



MESSAGE FROM THE DIRECTOR



In Illinois, we sit at the transportation crossroads of the nation; a significant percentage of the nation's goods and people pass through our state every day. This role as a transportation hub to the nation brings many benefits to the state in terms of our economy, employment, mobility, and much, much more, but it also carries responsibilities. The ICT helps ensure that our transportation facilities and systems are kept at peak efficiency. Hence, ICT's responsibility is to lead the discovery, development, and implementation of solutions that improve transportation safety, efficiency, and sustainability.

Our role as a premier transportation research center in North America is to address the urgent and evolving transportation needs of the state of Illinois, the country, and the world at large. This leadership has been remarkably boosted by the partnership between IDOT and UIUC, and this relationship allows both organizations to better serve the state and its people, optimize our resources, and achieve distinction at both national and international levels.

The research at ICT is conducted by investigators at UIUC in collaboration with experts at many other universities as well as research agencies across the country and around the world. This brochure highlights only a sample of the diverse and groundbreaking transportation research ICT is conducting. Please feel free to contact any of our researchers for more information, and you may also visit our website, www.ict.uiuc.edu, for more information on our research and outreach activities.

Imad L. Al-Qadi
Founder Professor of Engineering, UIUC
Director, ICT and ATREL

THE ILLINOIS CENTER FOR TRANSPORTATION

—WHERE EXCELLENCE AND TRANSPORTATION MEET

The Illinois Center for Transportation (ICT) is an innovative partnership between the Illinois Department of Transportation (IDOT) and the University of Illinois at Urbana-Champaign (UIUC). The ICT builds on the experience of renowned experts in transportation and related fields at the University of Illinois, IDOT, and other universities worldwide by providing the appropriate tools and support required for objective research. The ICT facilitates the development and timely implementation of cost-effective technologies that improve safety and reliability, reduce congestion and impact on the environment, optimize the utilization of the state transportation infrastructure, and maximize the return from taxpayers' dollars. The ICT serves the needs of IDOT, the State of Illinois, and the nation through research, education, and outreach.

The ICT is headquartered at the Advanced Transportation Research and Engineering Laboratory (ATREL), one of the top transportation research facilities worldwide, located on 47 acres of the former Chanute Air Force Base in Rantoul, Illinois. The facility has 60,000 square feet of laboratories and three major buildings for testing pavement materials and transportation operations. The large land area at the ATREL complex houses a full-scale pavement testing facility that uses an Accelerated Transportation Loading ASsembly (ATLAS), which is capable of evaluating multiple transportation support systems under real environmental and vehicular loading conditions.

Examples of ICT's Varied Research to Advance the Safety of Our Transportation System and Protect the Environment

TRANSPORTATION FACT	ICT'S RESPONSE
Trucks move a majority of the total tonnage of U.S. shipments and therefore are responsible for significant gas emissions that are related to ozone depletion.	Investigating innovative technologies, such as wide-based tires, that reduce fuel usage and therefore decrease environmental damage.
It is predicted that by the year 2030, the elderly population in the U.S. will double.	Researching transportation alternatives that help seniors maintain their independence while also assuring the safety and comfort of other travelers.
Bridge scour, the erosion of stream bed material around the bridge foundation, is responsible for many of the bridge failures in the United States.	Developing and implementing new technologies to predict bridge foundation scouring.
In Illinois, an average of 6,700 crashes occur in highway work zones every year.	Investigating driver behavior and improving the set-up of work zones.



The ICT takes a proactive role in protecting our environment by developing technologies that conserve resources. Tires, pavements, and even rest areas all contain opportunities for environmentally friendly practices, and ICT's research is at the forefront of these ideas.

RECYCLED ASPHALT PAVEMENT

Many states, including Illinois, and countries have been using reclaimed asphalt pavement (RAP) in hot-mix asphalt (HMA) pavements since 1980, but the optimal design of these pavements has been continually questioned. Therefore, ICT is working to improve the design of pavements with RAP and investigate the use of RAP with up to 50% of the total original material. This research focuses on understanding the interaction between the new and recycled asphalt components using state-of-the-art technologies, including nanotechnology and scanning electron microscopy, to quantify the effectiveness of using RAP in HMA.

Developing a better design for pavements that use recycled materials results in significant environmental benefits and cost savings. The project outcome is a scientifically proven approach to optimize the use of RAP in new pavements.

For more information, contact Imad Al-Qadi (alqadi@uiuc.edu) or Sam Carpenter (scarpent@uiuc.edu).





ENVIRONMENTALLY FRIENDLY TIRES

The new generation of wide-base tires (as an alternative to the conventional dual-tire system) has the potential to provide numerous benefits to the trucking industry, including improved fuel efficiency, hauling capacity, comfort, vehicle stability, and safety. Additionally, wide-base tires can lessen gas emission, initial tire cost, tire repair cost, and noise. One source of concern about wide-base tires has been that they may cause increased damage to highway pavements. However, ICT's international leading role in advanced modeling research, input into tire design, and extensive testing on the new generation of wide-base tires show that they actually have similar total pavement impact on the interstate highway pavements as the dual-tire system; although the pattern of damage could be different. Therefore, the environmental impact and other benefits of wide-based tires, including cost-effectiveness, prove them to be a technology worthy for the future of heavy trucks in the U.S.

By taking the lead on U.S. and international research related to the wide-base tire, quantifying its impact on pavements through advanced modeling and measurements of pavement response, planning for the future increase in truck loading, and addressing potential concerns, the ICT has demonstrated that wide-base tires will benefit the nation's trucking industry and the environment. The expected savings through hauling more goods, lowering the impact on the environment, and increasing safety is expected to be in the billions of dollars.

For more information, contact Imad Al-Qadi (alqadi@uiuc.edu).



WIND-POWERED REST AREAS

The ICT is investigating the viability of using wind power to provide electricity for highway rest areas and weigh stations. Wind power is an attractive option because it is a clean, renewable energy source that avoids greenhouse gases; it uses relatively little land or other natural resources; and it is a hedge against further increases in electricity costs. For each proposed wind-energy site, available wind resources (in kilowatt-hours per year) are determined. The study also determines location suitability, upfront cost of building and maintaining wind turbines, and potential cost savings from using wind turbines.

The final product includes site-by-site recommendations along with an economic analysis for using wind turbines. The implementation of this project's recommendations would reduce energy costs while protecting the environment.

For more information, contact Patrick Chapman (plchama@uiuc.edu).

In Illinois alone, work zone accidents result in an average of 2,800 injuries and 33 fatalities per year. Contrary to popular belief, motorists are more likely to get hurt in work zones than workers; motorists account for approximately 85% of the total injuries. With the end goal of safer work zones for everyone, ICT supports research to study driver behavior and improve the set-up of work zones.

CONTROLLING NIGHTTIME GLARE

Nighttime highway construction is often advocated to minimize inconvenience for the traveling public and to reduce the potential for work zone accidents. However, poor utilization and placement of the lighting equipment to illuminate the work zone can cause glare that is dangerous to drivers and workers. With the goal of making nighttime construction zones safer, ICT researchers have analyzed and compared the levels of glare and lighting performance generated by typical as well as innovative lighting arrangements and have identified the factors that affect glare measurement.

This ICT research has provided recommendations for lighting arrangements to reduce and control lighting glare at nighttime work zones. In addition, the study identified a practical method that can be used to measure and quantify glare during nighttime highway construction. A major advantage of this new method is that it saves significant costs by not requiring a pavement luminance meter.

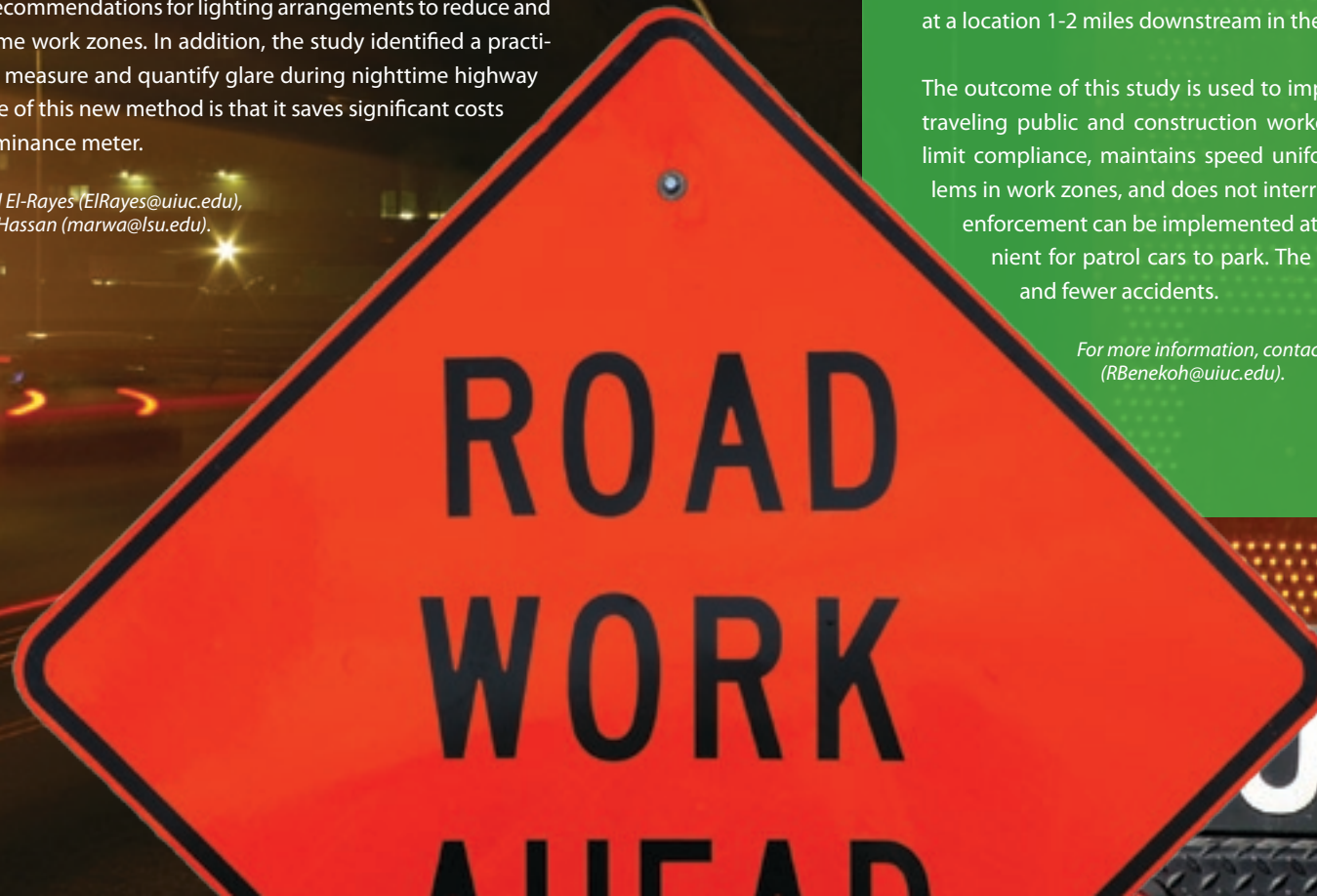
For more information, contact Kahled El-Rayes (ElRayes@uiuc.edu), Liang Liu (lliu1@uiuc.edu), or Marwa Hassan (marwa@lsu.edu).

SPEED ENFORCEMENT TECHNOLOGIES

ICT investigated the effects of automated speed-radar photo enforcement (SPE) systems on traffic flow characteristics and safety in interstate work zones. The effects of SPE on average speed of vehicles and percentage of speeding drivers were compared to the effects of police presence, signs displaying the driver's speed, and combinations of these treatments. ICT also determined the spatial effects of SPE and police presence at a location 1-2 miles downstream in the work zone.

The outcome of this study is used to improve work zones' safety for the traveling public and construction workers. Using SPE increases speed limit compliance, maintains speed uniformity, reduces speeding problems in work zones, and does not interrupt traffic flow. With SPE, speed enforcement can be implemented at locations where it is not convenient for patrol cars to park. The outcomes are safer work zones and fewer accidents.

For more information, contact Rahim (Ray) Benekohal (RBenekoh@uiuc.edu).





ROLLING LANE CLOSURES

Rolling lane closures are a common traffic control technique in work zones; they consist of a convoy of traffic protection vehicles equipped with warning lights and arrowboards that alert drivers to the presence of work crews and guide them to the adjacent lane until they have safely passed the work zone. However, a danger of rolling closures is that their moving nature does not allow for the placement of barricades between the work crew and the adjacent open traffic lane. An ICT project aims to improve the safety of work crews, traffic control providers, and the traveling public by studying the factors that affect driver behavior around moving work zones. Specifically, the researchers are studying pertinent safety parameters that include traveling speed, number and spacing of trucks, buffer distances, and visibility of work crews. The research also includes performing full-scale field experiments in collaboration with the Illinois State Toll Highway Authority and determining energy absorption to predict typical roll-ahead distances of protection vehicles when they are impacted by vehicles of varying sizes and speeds.

The results of this study are an improved understanding of driver behavior near and around rolling lane closures and recommendations for increasing the safety and effectiveness of moving lane closures. The impact of this research is to reduce the thousands of accidents that occur on our nation's highways each year, including the numerous fatalities occurring in highway work zones.

For more information, contact Douglas Steele (dsteele@ara.com) or William Vavrik (wvavrick@ara.com).

The ICT has been conducting research related to bridge safety since the center's inception. From monitoring specific bridges to developing and implementing innovative technologies to improve bridge monitoring, the ICT has an ongoing role in assuring the safety of our nation's bridges. Additionally, the ICT has rapidly responded to the Illinois Department of Transportation's (IDOT's) requests on issues related to bridge integrity.



MONITORING THE KISHWAUKEE BRIDGE

The ICT sponsored a research project for the continuous monitoring of the Kishwaukee Bridge. The data collected includes measurements such as bridge deck acceleration, temperature changes, and crack opening displacement data from local deformation gages. The monitored data also includes modal frequencies, shear strain at known crack locations, and daily truck traffic. The instrument response provided needed information for real-time inspection and planned maintenance and rehabilitation.

The measurements collected by the ICT will be used to infer possible structural changes and to guide retrofit strategies for compromised components, ensuring the bridge's integrity and stability into the future.

For more information, contact Ming Wang (mlwang@uic.edu).

ESTIMATING BRIDGE SCOUR

Bridge scour, the erosion of stream bed material around the bridge foundation, is responsible for many of the bridge failures in the United States. To assess scour in cohesive sediments (silts and clays), a new methodology, The Scour Rate in Cohesive Soils-Erosion Function Apparatus (SRICOS-EFA) has been developed and is being evaluated along with the current methodology used in Illinois for non-cohesive sediments (primarily sand), HEC-18. Currently, ICT is testing the SRICOS-EFA method for estimating scour depth of cohesive soils to potentially validate its use for Illinois streams. This project will then compare the SRICOS-EFA method to the HEC-18 scour estimates.

The ICT research is being used to validate and calibrate the SRICOS-EFA for various cohesive soils. Additionally, the project analyzes standard soils testing data that is correlated to results from SRICOS-EFA and HEC-18. Accurate scour assessment results in longer-lasting and safer bridges.

For more information, contact Tim Straub (tdstraub@usgs.gov).



RAPID RESPONSE

When a highway bridge girder suddenly collapsed on the suburban Chicago Kingery Expressway construction site killing one person and injuring others, ICT was called in to detect internal structural damage and identify the reinforcement steel condition. The ICT was also requested to conduct a non-destructive evaluation of the Dan Ryan Expressway (I-90/94) bridge decks, using ground penetrating radar to measure the reinforcement cover depth.

The ICT's rapid response to bridge issues saves additional testing and repair costs. In the case of the Kingery Expressway, ICT's evaluation also reduced construction delays and costly construction downtime. In the case of the Dan Ryan Expressway bridge, the ICT provided timely and accurate measurements that were validated by taking ground-truth cores. These accurate measurements resulted in IDOT changing its rehabilitation technique, which saved the state millions of dollars in repair costs.

For more information, contact Imad Al-Qadi (alqadi@uiuc.edu) or John Popovics (johnpop@uiuc.edu).



The traveling public expects safe, long-lasting, and smooth-riding pavements as well as minimal delays due to construction. To help meet their expectations while maximizing the use of their tax dollars, ICT investigates causes of pavement deterioration and ways to improve pavement design, monitoring, evaluation, performance, and rehabilitation methods. The information gained from these studies leads to lower construction costs, increased maintenance intervals, extended pavement life, and reduced travel delays.

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ENHANCING PAVEMENT DESIGN

Recent ICT research optimized the structural design used for new hot-mix asphalt (HMA) pavements for the busiest Illinois highways. The research included examining numerous HMA designs and the construction of instrumented full-depth HMA test sections. Full-scale testing of the sections was conducted using nondestructive testing techniques and the Accelerated Transportation Loading ASsembly (ATLAS). The researchers used the results to validate developed pavement models capable of predicting the pavement response to vehicular loading. The researchers also conducted testing to compare laboratory predicted fatigue life to field performance. Their validated method provides a more efficient means for optimizing pavement design parameters.

The laboratory and field information generated during this project supports the use of an improved structural design procedure for HMA pavements based on Illinois materials and environment. Additionally, as a result of the project, ICT recommended a design approach that can save IDOT millions of dollars in pavement construction costs each year.

For more information, contact Sam Carpenter (scarpent@uiuc.edu) or Marshall Thompson (MRThomps@uiuc.edu).

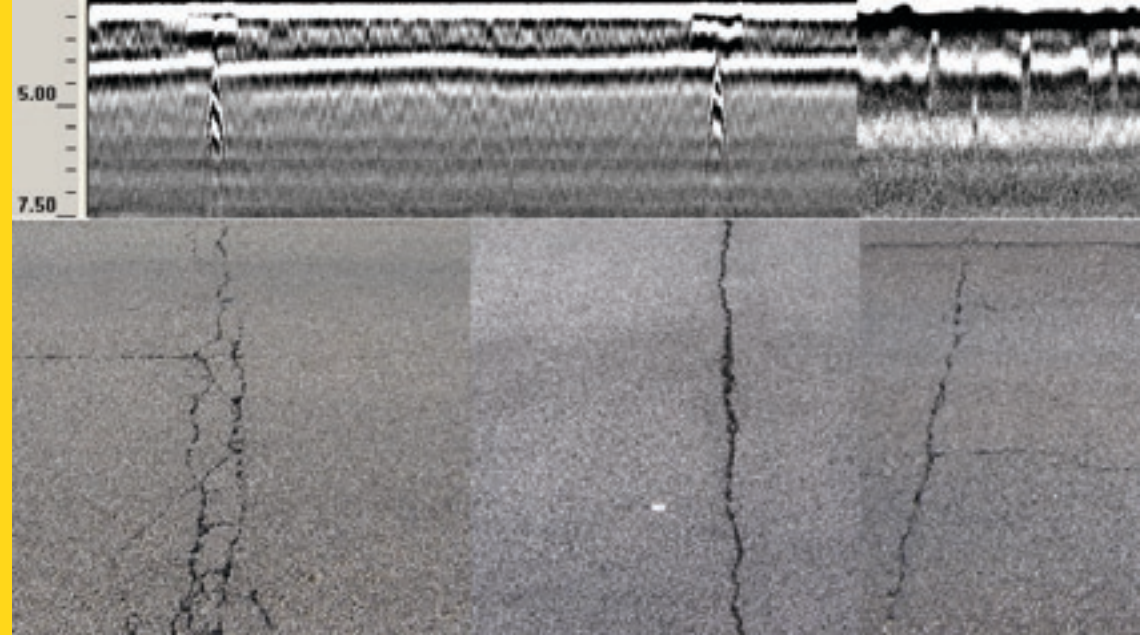


DEVELOPING OPTIMAL REHABILITATION STRATEGIES

Ultra-thin whitetopping (UTW) is a pavement rehabilitation strategy where a thin layer of concrete is placed on top of an existing hot-mix asphalt (HMA) pavement. The ICT conducted research to assist IDOT with optimal design and construction strategies for its UTW projects. As part of this research project, ICT developed guidelines for UTW projects that address thickness, concrete material selection, and construction practices. Specifically, ICT researchers evaluated the effects of structural macro-fibers and concrete material properties on slab size and thickness requirements for UTW rehabilitation. Other factors evaluated included the existing condition of the HMA, HMA thickness, interface preparation and strength, and saw-cut timing and depth.

IDOT uses the new guidelines to improve the efficiency and quality of the design and construction for UTW projects. The expected end results include increased maintenance intervals, extended pavement life, and reduced travel delays.

For more information, contact Jeff Roesler (jroesler@uiuc.edu) or Anastasios Ioannides (anastasios.ioannides@uc.edu).



REFLECTIVE CRACKING: INITIATION AND PROPAGATION MODELING, ASSESSMENT, AND CONTROL SYSTEM EFFECTIVENESS

When a pavement deteriorates to an unacceptable level due to cracking or moving joints, a hot-mix asphalt (HMA) overlay is usually applied. However, this type of overlay may still show cracking after a short period of time. Installing an interlayer system under the overlay is one of the most efficient techniques to delay this trend known as reflective cracking. Interlayer systems are comprised of various materials/systems including geosynthetics, geocomposite, steel reinforcement netting, and polymer-modified fine HMA. These techniques provide some level of reflective cracking control. However, crack initiation, propagation, and control mechanisms are not well understood. Hence, the effectiveness and efficiency of interlayer systems may not be quantified. To address this important need, ICT researchers have quantified cracks in the field using image analysis and ground penetrating radar (GPR) surveys, conducted advanced laboratory material characterization, and developed finite element models to simulate crack initiation and propagation, as well as to simulate various interlayer systems. As part of the research project, the cost-effectiveness of interlayer systems through life-cycle cost analysis was also investigated.

As a result of this research, the ICT introduced a method to better identify reflective cracking in the field using digital imaging and GPR signal analysis. The developed models are capable of predicting the initiation and propagation of cracks. They can also be used to quantify the effectiveness of current and future interlayer systems. Additionally, ICT introduced performance indices to quantify the cost-effectiveness of interlayer systems. The outcome of this study is a better understanding of reflective cracking mechanisms; hence, enhanced simulation of crack development and field assessment, and the quantification of the efficiency and cost-effectiveness of interlayer systems used to retard reflective cracking.

For more information, contact Imad Al-Qadi (alqadi@uiuc.edu) or Bill Buttlar (buttlar@uiuc.edu).

To provide quality transportation structures to the traveling public, the Illinois Department of Transportation (IDOT) needs to accurately evaluate the status of its pavement and bridge networks and predict construction needs. Through various studies and research on innovative technologies, ICT is helping IDOT improve its processes for assessing infrastructure condition and planning for future work.

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ACCURATE AND EFFICIENT PAVEMENT EVALUATION

As part of its routine maintenance and rehabilitation activities, IDOT evaluates the structural capacity of the state's existing, in-service roadway pavements. In one of the methods, IDOT uses a Falling Weight Deflectometer (FWD) which simulates the weight of truck axles and provides deflection data that is used to characterize the pavement's structural capacity. To improve the process of utilizing the FWD, ICT has proposed and tested the use of Artificial Neural Network (ANN) techniques to predict pavement layer properties from FWD deflection data and predict critical pavement responses to loading. These newly developed models more rapidly and accurately determine existing pavement layer properties and estimate remaining pavement life. Additionally, ICT developed user-friendly software for the ANN models.

The outcomes of this research are models that accurately assess pavement condition and can be used to estimate the remaining life of pavements when performing pavement life-cycle cost analyses.

For more information, contact Erol Tutumluer (tutumlue@uiuc.edu) or Marshall Thompson (MRThomps@uiuc.edu).

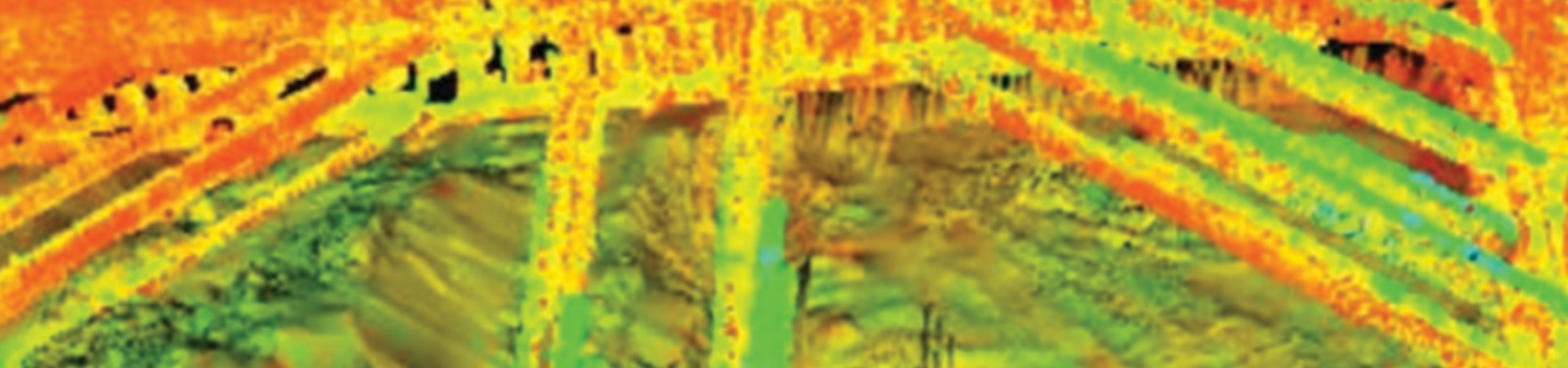


PREDICTING REHABILITATION NEEDS

The IDOT surveys every state-maintained roadway every two years. The surveyors look for five predominant pavement distresses and determine the severity of each distress on each roadway. They then input the data into software to determine a current Condition Rating Survey (CRS) value, which is a score that reflects the overall condition of the pavement. The condition data and prediction models are used to estimate future CRS values and the anticipated needs for future rehabilitation. An ICT study recently revised IDOT's existing CRS calculation and prediction models and developed new models to reflect the changes in pavement systems and the rehabilitation and assessment techniques.

As a result of this project, IDOT now has more accurate CRS values and is able to more accurately project rehabilitation needs into the future.

For more information, contact Laura Heckel (HERE_laura@sbcglobal.net).



LASER TECHNOLOGY FOR BRIDGE AND PAVEMENT CONSTRUCTION

The use of laser scanning equipment to produce three-dimensional representations of objects and surfaces is a new technology that has significant potential for monitoring highway and bridge construction activities. Examples of potential uses of laser scanning include obtaining accurate pre- and post-construction terrain models for determination of earthwork quantities, especially in urban areas or on reconstruction projects; monitoring pavement smoothness and adherence to design grade; and monitoring ground movement near excavations, large embankments, or pile-driving operations. However, to prove the accuracy of this new method, data obtained using laser scanning technology need to be compared to data obtained using traditional methods.

ICT is conducting this research to validate the feasibility of using laser technology to monitor IDOT highway construction activities and transportation structures. A cost-effective and accurate laser technology has significant potential to impact the efficiency and cost control of future construction projects.

For more information, contact Dianne Kay Slattery (DKay@siue.edu).

Photo courtesy of Trimble

PREPARING FOR FUTURE TRANSPORTATION NEEDS

The ICT's research to develop transportation solutions is as varied as it is innovative. Several studies serve to improve the regulation, accessibility, and forecasting of our transportation system.

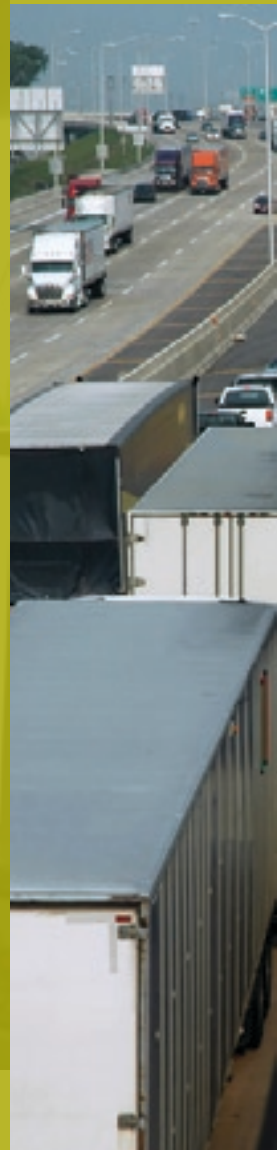
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IMPROVING MOTOR VEHICLE REGULATION

As a result of an ICT project, a Commercial Vehicle Information Exchange Window was developed to exchange motor carrier safety information with other federal and state agencies involved with motor carrier regulation. The ICT project also developed system requirements for a Commercial Vehicle Information Systems and Networks (CVISN) to exchange motor vehicle information amongst the Department of Transportation, the Secretary of State, and the Department of Revenue.

Other project deliverables that serve to improve vehicle regulations include a roadside information viewing mechanism; a system for oversize/overweight vehicle permitting, tracking, and mapping; and an input system for the Illinois Department of Revenue's International Fuel Tax Agreement (IFTA) program. The use of CVISN improves highway safety, streamlines regulation of the trucking industry, and enhances motor carrier efficiency and productivity.

For more information, contact Peter Nelson (nelson@uic.edu).





PLANNING FOR AN AGING POPULATION

By 2030, the elderly population in the U.S. is expected to double. An aging population brings new challenges for transportation researchers, such as providing seniors with innovative transportation alternatives that help them maintain their independence while also assuring the safety and comfort of other travelers. Exploring the usefulness of strategies that can improve seniors' perception of the public transit system was the main goal of an ICT study. The results showed that most seniors are not familiar with the public transportation system; hence, they keep driving. Additionally, their safety concerns and expectations of frequent stops and wait time influence their choices about transit. The study showed that the most appealing technological solutions to seniors are the availability of real-time wait time and lower-height buses. Other successful strategies could include transit schedule brochures, increased frequency of services, and fixed routes especially designed for seniors.

The results of the study are being implemented to plan for and encourage effective transportation solutions for an aging population, which are safer, cleaner, well-equipped, and more accessible services.

For more information, contact Kouros Mohammadian (kouros@uic.edu).

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FORECASTING TRUCK TRAVEL ACTIVITIES

Recent advances in intermodalism, the connections between various modes of transportation, have resulted in quantum leaps in transportation, logistics, and warehousing. As a result, it is common to have million square foot warehouses, intermodal rail facilities capable of handling one million lifts of a container or trailer annually, and 8,000-ft-long trains of 400 containers. The Chicago-area has embraced these advances to become an intermodal "epicenter" and consequently could be considered one of the largest "ports" in the world. These developments attract and produce truck activity, and the "center of gravity" of this ecosystem is inexorably centrifuging to other communities. To gain insight into these activities, ICT sponsors research that includes surveying truck traffic and production at large warehouses in Northeast Illinois.

The ICT is illustrating the array of distribution activities, supportive truck movements, and meaningful ratios of truck traffic related to business and building profile factors. This allows for estimating truck movement and growth relative to new distribution space being added in the Chicago area. This study will assist national agencies in determining the demand freight transportation has on infrastructure, forecasting travel activity, and anticipating needs for additional transportation assets.

For more information, contact Jon B. DeVries (JDeVries@roosevelt.edu).



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ICT acknowledges the input of the IDOT technical review panels for each research project and thanks the many universities, agencies, and consultants who actively participate in the ICT research projects.

In addition to IDOT, ICT's sponsors include federal and state agencies and international corporations, institutes, and universities.

Learn more about ICT's innovative research at www.ict.uiuc.edu, or contact us at:

Illinois Center for Transportation
University of Illinois at Urbana-Champaign
1611 Titan Drive
Rantoul, IL 61866
(217) 893-0705
Fax: (217) 893-0601

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