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Field Notes

The newsletter of the Infrastructure Technology Institute at Northwestern University

February 2011



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Above: CTA electricians install sensor cables along the tracks on the Devon/Sheridan viaduct.

Front Cover: William O. Lipinski with Samuel K. Skinner, winner of the David F. Schulz Award for Outstanding Public Service in Transportation Policy, at the 2010 William O. Lipinski Symposium.

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STATE OF GOOD REPAIR, INTERGENERATIONAL TRANSFERS AND CHEAP TRANSPORTATION

The immense backlog in projects to renew and improve surface transportation is not news. Way back in 2009 the American Society of Civil Engineers estimated that spending on highways and bridges needed to be increased by 45 percent; the transit situation was worse, with the needed funding increase around 153 percent. These are huge numbers but not really hard numbers. Some of these funds would go beyond the basic objective of keeping systems in a state of good repair (SGR) to investing in capacity expansions that might improve service quality, reduce congestion, and enhance accessibility. Some of those investments are important, but we should not be confused between wishes and needs.

Focusing only on SGR, the need is still very large, and the manifestations many. Roadway congestion and crowding on urban transit systems are obvious symptoms. More subtle events have pervaded the news lately. A series of underground pipeline failures across the country have resulted in many deaths and substantial damage. These can be attributed, at least in part, to aging and poorly maintained infrastructure. The breakdowns in transit services due to heavy snow storms – recently in New York, Washington, DC, and Chicago – are the result of natural forces, but we need these systems most under adverse weather conditions, and their failure under these circumstances is a reflection of lack of resilience and preparation.

Even more subtle are those little component failures that mean a lot to individual travelers. Consider escalators and elevators – at this writing, 11% of the escalators on Washington Metro are out of service. (The picture is probably

similar on some other rail systems, but the data are not so readily available.) Slow zones, load restrictions, and deteriorating pavements restrict mobility and increase user costs and pollution emissions. The freight sector does not escape this infrastructure challenge. Disruptions due to extreme weather affect freight as well as passengers, load limits constrain truck routing, and bottlenecks due to facility condition and congestion affect reliability and safety.

All of these failures increase costs in time, money, and reliability of travel. Narrow cost accounting is at the root of this problem. For example, the delays and disruptions experienced by travellers and carriers do not show up on the accounts of transportation agencies; importantly, remedying those delays costs money but the benefits felt by transportation customers do not come directly back to the agencies in the form of revenue streams that will pay the bills. This is a problem of cost accounting and allocation – who benefits and who pays. Although rehabilitating a bridge may save user operating costs, those savings do not find their way directly back to pay for the rehabilitation: they do not generate an immediate and allocatable cash flow.

But almost anything that affects transportation costs influences economic competitiveness, and that means jobs. While economic development, and especially now, economic recovery, are paramount goals, limited ability to account for the value of these connections makes it hard to justify some investments to put our transportation infrastructure in a state of good repair. Leadership at all levels of government is concerned about controlling and reducing expenditures, but

achieving our other goals will cost money, and we need to spend to achieve. It's a conundrum without a simple solution.

At the Infrastructure Technology Institute, we sometimes see this manifested in investment and policy decisions. For example, offered the opportunity to replace a bridge with an advanced material with a lower life cycle cost but a marginally more expensive initial cost, agency decision makers commonly focus only on initial costs and elect to build a bridge with a higher life cycle cost. Managers are responsible for today's budget and its constraints, not for the long term cost implications of an investment choice. Of course a part of the problem lies in uncertainty about future performance and costs of new materials and technologies. It (usually) seems responsible to take a conservative approach to risk management, and that often means not deviating from a long standing design code or specification, or not banking on a future cost savings when one can gain an immediate (and apparent) savings. But such conservative decisions may also mean not benefiting from innovation, and not achieving long term cost savings.

That leads to intergenerational cost transfers, a long phrase that means letting the next generation, our children and grandchildren, pay the increased cost that comes from foregoing long term savings. They won't know the difference because they won't have a vision of what costs might have been. In the face of immediate budget pressures, the voice for long term viability and costs for our infrastructure is often silent.

Arguably, that is one reason why we are where we are today, facing massive backlogs to achieve SGR for transportation infrastructure, because we failed to understand the future costs of plodding along with failing infrastructure and the pig-in-the-python effect of rebuilding a large fraction of the infrastructure in a short period of time.

There is at least one more factor involved here. The United States has benefited from relatively cheap transportation because we have not been paying the



full costs of travel. User fees have been kept below the level necessary to account for the fact that we have been using up transportation infrastructure over time and intensive use. Facilities wear out, and logically we should be putting aside some resources, a sinking fund, to cover the costs of repair, rehabilitation, and reconstruction. Instead, we have largely been consuming that infrastructure.

The expansion plan of the Autoridad del Canal de Panamá, the Panama Canal Authority, offers an interesting counter-example. The \$5.25 billion plan to expand the capacity of the canal - to maintain its global competitiveness - is to be paid for by tolls, which have been systematically increased for the past 8 years. The result is the ability to pay for 60 percent of the expansion costs from retained revenues and the rest from borrowing secured by a growing future revenue stream. The Authority has been careful to engage its

customers in pricing discussions so that users can understand both the benefits as well as the costs of price escalation.

How can we ensure the future of the nation's transportation infrastructure? Here are a few ideas:

- Remember, it's all about employment – job creation – and economic competitiveness, but not just today: we need to produce long term benefits. As the recent monograph by published by the Bipartisan Policy Center suggests, to promote long-term economic development, transportation investments must be targeted to real increases in connectivity and reliability, rather than being spread across the landscape. We need to make the right transportation investments, not just any investments.
- When budgets are tight, the need is great, and times are tough, the value of

information goes up. Now more than ever we need to drive decisions with objective information on the condition of infrastructure components, the role and utilization of those components, and the costs to fix problems. Information on condition means measuring the real condition, not simply the recorded age. This requires development and deployment of real-time structural health monitoring systems, a key part of the work of ITI. The role of infrastructure elements defines their importance to the economy and society, and thus can help set priorities for reinvestment. And the view of costs should expand to include life cycle costs, to leave a legacy for the next generation.

- We need to be more open to innovations that can give better performance and/or reduce costs. This includes materials and technologies that facilitate rapid (minimum disruption) repair, and that deliver more cost-effective service

Above: NUCu Steel developed by ITI Principal Investigators Morris Fine and Semyon Vaynman. This high performance steel has high corrosion resistance and lowers life cycle costs of bridges.



over their lives. The barriers to innovation are many, as described in the results of the 2009 TRB Spotlight Conference on Infrastructure Preservation and Renewal. Among those barriers is the rigidity of codes and standards developed long ago, which make it difficult to move new ideas into practice. In some cases – as shown by the ITI-supported research of Northwestern’s Prof. Zdeněk Bažant – using old design codes can lead not only to adverse performance and cost, but also to long-term life safety risks.

Methods and models for rapid testing and evaluation of new materials and methods will help deliver the confidence that designers and decision makers need to implement new ideas in the field.

- We must give more serious consideration to the performance and costs likely to be experienced by future generations. This means estimating - and conveying to

decision makers and the public - the life cycle costs and performance of proposed infrastructure actions – and inactions. This task includes communicating both outcomes and uncertainties to ensure that infrastructure investment decisions are founded on the best possible information.

Finally, we need to be more realistic about the benefits and costs of safe, reliable, and resilient transportation in the long term, and to convey that to the public and our leaders, so that we have the resources to assure the best transportation system for the future.



US DOT ADMINISTRATOR PETER APPEL VISITS ITI

On September 28, 2010, Peter Appel, Administrator of the Research and Innovative Technology Administration (RITA), visited ITI's offices at Northwestern University. Administrator Appel spent the day touring Northwestern University's RITA-funded University Transportation Centers, including ITI.

During the ITI portion of Administrator Appel's tour, ITI research engineers, faculty members, and students gave hands-on demonstrations of their RITA-funded research:

The Research Engineering Group (REG) demonstrated its structural health monitoring system in Hurley, Wisconsin, by showing live, real-time strain data and video as trucks crossed an instrumented bridge hundreds of miles away. This system, installed in partnership with the Wisconsin Department of Transportation allows engineers to determine directly

the damage done by overweight trucks to bridges that were not designed to accommodate them.

The REG then demonstrated the structural health monitoring system to evaluate a Chicago Transit Authority 'L' bridge by presenting a video that shows loads borne by a newly-designed retrofit as a train passes overhead. This system will allow the CTA to quantify the long-term efficacy of the retrofit and give their engineers real data about the health of their bridges that will allow them to wisely allocate limited funds for repair and replacement.

Finally, undergraduate civil engineering student Amanda Chen gave Administrator Appel a live demonstration of her work on the instrumentation to monitor strain on the John F. Kennedy Memorial Bridge carrying I-65 across the Ohio River in Louisville, Kentucky. After a failed anchor bolt was found on the bridge in 2006,

a retrofit anchor bolt was installed, and Northwestern University researchers applied strain gages to continuously monitor the new bolt. In 2008, researchers were able to remotely detect an abrupt failure in the new anchor bolt, and immediately notified transportation officials in Kentucky.

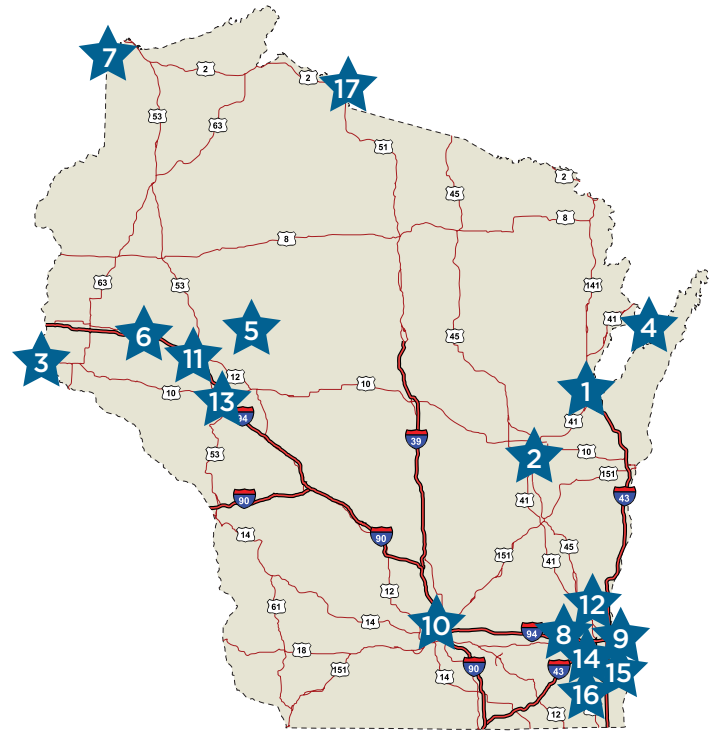
Administrator Appel noted that all three of these projects directly advanced the US DOT strategic goals to achieve and maintain a state of good repair of the entire national surface transportation network.

Above: Undergraduate civil engineering student Amanda Chen demonstrates a full-scale mock-up of an instrumented bridge retrofit to RITA Administrator Peter Appel.

ITI DEPLOYMENTS WITH WISCONSIN DOT: A CLOSER LOOK

Since 1993, ITI has enjoyed productive research partnerships with the Wisconsin Department of Transportation (WisDOT) on a wide variety of transportation infrastructure projects. Instrumentation and remote monitoring technology and methods developed at ITI have given WisDOT engineers data for important decisions. ITI experience with WisDOT has shown that:

- Continuous remote monitoring with sensors makes the effect of environmental factors and extreme events apparent – for example, monitoring showed that cracking in the hull of the Merrimac Ferry was driven by winter ice, and that the excessive movement of the Chippewa River bridge in Eau Claire was driven by temperature changes.
- Acoustic emission monitoring provides readily useful data for detecting and characterizing cracks in steel bridges - information useful for choosing bridge preservation strategies to promote a state of good repair.
- Short-term and continuous monitoring of bridge components can provide insight into failure mechanisms – useful for preventing future problems of a similar type. For example, ITI's strain gage monitoring of the sister span to the failed Hoan Bridge approach span helped improve understanding of the failure mechanism.
- Continuous remote monitoring allows gathering of data – and detection of problems – between inspections. Monitoring of the Sturgeon Bay bascule bridge remotely detected a cracked drive gear. Monitoring of the Hurley bridge shows the effects of overweight trucks in near-real time.



WisDOT DEPLOYMENT SUMMARIES

- 1. I-43 High Bridge over the Fox River, Green Bay**
Strain gage and acoustic emission monitoring in response to concern over cracks along stiffeners inside the box girder. Cracks determined to be fabrication flaws.
- 2. Tayco Street Bascule Bridge, Menasha**
Acoustic emission and strain gage monitoring to determine the source of loud “banging” noises during operation of this new bascule bridge. Noises traced to damaged track casting.
- 3. USH-10 St. Croix River Bascule Bridge, Prescott**
Acoustic emission and strain gage monitoring to determine the source of loud “banging” noises during bridge opening. Noises found to be benign.
- 4. Michigan Street Bascule Bridge, Sturgeon Bay**
Continuous remote structural health monitoring for life extension of a 70+ year-old rolling bascule bridge. Monitoring continued for almost 10 years, until bridge was rehabilitated. Crack in drive gear remotely detected in 1995. Monitoring data displayed on web site in near-real time from 2002-2007. Bridge is now being rehabilitated.
- 5. STH-64 Chippewa River Bridge, Cornell**
Acoustic emission and tiltmeter monitoring in response to high live loads due to logging traffic.
- 6. USH-12 Red Cedar River Bridge, Menomonie**
Investigation of quality of concrete in piers with impact-echo testing.
- 7. STH-35 Nemadji River Bridge, Superior**
Strain gage monitoring in response to concerns over high live loads from logging trucks.
- 8. I-794 Hoan Bridge tied arch box girder, Milwaukee**
Acoustic emission and strain gage monitoring of cracks inside tied arch box girder under live loads. No indications of live load cracking.
- 9. I-43/94 Becher Street Overpass, Milwaukee**
Experimental deployment of ultrasonic pin-and-hanger connection inspection device.
- 10. STH-113 Wisconsin River Ferry, Merrimac**
Strain gage study of cracks in steel ferryboat hull under traffic loads and winter ice. Ice shown to be major driver of cracks; ferry subsequently taken out of water during winters.
- 11. USH-12 Chippewa River Bridge, Eau Claire**
Tiltmeter monitoring of pier movement. Piers shown to be moving under thermal stresses due to frozen bearings.
- 12. Kinnickinnic Avenue Bascule Bridge, Milwaukee**
Strain gage monitoring to measure torque in drive shaft – used to balance bridge.
- 13. Sign bridge cracks, Eau Claire**
Post-mortem analysis of weld cracks on large sign bridge taken out of service due to excessive movement. Cracks found to be fabrication flaws.
- 14. I-794 Hoan Bridge approach span, Milwaukee**
Strain gage monitoring of load tests at low temperatures on sister span to approach span that failed in December 2000; data used by others to calibrate finite element model
- 15. STH-100 Amtrak overpass, Milwaukee and**
- 16. I-43/94 6th & Washington Overpass, Milwaukee**
Strain gage monitoring of fatigue cracks in highway bridge girders. Live strains found to be low.
- 17. USH-2 Montreal River Bridge, Hurley**
Combined structural health monitoring/weigh-in-motion system to determine effect of Michigan-loaded trucks on border bridge. Ongoing.

Above: ITI's field deployments in partnership with the Wisconsin Department of Transportation since 1993.

CTA PUTS ITS VIADUCTS TO THE TEST



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By Jon Hilkevitch

A deteriorated CTA [Chicago Transit Authority] bridge on the Red Line has an important story to tell about the health of the rail system's viaducts. Each day, thousands of CTA elevated trains operate across 564 bridges, many nearing 100 years old.

The crumbling bridges, some inspected monthly and others every two years, pose a potential danger to CTA passengers as well as to motorists and pedestrians who pass under the viaducts. But the CTA, saddled with a backlog totaling \$7 billion in unfunded capital-improvement needs, can't afford to replace bridges. The antiquated bridges have exceeded their useful life, experts say. They remain open due, in part, to luck.

The bridges were built to carry steam locomotives, which generate approximately four times the load of a moving CTA rail car, said CTA chief engineer James Harper.

"We are kind of benefiting from that a century later," Harper said. "One hundred years is beyond anyone's expectation for a bridge structure."

The bridge at Devon Avenue and Sheridan Road on the Red Line is one of the most deteriorated crossings in the CTA system. Its arch design columns have lost significant amounts of concrete, exposing — and in some spots shedding — the reinforced steel below, CTA engineers observed. Braces providing additional shoring were installed near the bridge piers late last year to help the structure support the weight of trains and to withstand a possible hit by errant vehicles on the street.

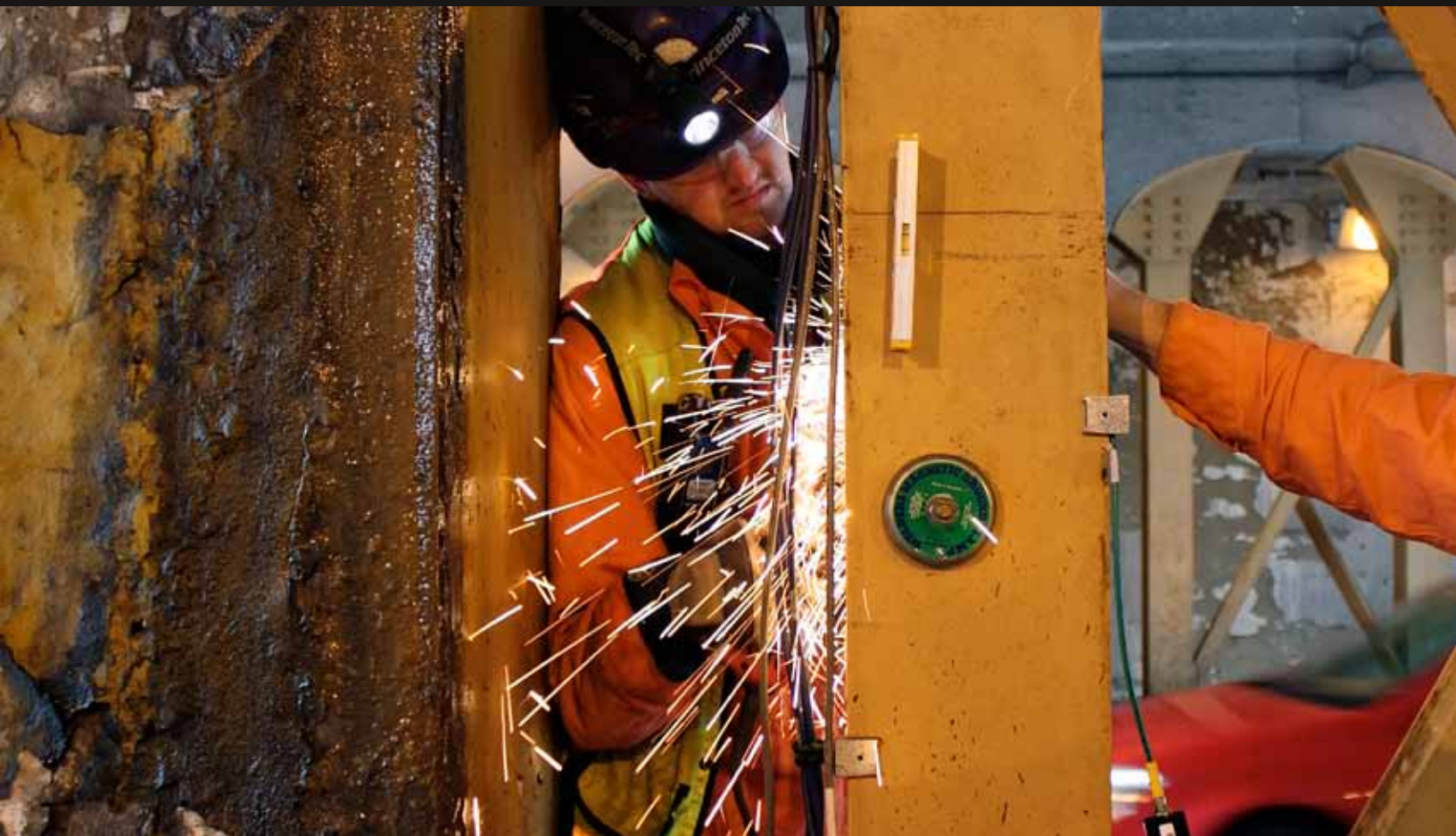
But CTA officials had little idea how much strain, if any, the braces were taking off the bridge.

Then CTA president Richard Rodriguez picked up a newsletter published by the Infrastructure Technology Institute at Northwestern University. The newsletter carried a story about Northwestern researchers monitoring concrete highway bridges in Wisconsin using an automated system that collects and analyzes data. Rodriguez then surprised Northwestern officials with a phone call.

"It was unusual for someone to respond to the newsletter," said Joseph Schofer, associate dean of Northwestern's Robert R. McCormick School of Engineering and Applied Science. "But Rodriguez was particularly concerned about the reinforced concrete structures on the Red Line and he said, 'Come on down and meet with us.'"

In July, the Northwestern team embedded sensors in the Devon-Sheridan bridge to measure how much the structure bends when trains pass over. That information is automatically stored, analyzed and transmitted to a Web site that Northwestern and CTA officials monitor.

Above: Strain and temperature sensors installed on the Devon-Sheridan viaduct



The data collected from the gauges will tell more of a story over time, but officials have learned the yellow steel supports that were added are not doing a lot of work — a good sign that means the original structure is tolerating the strain of train traffic.

But given the CTA’s budget constraints, the “temporary shoring” at Devon-Sheridan and other locations likely will be in place for many years, officials said. Replacement dates for the bridges remain indefinite, officials said.

The Infrastructure Technology Institute’s around-the-clock monitoring of the Devon-Sheridan bridge will provide an early warning to changes that could compromise the bridge’s integrity, Harper said. The monitoring will also provide good clues about the condition of other similarly constructed bridges and any retrofits installed there as shoring. “Given that we don’t have a lot of money to install sensors everywhere, the Devon project is a great predictive tool that helps us predict how much life we have left on

our bridges,” Harper said. CTA officials hope over time to expand the monitoring to at least some other bridges and to add Web cameras to create a visual record, including the common problem of trucks hitting viaduct support columns and taking out pieces of concrete, or getting wedged under the crossing, which has a clearance of only 12 feet 10 inches.

“The broader purpose for the monitors is not to tell that a failure is imminent, but to focus on parts of the structure that are most vulnerable in order to identify developing problems,” said David Kosnik, a researcher at the institute, which has installed monitoring devices at more than 80 locations in the U.S.

Widespread use of monitoring equipment will depend in part on keeping the cost low, said Daniel Marron, chief research engineer at the institute. “We try to use off-the-shelf components,” said Marron, who estimated the Devon-Sheridan cost about \$35,000. The researchers learned that a tall truck recently struck the Devon-

Sheridan bridge. The truck damaged instrument wires, knocking out one of the sensors. Harper said CTA officials plan to install cameras at the bridge to chronicle such mishaps. The next step would be to deploy sensors and cameras at other viaducts across the system. After Devon-Sheridan, the next bridge in rough shape is at Hollywood, Harper said.

“At this and other locations, we can help a public agency that has serious budget constraints to safely extend the service life of its infrastructure,” Schofer said.

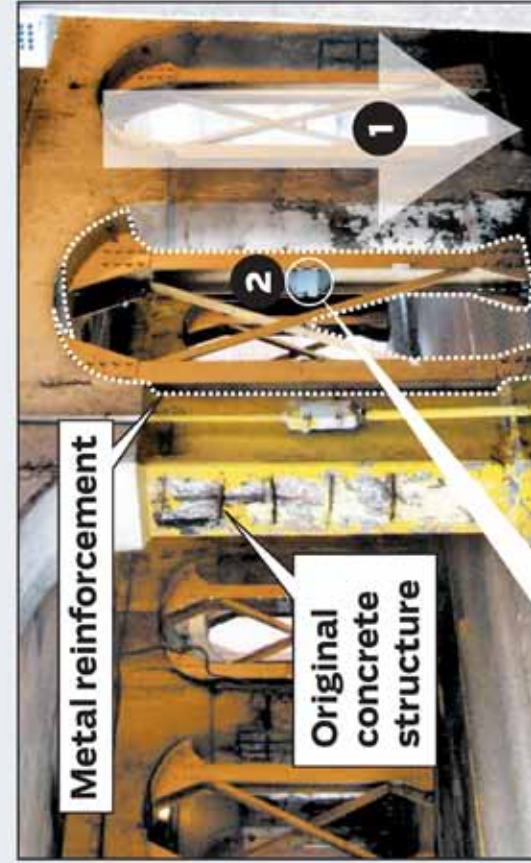
Above: ITI research engineer David Kosnik prepares a steel column for sensor installation.

An aging system of bridges

The CTA system has more than 500 bridges and viaducts, many of which are nearing 100 years old. Data show that many of these bridges, especially the concrete structures on the north leg of the Red Line, are crumbling and past their useful life. Recently, the Northwestern University Infrastructure Technology Institute is developing a system for monitoring these viaducts.

A pressing issue

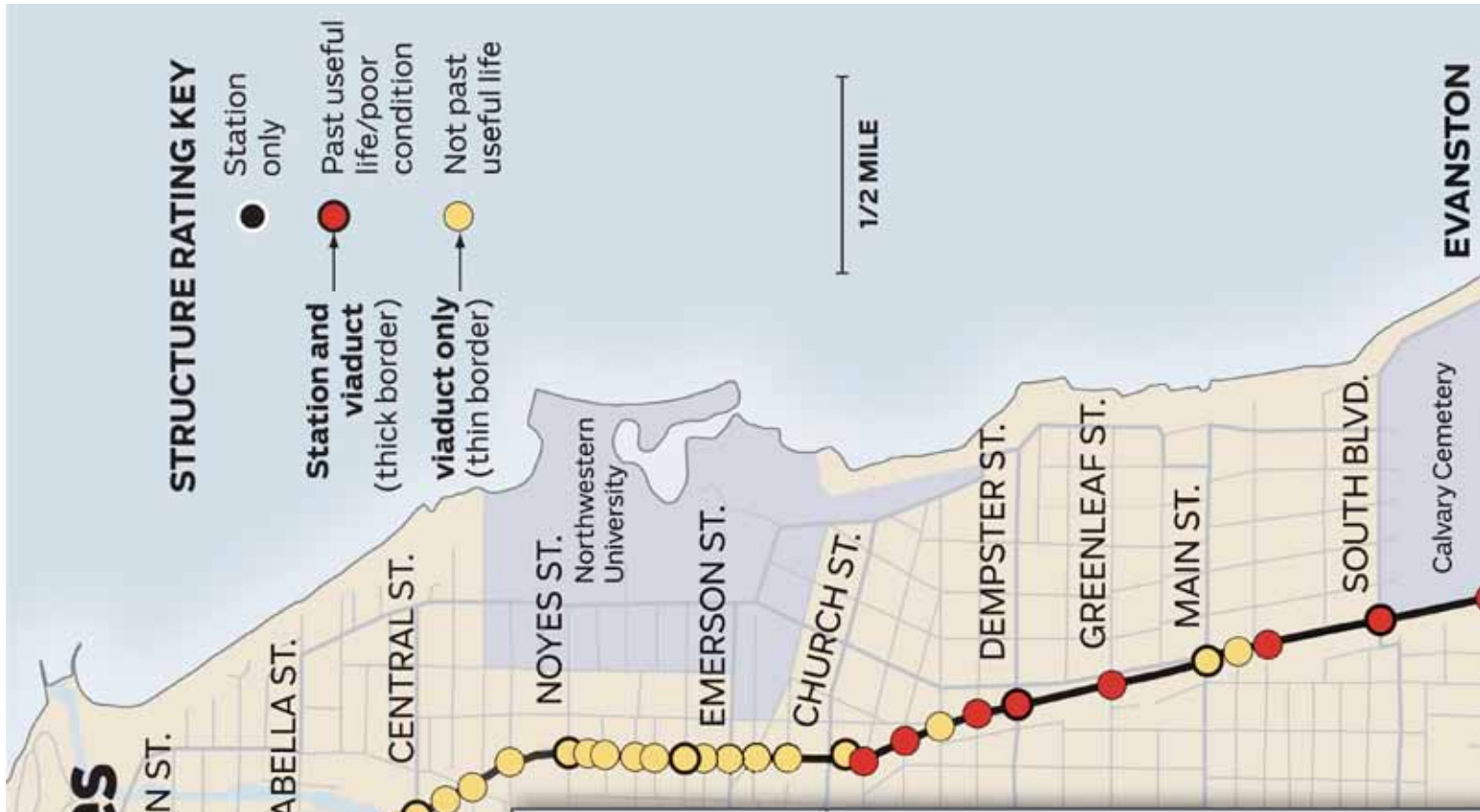
To monitor the steel reinforcement of the viaduct at Devon and Sheridan, Northwestern researchers are using strain gauges. These small devices have been around for more than a century, but are being used in a relatively new way to continuously collect information. Since mid-July, the project has monitored more than 52,000 train crossings with the aim of finding the best method to monitor the entire system.



STRUCTURE RATING KEY

- Station only
- Station and viaduct (thick border)
- viaduct only (thin border)
- Past useful life/poor condition
- Not past useful life

1/2 MILE





Strain gauges are made up of flexible, electrically conductive material that can measure the external forces affecting the viaducts.

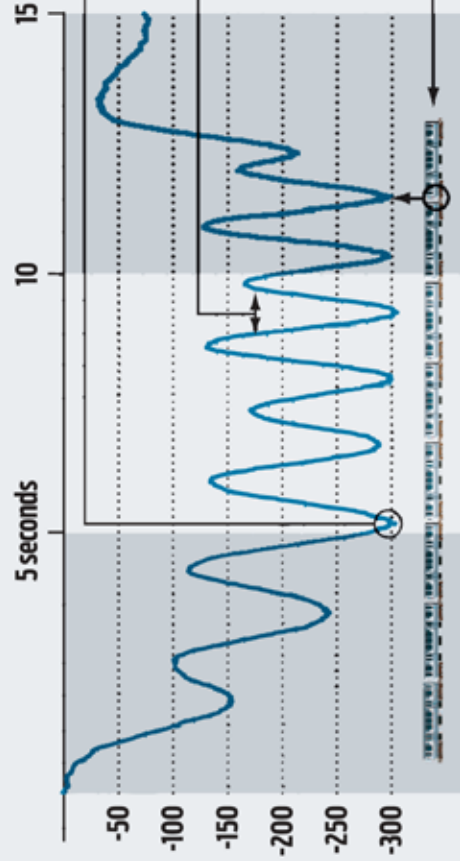


- 1** The weight of trains crossing the viaduct compresses the original structure and metal supports equally.
- 2** The gauge, affixed to the metal, is similarly affected.
- 3** When the gauge's shape changes, so does its electrically conductive property, which is measured.

THE RESULT: These changes are recorded by an on-site computer and used to measure the stress on the bridge.

COMPRESSION MEASUREMENTS

Scale in millionths of an inch




Under the most strain, the gauges show compression of about 305 millionths of an inch, which is about 1/10 the diameter of a human hair.

As the train speeds up, the troughs get closer.

Each depression represents weight moving along the bridge.



SOURCES: CTA, Northwestern University Infrastructure Technology Institute



THE 2010 ANNUAL WILLIAM O. LIPINSKI SYMPOSIUM ON TRANSPORTATION POLICY

The 2010 William O. Lipinski Symposium, held this past November at Northwestern University, focused on the challenges and opportunities facing public transit in Chicago, in the Midwest, and nationwide. Attendees participated in a full day of presentations, panel discussions and question and answer sessions with national and international transportation leaders and experts.

Former US Representative William O. Lipinski began the session with opening remarks with a strong statement underscoring the financial need: “If we don’t get an infusion of money on the state and federal level, mass transit is going to crumble. Not only in northeastern Illinois, but throughout this nation.” His assertion was echoed by many presenters in the morning session.

ITI Director Joseph Schofer summarized the confronting transit in the Chicago region, as well: “Mass transit in this region carries approximately 9% of all trips. Key parts of the transit system are 100 years old and need an enormous amounts of maintenance and in some cases total

reconstruction. Costs are increasing and revenues are stagnant. Integrated thinking is a big part of the solution to ensure seamless travel for trip makers. Importantly, the future lies in innovation and change. We need to look for new ideas for better service coverage, cost control, revenue enhancement, integrated traveler experience, as well as modernizing design and maintenance.”

US Reps. Peter DeFazio (D-OR) and Daniel Lipinski (D-IL) discussed the national perspectives on the challenges facing public transit. Both discussed the need for communicating to government leaders and the public the idea that putting money into transportation is an investment, making the country more energy efficient, producing a higher quality of life, stimulating community growth and raising tax-revenue. “If we want to tread water, we’ll need an 18% increase in funds,” Rep. DeFazio said. “If we want to improve our systems, we’ll need a 65% increase, but ultimately if we want to put everything in a state of good repair, we’ll need to double the transportation investment – \$30 billion per year.”

Leadership of Chicago area transportation agencies discussed critical transit issues at the regional level. Speakers were Richard Rodriguez, President of the Chicago Transit Authority; William Tupper, Acting Director of Metra; Thomas J. Ross, Executive Director of Pace; and Kristi LaFleur, Executive Director of the Illinois State Toll Highway Authority. The concern of each was the combination of rising costs and static revenues. The leaders of each agency offered ideas for improvements and new projects they would start with new money, but funding remained the main barrier to progress. Mr. Ross argued that, “We need to begin treating public transit as a public service, not a for-profit product.” Ms. LaFleur urged the other panel participants that all agencies in the region must “think regionally,” and that no forward progress can really be made if they “continue to work in silos.”

Professor Hani Mahmassani, Director of Northwestern’s Transportation Center, discussed new technologies and concepts available to enhance the travel experience of transit users, including sensor technologies that track vehicle location, systems

Above: Former US Rep. William O. Lipinski opens the 2010 Lipinski Symposium.



to deliver real time information to users, and strategies to integrate highway and transit services to provide seamless travel. He urged participants that “the idea is to think mobility, not just transit.”

Dr. Robert Peskin of AECOM discussed the difficulties of continued reliance on sales tax to fund transit and suggested possible solutions, including cost management measures such as productivity improvements, competitive contracting, basing decisions on life-cycle costs, and even considering public-private partnerships.

This year’s David F. Schulz award was presented during lunch to Samuel K. Skinner, who served as Secretary of Transportation and later White House Chief of Staff to President George H.W. Bush, as well as chairman of the Regional Transportation Authority for northeastern Illinois. Mr. Skinner echoed all presenters saying, “the presentations from this morning are right on. It’s clear that there are needs and the funding mechanisms in place currently are not working.” He also pointed out that there are some good signs: “We have a president who is extremely committed to

infrastructure. While we may argue about his priorities versus ours, he has decided this is important – and it is.” Skinner went on to say that now that we have “licked our wounds and celebrated our victories,” we must get back to work and recognize the severe problem we have with infrastructure in Illinois.

In the afternoon session, Glen Weisbrod, president of Economic Development Research Group, Inc. spoke about the changing economy and how the issue of public transit is much broader and more complex than many people realize, with implications for how (and how much) we invest. “Transportation spending – and particularly public transportation spending – allows a particularly high portion of funds to stay in the regional economy. The operators and maintenance workers are local, vehicle manufacturing is not all regional but does take place in America. But of course we don’t justify our public transportation spending now because it is creating jobs, we do it because in the long-term it increases the productivity and competitiveness of our economy, nationally and internationally.”

Gerhard Menckoff of the Institute for Transport Policy and Development discussed the promise and productivity of Bus Rapid Transit (BRT), presenting examples from Europe and South America. BRT differs significantly from traditional bus service, including off-board fare collection, level boarding of the bus through many doors, and segregated busways. “Nearly every major city in Latin America has implemented a BRT system, and many countries in Europe and Asia are following. There are some cases, such as in India, where the implementation of the system is extremely poor, which then gives all BRT a bad reputation. The truth is that it is not because of the concept, it is because of the execution.”

Phillipe Payen, Chief Prospective Officer of Veolia Transport, discussed the importance of innovative technologies for public transit, as well as the importance of the idea of “mobility management” rather than the traditional idea of transportation. “Transit is an industry looking for innovations – the target of which is to bring more and more intelligence within transportation to city inhabitants and to every piece of the ecosystem. Digital mobility will allow each city inhabitant to choose and control his mobility needs. The commuter time now is an imposed time, and we have to make it a useful time. It can never be more comfortable than the car, but it can be a lot more useful.”

The last and most highly anticipated panel of the day featured leadership of the Illinois state legislature, including Illinois Rep. Michael Madigan (D-22nd Dist.), House Deputy Republican Leader Timothy Schmitz (R-49th Dist.), Illinois Senate President John J. Cullerton (D-6th Dist.), and Illinois Senate Republican Leader Christine Radogno (R-41st Dist.) Panelists took questions from participants, and discussed the difficulties in securing revenue for Illinois transit projects. All panelists agreed that this is the greatest challenge with moving the region’s transit forward.

Above: Distinguished guests at the Lipinski Symposium included (front row, left to right) Northwestern University President Morton Schapiro, US Rep. Peter DeFazio, and former Northwestern University President Henry Bienen.



Top: U.S. Rep. Peter DeFazio (D-OR) discusses the national challenges facing public transportation.

Bottom: (From left to right) U.S. Rep. Daniel Lipinski (D-IL), ITI Director Joseph Schofer, Jo Ann Schulz, Samuel K. Skinner, former Northwestern University President Henry Bienen, William O. Lipinski



Top: The morning panel (left to right) Richard Rodriguez, President of the Chicago Transit Authority; William Tupper, Acting Director of Metra; Thomas J. Ross, Executive Director of Pace; and Kristi LaFleur, Executive Director of the Illinois Tollway
Bottom: Illinois Deputy Republican Leader Timothy Schmitz speaks during the afternoon panel.

MIDWEST BRIDGE WORKING GROUP



The Midwest Bridge Working Group (MBWG), a technology transfer forum sponsored by ITI and operated by the University of Kentucky, held its winter meeting December 13-14, 2010. The meeting was hosted by the Indiana Department of Transportation at the Indiana Government Center in downtown Indianapolis.

In spite of blizzard conditions across the region on the day before the meeting which forced many people to cancel travel plans, the meeting attracted 118 people: 47 state department of transportation personnel representing 14 states, 13 researchers representing five universities, two Federal Highway Administration representatives, and the balance representing consultants, vendors, and industry.

The meeting was divided into a full day of maintenance, inspection, and safety topics of general interest to bridge professionals followed by a half-day session dedicated exclusively to coatings for steel and concrete bridges.

Harry Capers of Arora & Associates kicked off the meeting with a presentation on the findings of National Cooperative Highway Research Program project 20-24(37E) on sharing best practices among state departments of transportation. Several subsequent presentations showcased recent research studies and performance evaluations by state departments of transportation. Chris Keegan of the Washington State DOT presented the results of a bridge washing pilot project to establish a procedure by which the benefits of power-washing bridges to

remove salt residue and other corrosive debris could be realized without causing environmental problems in the river below the bridge. Michael Sprinkel of the Virginia DOT presented a case study on the failure and repair of a deck closure pour (the strip of concrete that completes the deck of a bridge between two girders), which included an investigation of the failure mechanism and recommendations for repair. Scott Neubauer of the Iowa DOT and Jeremy Shaffer of Inspect-Tech Systems discussed the development of a bridge inspection data management system for Iowa. Bruce Brakke, also of the Iowa DOT, re-examined a number of fractures in Iowa steel girder bridges over the past 30 years in light of lessons learned in the Hoan Bridge failure in Milwaukee in December 2000.

Above: the Winter 2010 Midwest Bridge Working Group meeting held at the Indiana Government Center in downtown Indianapolis



Prof. Robert Connor of Purdue University presented results from two research projects. The first was a fitness-for-purpose investigation of the US-41 bridge over the White River in southern Indiana. The bridge was to be subjected to extremely heavy permit truck loads due to construction of a power plant in the area. Prof. Connor presented his team's analysis of the bridge for various limit states under the expected loads and then compared the predictions to data acquired from sensors on the bridge as heavy trucks crossed. Prof. Connor's second presentation was a discussion of advanced computer image analysis to identify out-of-plane bending and other performance problems on gusset plates.

Ted Zoli of HNTB gave a presentation on a rare but serious bridge safety incident:

hydrocarbon fuel fires on bridges. Recalling the 2007 gasoline tanker fire and subsequent collapse of the I-580 "MacArthur Maze" connector in Oakland, California, and similar incidents, Zoli discussed the mechanics of hydrocarbon fires as they related to bridges and ways to mitigate the risks and respond to bridge fires.

Vendor presentations included a selection guide for bridge deck joints and seals, hydrodemolition for repair of concrete bridge elements, automated entry of inspection data using tablet computers, new non-destructive testing methods for bridge decks, and acoustic imaging for underwater bridge inspection in situations where diving would be unsafe.

Recognizing that protective coatings (including, but not limited to, paints) are

critical for preservation of bridges, the second day of the meeting was devoted exclusively to coatings. Presentations included improved methods for field measurements of surface profiles, performance evaluation of one-coat paint systems on new steel bridges, weathering performance of various polyurethane coating formulations, new coating systems for bridges, inspectability of certain coating systems, and the results of a 20-year study of bridge repainting system performance.

The next MBWG meeting will be held in May 2011 in St. Louis.

Above: Prof. Robert Connor of Purdue University presents applied research results at the Winter 2010 Midwest Bridge Working Group meeting

ITI REG PRESENTS RESEARCH RESULTS AT CONFERENCES NATIONWIDE



Members of the ITI Research Engineering Group (REG) attended a variety of technical conferences to present the REG's work and exchange ideas with transportation and infrastructure professionals.

In June 2010, research engineers David Kosnik and Mathew Kotowsky attended the International Bridge Conference in Pittsburgh, Pennsylvania. Kosnik presented a paper, "Noise Localization via Acoustic Emission Monitoring on a Rolling Bascule Bridge", (co-authored by the other REG members) on locating the source of unusual "banging" noises on a new movable bridge using acoustic emission (AE) technology. AE data from several test configurations showed that the noises were not coming from the bridge's lift machinery but were instead originating along the bottom flange of the bascule girder where the girder was attached to a track plate. Further testing strongly suggested that the source of the noise was benign, highly-localized stick-slip behavior along the girder-track plate interface as the bridge opened and closed.

In July 2010, research engineer David Kosnik presented at the Review of Progress in Quantitative Non-Destructive

Evaluation (QNDE 2010) conference in San Diego, California. QNDE 2010 featured a special track on applications of advanced non-destructive evaluation techniques to civil infrastructure, including bridges, railroad tracks, and pavements. Kosnik presented a paper, "Acoustic Emission Monitoring for Assessment of Steel Bridge Details," which described the ITI REG's experience in applications of acoustic emission monitoring to two large fracture-critical highway bridges: the Bryce Bend Bridge, a 4,050-foot-long steel trapezoidal box girder structure which carries Interstate 80 over the Sacramento River in Sacramento, California, and the John F. Kennedy Memorial Bridge, a 2500-foot-long steel cantilever truss which carries Interstate 65 over the Ohio River at Louisville, Kentucky.

In October 2010, David Kosnik, in collaboration with David Simon, roadside facilities engineer with the Wisconsin Department of Transportation, gave an invited talk to the Western Association of State Highway and Transportation Officials Committee on Highway Transport (WASHTO-COHT) at their meeting in Reno, Nevada. The presentation, "Doing More with Weigh-In-Motion on a Wisconsin-Michigan Border Bridge",

described the combined weigh-in-motion and bridge structural health monitoring system installed by the REG and the Wisconsin Department of Transportation on the US Highway 2 bridge over the Montreal River between Hurley, Wisconsin, and Ironwood, Michigan.

In December 2010, research engineers David Kosnik, Mathew Kotowsky, and Daniel Marron attended the Transportation Research Board's 7th International Bridge Engineering Conference, held in San Antonio, Texas. Kosnik presented a paper, "Continuous Remote Structural Health Monitoring for Life Extension of an Uplift Bearing Assembly on a Large Cantilever Truss Bridge", which was co-authored by the other REG engineers and Theodore Hopwood of the University of Kentucky. The paper described instrumentation and monitoring for an uplift bearing on the I-65 John F. Kennedy Memorial Bridge over the Ohio River at Louisville, Kentucky. The uplift bearing monitoring project, which was distinct from the acoustic emission project presented at QNDE 2010, involves continuous remote strain monitoring of a large bridge component, including remote detection of a failure of one of the sub-components.

Above: David Kosnik presents ITI Research Engineering Group research results at the International Bridge Conference

STUDENT OF THE YEAR: KEN FULLER



ITI named J. Ken Fuller, a senior in Civil & Environmental Engineering at Northwestern's McCormick School of Engineering and Applied Science, as its student of the year for 2010.

For the past two years, Fuller has worked closely with the REG on several of their most important projects, including actively participating in the installation of a remote monitoring system in Hurley, Wisconsin. Fuller is working on an independent study project with ITI researcher Professor David Corr to investigate the effects of truck loads on the structure, specifically investigating the correlation between input measures, such as vehicle speed, axle configuration,

gross weight, and axle weight) and outcome measures, such as the observed strains, accelerations, and deflections of the bridge and its components.

In his free time, Ken serves as Administrative Director of Northwestern's student chapter of the American Society of Civil Engineers, enjoys backpacking, and plays bass in a student-run jazz combo. He will graduate this coming June, and is looking towards a career in infrastructure management and construction.

This past January, Ken travelled to Washington, DC to accept this award and a \$1000 scholarship at the 14th Annual

Council of University Transportation Centers Awards Banquet as part of the 90th Annual meeting of the Transportation Research Board.

Above: (From left to right): Student of the Year J. Ken Fuller, ITI Research Engineer David Kosnik, and ITI Director Joseph Schofer.



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