NORTHWESTERN UNIVERSITY
Infrastructure Technology Institute

Year 5 Annual Progress Report
Part A – Corporate-Style Annual Report

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Corporate-Style Annual Report

Introduction

Founded in 1992, the Infrastructure Technology Institute of Northwestern University is an upper tier university transportation center funded under the Transportation Equity Act for the 21st Century (TEA-21). This report documents progress from January 1, 2004 to December 31, 2004 as the Institute's TEA-21 Year Five funding progress report.

Center Theme

The theme of the Infrastructure Technology Institute is improving the technology and expertise available to address the problems of the nation's transportation infrastructure.

Management Structure and Center Staff

Center Director. As the head of an interdepartmental center within Northwestern's McCormick School of Engineering and Applied Science, the Director of the Institute is appointed by and reports to the Dean of the McCormick School. The Director is responsible for the day-to-day management and administration of the activities of the Institute, including but not limited to developing, implementing and monitoring the Institute's annual budget; interacting with federal officials responsible for administering the Institute's grant funding; and carrying out all other aspects of the Institute's program. The Director is currently 100% funded by the Institute. The Center Business Manager assists the Director.

Center Faculty and Staff. In addition to the Director, the Institute's only other direct full-time administrative employee is a Center Business Administrator, Ms. Elizabeth Brasher. The Business Administrator is responsible for all aspects of the Institute's administration including budgeting, financial monitoring, purchasing, travel arrangements, computer system maintenance, interaction with other University departments, and other responsibilities as assigned by the Director.

The Institute also employs a three-person team of research engineers, including Mr. David Prine, Chief Research Engineer, Mr. Dan Marron and Mr. Dan Hogan, Research Engineers. The team also includes two half-time research engineers, Mr. David Kosnik and Mr. Matthew Kotowsky. This team is totally supported by outside income and Institute research project support.

The Institute does not directly employ any faculty. Project-related research funding supports all faculty, research staff, and graduate students employed on Institute-supported research projects. The Institute also supports the full-time

services on the payroll of the University Library of the Infrastructure Knowledge Manager and an assistant.

Program Activities

Education. The Institute's primary desired educational program outcome is to enhance the multi-disciplinary Transportation Infrastructure Management specialization in the Master's of Project Management (MPM) program in the Department of Civil and Environmental Engineering. This program is evolving from and building upon the more generalized Infrastructure Management specialization currently offered in the MPM program.

An additional desired educational program outcome is to use the resources and activities devoted to the Master's program to enrich the available educational opportunities for undergraduate civil and environmental engineering students, and for graduate students at Northwestern in other engineering disciplines, the Transportation Center, the Kellogg Graduate School of Management, and the Medill School of Journalism and other programs. These resources and activities include courses, seminars and symposia, field trips, and other activities associated with the program.

At the pre-college level the desired educational outcome is to develop methods to effectively teach K-12 students about various aspects of transportation and other infrastructure related studies.

Research. The Institute's recent research efforts have emphasized nondestructive testing and evaluation of transportation infrastructure facilities – principally bridges – improved transportation infrastructure materials including weldable high-strength steel, better incorporation of recently-developed principles in concrete construction codes, enhanced ability to determine strength of recently-poured concrete, and development of blast fragmentable concrete, among others.

As detailed in the discussion of success stories below, Institute researchers have made a series of successful breakthrough deployments in continuous remote monitoring of transportation infrastructure facilities. The Institute is exploiting these advances in continuous remote monitoring while continuing selective work in transportation infrastructure materials research.

One of the key aspects of the Institute's success to date continues to be its demonstrated ability to work closely with infrastructure agencies as true partners in the development and deployment of innovative technologies. To that end, Institute researchers work directly with the partner agencies, which provide support (and match) to the Institute's activities in three ways: (1) partner agencies provide on-site personnel and equipment to support Institute researchers undertaking field trials and demonstrations; (2) partners provide in-

kind support through engineering and other services conducted off site in direct support of the field work undertaken by the Institute researchers; and (3) partners on occasion contract directly with Institute researchers to provide technical assistance in the deployment of advanced technologies in the field.

Technology Transfer. The Institute's desired technology transfer program outcomes are to: (1) continually increase the number of visitors to the Institute Website, (2) double the number of peer-reviewed papers on the Website, (3) conduct a summer transportation infrastructure institute for high school juniors and conduct other K-12 transportation infrastructure education initiatives, (4) conduct two meetings, one seminar, and one remote learning course annually, reaching 200 professionals, (5) provide frequently updated reports on Institute progress and news on the Institute Website, and (6) achieve an average of one successful research product deployment per funded project.

Policy and Management Studies. The Institute Director has had to curtail his speaking calendar due to illness. However, he does maintain an active phone interview schedule with local and national news media on various transportation and infrastructure issues.

Vision

In its strategic plan, the Institute established an ambitious vision for the six-year period:

• Develop a transportation infrastructure engineering **educational program** at the Master's level while enriching the undergraduate civil engineering curriculum at Northwestern and providing significant professional development opportunities to transportation infrastructure practitioners,

• Continue its successful transportation infrastructure **research programs** in nondestructive testing and evaluation of transportation infrastructure and materials,

• Build on its success in **moving the innovative transportation infrastructure technologies it develops into practice**,

• Contribute to advances in transportation infrastructure **policy and management**, particularly the vexing problem of the increasing paralysis of the transportation infrastructure industry in pursuing large complex projects,

• Grow the number of public and private sector transportation infrastructure **industry partners** with whom it works on technology issues, broaden existing partnerships, and develop new partnerships to include human resource and management and policy dimensions, and

• Generally enhance its position as a recognized **center of excellence** in transportation infrastructure technology.

The Institute is pleased and proud to report a number of important successes on these goals during 2004.

Success Stories: Education

… achieve a multi-disciplinary Transportation Infrastructure Management specialization in the Master's of Project Management (MPM) program in the Department of Civil Engineering [italicized inserts throughout this report are quoted from the Institute's University Transportation Center Strategic Plan: 1999-2005]

> **Success Story: Public Infrastructure Management Course**. The Institute once again offered its popular (31 students) Public Infrastructure Management course. Lecture notes were posted on Northwestern's "Blackboard" electronic teaching site, as were student responses to weekly e-mail assignments, items from the trade and popular media in the class's weekly "Infrastructure in the News" discussion, results of the full-day student charrette, and the final student term papers. The all-electronic format again proved to be extremely popular with students, as indicated in the results of the post course evaluation.
>
> **Success Story: Infrastructure Facilities and Systems Course**. In spring quarter 2004, the Institute director for the second time taught, with CEE Chair and Professor Joseph Schofer, a course in infrastructure facilities and systems. Fifteen students enrolled in the course, in which a weekly lecture was followed by a field trip later in the week to an infrastructure facility or project. Trips included a trip on a CTA rapid transit train, a guided tour of the newly-rebuilt Midway Airport, the Millennium Park construction project in downtown Chicago, a visit to a project management firm office and tour of an office building construction project, and a boat trip on the Chicago River to view bridges and architecture from the water. Students were required to participate in team design projects, and three student teams developed outstanding projects. Post-course evaluations indicated the course was very popular and it has been assigned a permanent course number. The Institute intends to offer it again in subsequent years.

… use the resources and activities devoted to the Master's program to enrich the available educational opportunities for undergraduate civil and environmental engineering students, and for graduate students at Northwestern in other engineering disciplines, the Transportation Center, the Kellogg Graduate School of Management, and the Medill School of Journalism and other programs.

Success Story: Summer High School Infrastructure Institute. In the summer of 2002, the Institute developed and offered a weeklong summer infrastructure institute on the Evanston campus. Educational and fun, each morning began with a lecture about elements of urban infrastructure presented by the Institute director. Each afternoon, students and teachers enrolled in the institute embarked on a supervised field trip to prominent facilities. Based on the success of the initial program, the summer institute was offered again 2003 and 2004. Field trips involving over 20 students and teachers included Midway Airport, a chartered the Chicago Transit Authority train, the Illinois Railway Museum, and a boat trip on the Chicago River. On the CTA trip, summer high school institute participants were joined by students and teachers from the Institute's lower elementary infrastructure program.

Students ride the CTA rails
High School Summer Institute.

The goal of the summer institute was to give students and teachers the opportunity to learn more about Chicago and urban infrastructure, while interacting with their peers and colleagues. While the Infrastructure Technology Institute hoped to pique the interest of at least a few of the participating students to pursue an education and career in civil engineering or a related infrastructure field, the main purpose was to give both teachers and students a richer and deeper understanding of how infrastructure works and the important role it plays in our society. Based on a post course evaluation and lessons learned, the Institute will continue to explore high school level infrastructure education alternatives looking to expand the summer institute to a regional and even national audience.

Success Story: Summer Infrastructure Program for Lower Elementary Students. Lower elementary students have proven

particularly difficult to reach when it comes to teaching them about the role and importance of infrastructure in American society. As part of its K-12 educational goal, in 2003 and 2004 the Institute partnered with the Country Meadows Montessori School to structure a ten-week, once-a-week program of morning classroom sessions and afternoon field trips dealing with various infrastructure facilities and systems.

The Institute staff, Infrastructure Knowledge Services, and the Country Meadows faculty developed a CD-ROM to document the lessons learned and provide guidance to other schools and professional organizations who may be interested in developing similar or related programs.

Based on the success of the 2003 and 2004 programs, the Institute will continue to experiment with K-8 infrastructure education modalities.

Success Story: **Student of the Year**. The Institute was proud to name Tanner Blackburn its 2004 UTC Student of the Year. Tanner received his award at a ceremony sponsored by the Research and Special Programs Administration of US DOT at the annual meetings of the Transportation Research Board.

Success Story: Infrastructure Management Students. Eight students currently enrolled in the Master's in Project Management program are specializing in infrastructure management, the same as reported in the Year Four Report.

…have a student profile enrolled in its curriculum which meets or exceeds the University-wide proportions of minorities and women enrolled in graduate programs.

The eight students currently enrolled include three white males, four minority males, and one minority female.

Success Story: Surveying Workshop. Northwestern's ASCE student chapter and the Infrastructure Technology Institute co-sponsored a workshop on surveying. In February Dr. Kurt Bauer explained the fundamentals of surveying and mapping to a group of students. A second workshop was held on Saturday, May 22, 2004. This workshop concentrated on instrumentation and surveying techniques. Professional surveyors Fred Campeau and Joerg Feldbinder lectured the group on the essential elements of surveying and then took the group outside and surveyed a building site. One group ran a level circuit and the other group used a total station to measure distance and angles. Every person was able to take a turn at setting up each instrument and taking shots. In the end, we were able to close the circuit horizontally and vertically. There was a discussion on errors and how to correct for them.

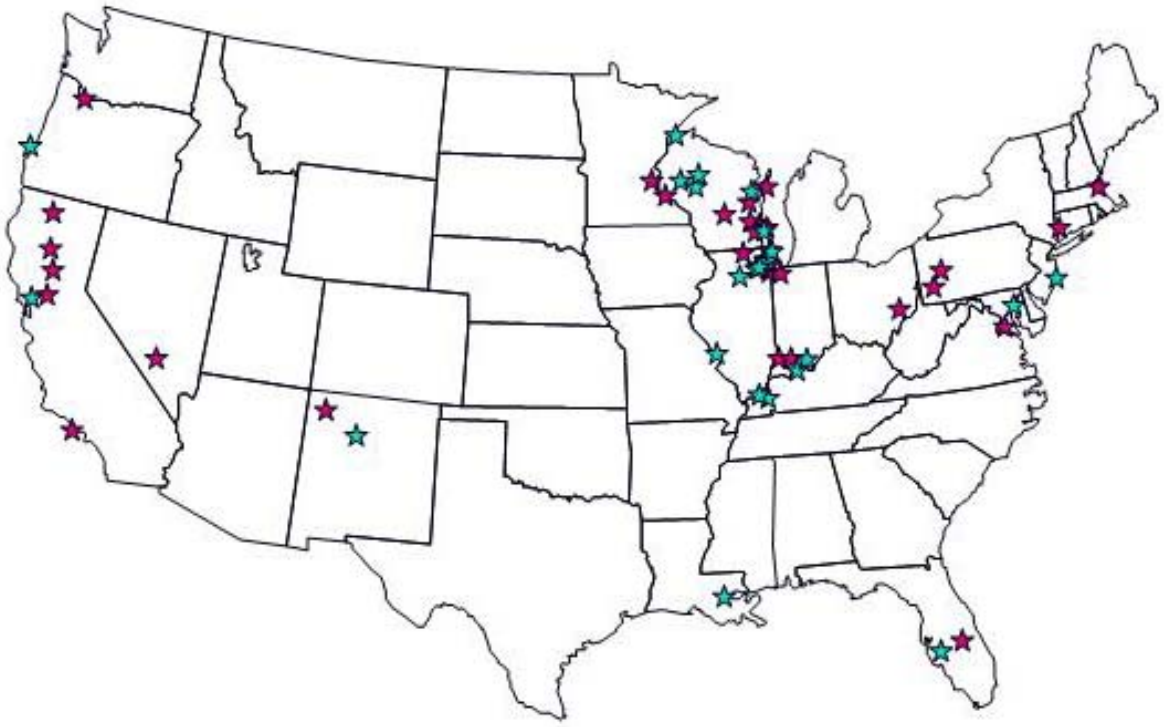
Success Stories: Research

…at least maintain, if not expand, the number of technology areas actively being researched (breadth), while continuing to increase both the number of innovations and the amount of technical expertise in the technology areas being researched (depth).

Have each principal investigator publish at least one peer-reviewed research report and present one paper annually based on Institute-supported research.

The Institute has prepared a report summarizing progress on all research projects funded under its TEA-21 funding during 2004. Rather than include that 84-page report either directly within this document, or as an appendix, it is in the process of being posted on the Institute Web site. The "Success Stories" below are excerpted from that larger report.

> **Success Story: 58 Successful Technology Deployments in 19 States and DC**. In preparation for the August, 2004 RSPA-FTA-FHWA site visit, the Institute for the first time totaled up its successful experiences deploying innovative technologies in partnership with infrastructure practitioners. The Institute was both proud and somewhat surprised that there have been at least fifty-eight such deployments in nineteen states and the District of Columbia since the Institute was created in 1992, almost five per year. As indicated in the figure, many of these deployments were totally or partially paid for by the technology deployment partnership agency (green stars). This remarkable record of achievement is high for any University research center and indicates success in ITI's objective of bringing innovative technologies to the field, testing them in partnership with the technology deployment partner agencies, and thereby promoting its acceptance by the infrastructure industry.



Success Story: Progress Made on Safety Concrete Research. The goal of this project is to continue to develop and commercialize a new type of concrete that will disintegrate into small fragments (rather than fracture into large chunks) when subjected to sudden and severe loading. Because of the emphasis on preventing damage to buildings and people, this material has been dubbed "safety concrete." A standard strategy in the post 9/11 era for increasing the security of sensitive buildings is a concrete perimeter wall intended to keep unauthorized persons and vehicles from approaching too closely. However, an unintended consequence is that a powerful explosion set off just outside the security wall can cause it to break into large pieces that become projectiles and cause considerable damage and loss of life. An unfortunate example of this phenomenon occurred when the U.S. embassy in Beirut was bombed in 1983. The specific application of safety concrete is thus to form security perimeters or walls around buildings that will fragment into small particles that cause minimal damage in the event of an explosion. To be successful, safety concrete must have a moderate strength while also exhibiting a high degree of fragmentation.

Significant progress was made on this project during 2004:

- Experiments verified that the combination of a sodium silicate accelerated slag binder and a high sand-to-binder ratio (s/b=5) results in improved strength and fragmentation behavior compared to either approach used alone.

- Blast testing was conducted on blocks of high-sand-content safety concrete. For this test, conventional concrete blocks were identified by the US Army Corps of Engineers, Engineering Research and Design Center in Vicksburg, Mississippi as the appropriate control. The safety concrete behaved similar to, although better than, the control in the blast test. It was determined this formulation is fundamentally too similar to that of the control, such that dramatically improved behavior cannot be expected.
- A new design approach, based on existing “no-fines” concrete technology, has been developed for application to safety concrete. Blast testing of these blocks is the next step.
- The laboratory impact test was modified to make it more stringent. The modified drop impact test should provide a better indication of the behavior of these materials under blast conditions.

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Semi-automatic concrete block making machine (Atlantica Maq, São Paulo, Brazil) used to make safety concrete blocks (left). The mold lists to reveal a freshly made block (made with red dye) sitting on a pallet.

Blast test field at ERDC showing C4 at ground zero and safety concrete and control walls at the right.

(a) (b) (c)

No-Fines Safety Concrete. Block sitting on pallet (a). Prism from block before (b) and after (c) modified drop impact test. Sample completely shattered upon impact, with fragments flying out to the sides of the dish.

Success Story: Updated Remote Monitoring System on Michigan Street Bridge. The Michigan Street Bridge is a rolling bascule type moveable bridge located in downtown Sturgeon Bay Wisconsin. This 1930 vintage structure is one of only two active bridges providing access to the Northern Door County peninsula. The bridge serves as a vital physical and economic link to the city. Wisconsin Department of Transportation (WisDOT) inspections from 1994 to the present have documented the ongoing deterioration of the structure.

Rack and Pinion Support Structure,
Michigan Street Bridge, Sturgeon Bay, WI

The Institute has been continuously monitoring the condition of the bridge for WisDOT since 1995. This system with further 2003 upgrades is now operating with autonomous data acquisition. ITI is now providing user specified notification (e-mail, pager, fax, etc.) and complex data reduction techniques to the Michigan Street website. During winter of 2004 ITI engineers performed “house cleaning” operations during an on-site visit. Some effort was also spent on further software improvements which include improved digital filtering to suppress noise spikes in the data to allow improved trend monitoring. The removal of artifacts such as spikes in the data is essential if functional active monitoring is to be achieved. The cause of the spikes is unknown but the digital filtering effectively removes them from the data thus greatly reducing “false calls.” The monitoring system continues to operate reliably and provide condition data in a user friendly format. The data is continually updated and any readings that exceed pre-set limits automatically result in an e-mail being sent to the customer informing him that he should check the data.

Success Story: Bryte Bend Bridge Revisited. In 1996 ITI played a key role in assisting Caltrans in selection of a crack mitigation retrofit for the I-80 (Bryte Bend) bridge over the Sacramento River near Sacramento California. Acoustic emission and load tests showed that one of the two retrofit designs developed by Caltrans was clearly superior. After several delays resulting from budgetary constraints, the project is under way and was scheduled for completion by end of calendar year 2004. Approximately 800 crack sites in the approach spans are being retrofitted. The retrofit consists of stiffening the corner connections where the cross frames attach to the web/flange connection. During 2004 ITI engineers visited the Bryte Bend project and applied acoustic emission (AE) monitoring to several retrofit sites prior to the installation of the retrofit. This experiment was

performed as part of a two part effort. AE data was recorded at a total of six sites under normal traffic live loading. A minimum recording time of one hour was used at each site to insure a reasonable statistical sample. Preliminary data analysis showed results very similar to the 1996 tests. For part two of this experiment these sites will be monitored again following completion of the retrofit project sometime in 2005. These tests should provide additional confidence that the retrofit design is functioning as desired by reducing crack activity.

ITI Chief Engineer Dave Prine Confers with Caltrans Bridge Engineer Erol Kaslan in Bryte Bend Bridge

Success Story: Evaluation of New Generation of Ultrasonic Testers. ITI assisted Wisconsin DOT in the evaluation of newly emerging ultrasonic testing technology. ITI Research Engineer, Dan Hogan constructed a test fixture to evaluate the ability of new generation ultrasonic test equipment to find cracks in bridge pins that are being inspected while in service. Wisconsin is considering using this approach to inspect bridge pins in-situ. In the past, it has been very difficult to reliably test pins that are in service and under load because of an anomaly that occurs while the pin is loaded. This anomaly, referred to as "acoustic coupling," is responsible for the majority of false positives when inspecting bridge pins that are in service. The contact area between the pin and the hanger straps under the pressure of in-service loading allows ultrasonic energy to couple from the pin into the surrounding structure. The edge of this coupling area produces back scatter of the ultrasonic beam which appears on the test device as a "false" reflection. Currently used UT devices cannot distinguish this reflection from a crack resulting in false positives due to their poor resolution limits. This new generation of ultrasonic testers uses phased array technology. The transducer consists of a 1 X 32 array of sensors. The focal point and incidence angle of the beam is electronically controllable by means of time differences between the incident pulses applied to the different sensors. This approach provides great improvements in the resolution of the UT device.

WISDOT engineers installed the fixture in a tensile test machine and applied service loads to the fixture/pin to simulate on bridge operating conditions.

Close up of pin installed in test fixture

In the test, the improved resolution allowed engineers to consistently distinguish between a crack and the acoustic coupling artifact. A crack has two distinct peaks, one coming from a corner reflection and the other coming from the crack tip. The acoustic coupling only produces a single peak. The phased array also clearly distinguished wear grooves from “false” indications. If Wisconsin acquires this technology, ITI in a cooperative effort will assemble a data base of the results of UT testing of a large population of pins to determine the frequency of crack detection in pins. The pins that produce positives would be removed and the presence and nature of the crack could be confirmed by sectioning.

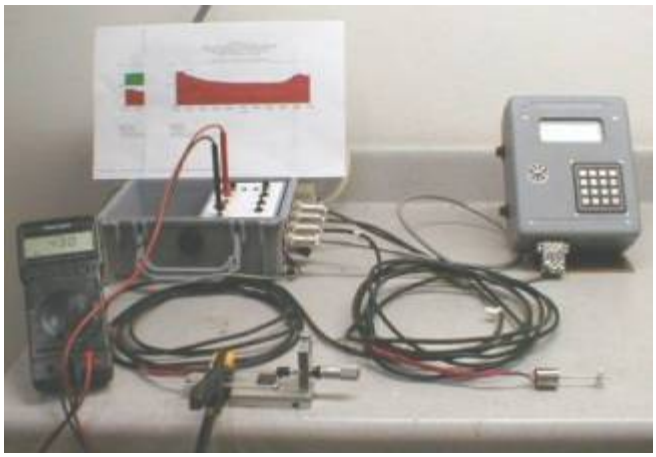
Success Story: Crack Monitoring for Street Project Adjacent to Blair House. Professor Chuck Dowding was approached by the Department of State in the summer of 2004 concerning a problem at the Pennsylvania Avenue pedestrian mall construction project in Washington, DC. The Blair House is located across Pennsylvania Avenue from the White House and functions as the president’s guest house for high level visitors. It is a historic structure and there was concern that the construction activities might cause damage. This was a perfect application for his advanced crack monitoring technique. ITI staff mobilized and installed a complete internet based remote crack and vibration system in the Blair house in under two weeks from the initial call. A total of six crack sensors, two temperature, two humidity, and three vibration sensors were placed throughout the house. The data was then sent over the internet to Civil Data Systems who

processed, archived, and displayed it on our secure website. All readings were made available to the Department of State, General Services Administration, and Federal Highway Administration personnel on the secure side of the ITI web page. The installation was especially arduous in light of the schedule and extreme security considerations at the site. The system was monitored from July 2004 until October 2004 when construction concluded. The data collected clearly showed that the effects on existing cracks from normal domestic activity, such as walking through a room or closing a door, far exceeded the effects from the construction activity.

Blair House TDR installation

Success Story: Remote Detection of Florida Highway Sinkhole Event. ITI still gathers and posts data from our previously installed remote monitoring sites to our secure web page. The data is posted automatically in an efficient format by Civil Data Systems. At this point the process is completely automated and requires no interaction from ITI staff. In early December, ITI was contacted by an engineer with Florida DOT about the State Route 66 sinkhole site which was part of our TDR monitoring project. He noticed changes in the TDR information on our web page and then physically visited the sinkhole site. His initial visual inspection found significant wash out of soil along the sides of the land bridge over the sinkhole. FL DOT has scheduled an in depth inspection to determine the extent of the failure in early 2005. ITI's remote monitoring and TDR technology, along with Civil Data Systems' web services, allowed FL DOT to remotely detect critical changes on a problem structure well before the next scheduled inspection cycle.

Success Story: First-Ever Commercial Instrument for Autonomous Crack Monitoring. During the fall of 2004, researchers finished the first phase of a two-year test program of the first commercial instrument developed for autonomous crack monitoring. GeoSonics of Warrendale, Pennsylvania, has produced the beta test model for validation under this project as GeoSonics also pursues additional validation.



First-Ever Commercial Instrument for Autonomous Crack Monitoring, Developed in Partnership with GeoSonics

This parallel deployment scheme was utilized by Prof. Dowding under this project and GeoSonics to enable GeoSonics to maintain clear ownership of any independently developed hardware or software. The system of parallel codeployment has allowed significant synergism as GeoSonics and project researchers can trade experience without GeoSonics fear of issues of ownership of intellectual property.

Success Story: Mobile Infrastructure Classroom. An initial testing phase has been completed in this project. It involved eight engineering undergraduates, split into two teams to evaluate the feasibility of existing technology for developing a mobile PDA-GPS-Phone (PGP) technology. One team investigated a low cost, non GPS system and the other the PDA-GPS system. These students were part of the Engineering Design and Communication class at Northwestern University.

The object of this project is to ultimately develop PDA-GPS-Phone (PGP) technology as a “virtual infrastructure teacher.” Such a purpose-built location-specific learning system would allow educational, civic, cultural, and infrastructure organizations to vastly improve their ability to offer multi-level self-selected information on infrastructure to high-end continuing education and K-12 students in the field. Examples include location-specific self-guided architecture tours, and bus or boat tours offering educational experiences on bridges, buildings, and other infrastructure. Eventually, PGP could allow people to ask “what if?” questions, and delve deeper into technology and history questions of interest. The technology allows full immersion in the subject itself: a city or a civil war battle field with access to a wide range of location-specific information.

Use of these two systems was tested on the Northwestern campus in a very preliminary fashion. The campus was chosen for content as the navigation challenges were similar to those that would be encountered in the downtown Chicago, where the large infrastructure would be located. One of the user

interfaces is shown below. It is planned to continue this project next year in the conjunction with the Engineering Design and Communication classes at Northwestern to both develop the system as well as to interest students in the infrastructure.

Self-Guided Infrastructure Tour Using PDA

Success Stories: Technology Transfer

… (1) double the number of visitors to the Institute Web site, (2) double the number of peer-reviewed papers on the Web site, (3) conduct a transportation infrastructure essay contest for pre-college students, involving 100 student entrants and/or other K-12 transportation infrastructure education initiatives, (4) conduct two meetings, one seminar, and one remote learning course annually, reaching 200 professionals, (5) develop a monthly Web site-based Institute newsletter, and (6) achieve an average of one successful research product deployment per funded project.

> **Success Story: Infrastructure Knowledge Services Program**. The Infrastructure Knowledge Services Program (IKSP), managed and operated by the University Library and supported by the Institute, continued to improve the Institute web site in 2004. In addition to adding new content and managing and maintaining the Institute web site, IKSP improved the ITI web site's accessibility for the visually impaired, and designed and developed:
>
> 1) web pages supporting and documenting the 2004 Summer Infrastructure Institute for high school students and teachers
>
> http://www.iti.northwestern.edu/education/high_school_institute/2004/index.html
>
> 2) web pages supporting the 2004 summer infrastructure class for elementary school students
>
> http://www.iti.northwestern.edu/education/elementary_school/country_meadows_2004/index.html

IKSP developed and distributed CD-ROMs containing presentations, course materials, field trip images, and video clips from the 2003 and 2004 summer high school and elementary school infrastructure classes to class participants and interested parties.

3) a 'technology transfer' streaming video, with presentation slides, of an ITI-sponsored talk by Professor Kimberly Gray, on "Sustainability: Engineering the City of the Future"

http://www.iti.northwestern.edu/video/index.html

IKSP redesigned and developed a new web site for the Special Libraries Association Transportation Division

http://www.library.northwestern.edu/transportation/slatran/

IKSP also provided support to the civil engineering classes "Infrastructure Facilities and Systems" and "Public Infrastructure Management", identifying and making available to the students reference and course materials, and digital images of field trips, via the university's course management web site. IKSP responded to inquiries that were sent to the Institute from practitioners, students, and the public at large, monitored two listservs, and continued to perform infrastructure-related collection development and provide reference service within Northwestern University's library.

Success Story: **Midwest Bridge Inspection and Maintenance Consortium**. An Institute-supported organization of state bridge inspection and maintenance engineers, the consortium consists of members from California, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New York, Ohio, Tennessee, Virginia, Wisconsin, and West Virginia.

The consortium held two successful meetings during 2004, a May meeting in Chicago with over 50 attendees, and a December meeting in Indianapolis with 63.

The consortium has evolved to offer presentations and discussions on themed agendas with topics such as bridge management systems, inspection methodologies, repair methods, emergency response, among others. The most valuable benefit of the semiannual meetings is the opportunity for bridge practitioners to interact with one another, both during and in between the meeting sessions. In addition, the consortium, which is managed by the Kentucky Transportation Center -- a state-

university cooperative research venture -- has its own technology-sharing Web site.

Success Stories: Policy and Management

Success Story: Impacting the National Infrastructure Debate. In addition to his regular speaking schedule on infrastructure, Institute Director Dave Schulz found himself in demand from various media outlets. He wrote an invited piece for Newsday on the long planned Second Avenue subway project and wrote a piece for the Chicago Tribune on the future of Wrigley Field.

Due to health issues, Mr. Schulz maintained only an abbreviated speaking schedule in 2004.

Success Stories: Industry Partners

Success Story: Miller Park Movable Roof Investigation. Based on their successful work in 2002 in evaluating unusual noises from the segmented movable roof of the Miller Park baseball stadium in Milwaukee, Wisconsin, which led to a comprehensive redesign and reconstruction of the roof segment pivot bearings, and follow-up work in 2003 to evaluate noises from the so called “bogie” electric locomotives which move the roof segments, the Institute engineers continued to provide follow-up consulting work for the main Miller Park consultants in 2004.

Conclusion: Center of Excellence

In conclusion, the Institute continued to make substantial strides in 2004 towards its goal of becoming a nationally recognized center of excellence for infrastructure technology. Institute researchers continued to successfully deploy their results in a growing number of locations across the country, and at the same time enhanced their stature as leaders in a number of important infrastructure technology areas. The Institute's rebuilt Web site was rapidly evolving to take advantage of streaming video, Internet-based televideoconferencing, and other innovations. The Institute-supported Midwest Bridge Maintenance and Inspection Technology Sharing Consortium continued to grow. And the Institute's management and policy studies efforts enjoyed great success as they examined and brought to public attention a number of important public policy issues including the interrelationship of sprawl and infrastructure problems, the growing difficulty of building large infrastructure projects in the United States, and development of improved means for mitigating the impacts of disruptions of the transportation system. Building on this success, the Institute looks forward to continued growth and achievement in 2005.

Appendix 1 – Research Projects

New Projects

A482, Micro-Instrumentation, Prof. Charles Dowding, $78,276

A484, Crack Dating, Prof. Charles Dowding, $87,878[1]

Continuing Projects

A452, Life Cycle Management of Steel Bridges Based on Nondestructive Testing and Failure Analysis, Prof. Brian Moran and Prof. Jan Achenbach, No Year Five funding

A472, Bridge Asset Management Based on Life-Cycle Cost Considerations, Prof. Raymond J. Krizek, $193,624[1]

A473, Safety Concrete – A New Impact-Absorbing Concrete for Protecting Buildings, Structures, & People, Prof Hamlin Jennings & Prof. Jeffrey Thomas, $146,145[1]

A475, Introducing Size Effect into Design Practice and Codes for Concrete Infrastructure, Prof. Zdenek Bazant, $179,570[1]

A476, Improved Condition Monitoring for Bridge Management, David Prine, $766,842[1]

A477, Ultrasonic Technique for In-situ Monitoring of the Setting, Hardening, and Strength Gain of Concrete, Prof. Surendra Shah, $228,332[1]

A478, Allowable Deformations of Gas Mains Adjacent to Deep Excavations, Prof. Richard Finno, $1,222,984[1]

A479, Improved Condition Monitoring of Bridges: Nondestructive Evaluation of Foundations, Prof. Richard Finno, $1,453,819[1]

A480, Commercialization of Instrument for Micro-Inch Measurement of Crack Width in Support of Thrust in Remote Monitoring for Bridge Management, Prof. Charles Dowding, $288,127[1]

A481, The Infrastructure Construction and Condition Monitoring Laboratory as a Novel Teaching Tool to Improve Undergraduate Education in Civil Engineering, Prof. Roberta Massabo, $119,153[1]

A483, Commercialization of TDR Measurement of Soil Deformation in Support of Thrust in Remote Monitoring for Bridge Management, Prof. Charles Dowding, $67,891[1]

Note: [1] Budgets shown are Year Five funding including match.

Completed Projects

A428, Analysis of the Performance of the Rehabilitation of the Chicago-State Subway Station and Its Effects on Adjacent Structures, Prof. Richard Finno

A433, Evaluation of Capacity of Micropiles Embedded in Rock, Prof. Richard Finno

A454, Further Commercialization of NUCu Steels, Prof. Morris Fine and Dr. Semyon Vaynman

A461, Use of a Remote Web-Accessible Camera to Improve Undergraduate Education in Civil Engineering, Prof. Charles Dowding & Prof. Roberta Massabo