in design and construction in the U.S. and abroad.

ITI has selected Ivan because of his important research achievements. He has developed a new mathematical formulation to describe the dimensional changes of a porous body during drying, as the water or other fluid evaporates from the pores. This is important theoretical work in the field of poromechanics and geomechanics with immediate practical implications to shrinkage of concrete. Ivan’s model has been verified using data from both cement paste and porous glass, and he is lead author of a paper describing this work, recently accepted for the Mechanics of Materials journal. Ivan expects to complete his Ph.D. in 2010. His thesis is titled “Mechanical performance cement-based and other heterogeneous materials: approach based on granular microstructure.”
MEETINGS & ANNOUNCEMENTS

**ITI DIRECTOR JOSEPH SCHOFER TO CHAIR UPCOMING TRB SPOTLIGHT CONFERENCE**

ITI Director Joseph Schofer will chair the 2009 TRB/UTC Spotlight Conference, with the theme of Transportation Infrastructure Preservation and Management. This topic is a critical issue for our nation’s transportation system, and it is at the core of the work of ITI. Many researchers around the country are actively working on aspects of the problem, including condition assessment and prediction, decision support, materials and methods, and policy and finance. Thus the conference should be of broad interest and high value.

Organized by the Transportation Research Board (TRB) and supported by the Research and Innovative Technology Administration (RITA) of the U.S. Department of Transportation, the conference series seeks to encourage and improve discussion and collaboration among researchers, universities, government, private interests and TRB committees, and to define research opportunities of interest to academia, government and the private sector.

**ITI LAUNCHES NEWLY DESIGNED WEB SITE**

Melissa Mattenson, ITI’s Manager of Publications and Communications, along with other ITI staff, has given a much-needed overhaul to ITI’s web presence. The new design focuses on usability and accessibility of project data as well as compliance with Northwestern University McCormick School requirements and RITA reporting requirements.

The web site currently houses many research publications, presentations, articles, and talks, as well as seminar and symposium information, a staff and principal investigator directory, and all other important required reporting documentation.

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**ITI TO HOST ACOUSTIC EMISSION WORKING GROUP MEETING IN STURGEON BAY, WISCONSIN**

ITI has a long standing relationship with the Acoustic Emission Working Group (AEWG), the primary technical organization supporting the international acoustic emission community. AEWG seeks to advance acoustic emission technology through exchange of technical information, defining and promoting standards, holding technical symposia, and promoting technical interchange with other groups interested in acoustic emission and its applications. ITI will host the 52nd meeting of AEWG in Sturgeon Bay, Wisconsin, September 18-20, 2009.
The Infrastructure Technology Institute is a National University Transportation Center supported under a grant from the U.S. Department of Transportation’s Research and Innovative Technology Administration (RITA). If you are interested in working with ITI, please contact:

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Above:
A view of downtown Chicago

Cover Photo: