

INTRANS EN ROUTE ANNUAL REPORT

JANUARY 2019 TO DECEMBER 2019





FOCUS AREAS







IOWA STATE UNIVERSITY

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INSTITUTE FOR TRANSPORTATION

Shauna Hallmark, Director Neal Hawkins, Associate Director intrans.iastate.edu

CENTERS

Bridge Engineering Center (BEC) Conducting research to solve real-world structural problems

Center for Earthworks Engineering Research (CEER)

Solving critical geotechnical engineering and earthworks construction challenges through research and advanced technologies Vernon Schaefer, Interim Director

Center for Transportation Research and Education (CTRE)

Exploring safety, infrastructure management systems, and sustainability in transportation Omar Smadi, Director

Center for Weather Impacts on Mobility and Safety (CWIMS)

Facilitating better and safer ways to travel when weather impacts transportation systems Zach Hans, Director

Midwest Transportation Center (MTC)

Employing data-driven performance measures for enhanced infrastructure condition, safety, and project delivery Shauna Hallmark, Director

National Center for Wood Transportation Structures (NCWTS) Integrating research, demonstration, and education to improve wood transportation structures Travis Hosteng, Codirector

National Concrete Pavement Technology (CP Tech) Center Serving as the national hub for concrete pavement research and technology transfer Peter Taylor, Director

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PROGRAMS

Asphalt Materials and Pavements Program (AMPP)

Improving asphalt pavements through research and education Chris Williams, Director

AURORA Program

Working to advance road weather information systems technology Zach Hans, Director

Construction Management and

Technology (CMAT) Program Researching innovative construction technologies and processes for the transportation industry Jennifer Shane, Director

Iowa Local Technical Assistance Program (Iowa LTAP)

Helping Iowa's local governments keep up with growing transportation demands Keith Knapp, Director

Iowa Statewide Urban Design and Specifications (SUDAS)

Providing uniform design guidelines and construction specifications for lowa's urban public improvement projects Paul Wiegand, Director

Program for Sustainable Pavement

Engineering and Research (PROSPER) Investigating and integrating innovative, sustainable pavement materials and technologies

Halil Ceylan, Director

Smart Work Zone Deployment Initiative (SWZDI)

Investigating better ways to control traffic through work zones Keith Knapp, Director

REACTOR (Real-Time Analytics of Transportation Data) Laboratory

Completing traffic calculations within seconds to enable the delivery of near real-time solutions

Codirectors: Anuj Sharma, Neal Hawkins, and Skylar Knickerbocker

DIRECTOR'S MESSAGE



Someone once said, "The road to success is always under construction," and I can't think of a better way of phrasing our transition into 2020.

We just celebrated our 30th anniversary, and as with any milestone, it makes us think of the future. What is next for the Institute for Transportation (InTrans)?

At the end of fiscal year 2019, the annual budget for work at InTrans continues to hold steady at \$20 million. But, what's in a number? This is evidence of the work of our researchers and staff and moreover the confidence that state agencies, industry groups, and the federal government have in our ability to deliver new best practices, technologies, and results.

More than the numbers, InTrans has an exceedingly dedicated and brilliant staff, who each year find new ways to strengthen our story—from hosting webinars to mentoring graduate students to simply dedicating even small opportunities to share experiences and breakthroughs.

We collaborate with 39 faculty members from the Iowa State University College of Engineering and employ another 83 research scientists, traffic engineers, and professional staff. They are supported by 134 graduate students who work on a variety of research and demonstration projects under the guidance of InTrans staff. These students are the future of transportation engineering and the experience and knowledge they gain here will catapult them into the unknown—where they get to discover what it's like to lead their own traffic study, consult with local agencies on a large-scale construction project, or just discover something completely new.

For those whose job is transportation, specifically transportation safety, in 2019, InTrans provided training, workshops, and hosted two successful annual events: the Midwest Traffic Incident Management Safety Summit and the Traffic and Safety Forum. InTrans' efforts on safety are a cornerstone of our success—bringing us back to the start of our initial program: Iowa's Local Technical Assistance Program, which today helps Iowa's local governments keep up with growing demands on local roads, streets, bridges, and public transportation through education, workshops, and site training.

We have published 45 technical reports on completed projects, as well as 30 tech transfer summaries, 7 tech briefs, and 4 manuals, all available for downloading on the new InTrans website. In fact, in this annual report we highlight the green research recently completed by Asphalt Materials and Pavements Program (AMPP) Director Chris Williams, whose efforts in using recycled materials have shown success.

Up next, InTrans will continue ongoing efforts and start new projects. We plan to continue providing strong Iowa State support and effective research into the coming year, but for now, please join us in celebrating today's achievements.

Shanna J. Mallmik

Shauna Hallmark Director, Institute for Transportation Professor, Department of Civil, Construction, and Environmental Engineering Iowa State University E

INTRANS' 30TH ANNIVERSARY CELEBRATION

It was a reminder to take a step back, look at the big picture, and recognize the work that has made InTrans what it is today.

During a short presentation, speakers noted how rare it is that these reflections occur.

"It was a great opportunity to step back and really celebrate," said David Sanders, Civil, Construction, and Environmental Engineering department chair. "There's a lot that's worth celebrating: the amazing accomplishments that have been done over the last 30 years."

Aside from Sanders, speakers included Iowa State's Vice President for Research Sarah Nusser, previous Iowa Department of Transportation Director Mark Lowe, Iowa DOT Office of Operations Director Scott Marler, and InTrans leaders.

The event was held in December 2018 and celebrated the 30th anniversary of InTrans, from its start with a single grant, and the 35th anniversary of its Local Technical Assistance Program (LTAP), which formed from similarly humble beginnings.

Sarah Nusser welcomed the group and acknowledged the "amazing growth path InTrans has taken (40% growth over the last 10 years), which has led to it being the largest research center at Iowa State University."

From its single grant, InTrans has now grown to \$20 million in expenditures. LTAP went from offering fewer than a dozen workshops as part of its \$100,000 federal grant to now hosting a large part of the 100-plus events that InTrans holds annually.



CP Tech Program Coordinator Sharon Prochnow reacts to receiving an award for her tenure



Shauna Hallmark welcoming the crowd



InTrans staff enjoying the festivities

InTrans Director Shauna Hallmark welcomed the more than 200 guests to the event and recognized the many partners there that have worked with InTrans and its 15 centers and programs over the years.

The celebration didn't just recognize the organization, but also honored the people who have made it possible.

InTrans Associate Director Neal Hawkins asked attendees to remember the "colleagues forever," who were integral parts of the organization before they passed away, and also thanked those current employees who have been here between 5 years and more than 30.

"I want to thank the staff and also the students of InTrans. Everybody at the Institute works really hard every day. We wouldn't be where we are today without the hard work of our staff and also our students," added Omar Smadi, director of InTrans' Center for Transportation Research and Education.

There was also a special recognition for the InTrans employee with the longest tenure with the organization, Sharon Prochnow. She's been at the university for 31 years and at InTrans for nearly all its existence.

"Twenty-seven years ago, she joined the InTrans team and has been a core member of our group since that time. She's gone through the different incarnations of what has become InTrans," said Smadi at the event.

Hawkins thought of the future of InTrans through a different lens.

"We're celebrating this 30-year milestone tonight, but we'll wake up tomorrow with an eye on getting better."



TWO INTRANS EVENTS EMPHASIZE TRAFFIC SAFETY: MTIMSS AND TRAFFIC AND SAFETY FORUM

Known simply as the MTIMSS, the Midwest Traffic Incident Management Safety Summit put the focus on first responders' safety.

Offered on a biannual basis, the event is an outgrowth from Iowa's Statewide Multidisciplinary Safety Team (MDST) program, which is a coordinated effort between the Institute for Transportation (InTrans), Iowa Department of Transportation (DOT), and Iowa Governor's Traffic Safety Bureau.

The summit was held on the Iowa State University campus from September 30th to October 1st, 2019. The keynote speaker was Sgt. Robert Bemis, a now-retired Pennsylvania State Police trooper and U.S. Marine Corps military policeman, who shared his story about surviving and thriving after being hit by his own unmarked car that was struck by a vehicle while he was assisting a stranded motorist.

Kurt Miene, of the Iowa DOT's Motor Vehicle Enforcement Agency, said crashes tend to be the first thing that comes to mind when people think of "traffic incident," but the term also includes flat tires and disabled vehicles. He defined a traffic incident as "anything that inhibits or changes the flow of traffic."

The first responders who address traffic incidents can at any time find themselves in the kind of danger that nearly took Bemis's life, which is why Bemis stressed the importance of continuing education when it comes to traffic incident management (TIM).

The summit included informational booths, additional presentations on safety efforts and challenges, and a four-hour optional TIM training session.



Iowa State Patrol's Col. Nathan Fulk offers introductory comments to kick off the Midwest Traffic Incident Management Safety Summit



Jay Otto giving the keynote speech at the Traffic and Safety Forum



MTIMSS attendees visiting informational booths on the first day of the summit

The Traffic and Safety Forum, an event focused more on the perception of traffic safety rather than training, was also held in October 2019. The purpose of this annual event is to enable traffic and safety engineering professionals to learn about new and innovative systems and processes, share individual experiences, and collectively address issues of interest.

Jay Otto, a research scientist for the Center for Health and Safety Culture in the Western Transportation Institute at Montana State University, gave the keynote speech. While Otto focused on shifting the values, attitudes, and beliefs in communities as a whole, the other presentations during the day-long conference highlighted the ways that DOTs, cities, counties, and researchers are working in their own individual communities to create a culture of safety.

Those talks ranged from improving work zone performance to increasing complete streets projects to reaching young drivers.

Iowa Department of Transportation Traffic and Safety Bureau Director Steve Gent added to Otto's presentation by discussing the statistics in Iowa. He stressed that the state does a good job on the infrastructure part of building a safety culture but agreed much more remains on the behavioral aspects.

"Right now we're looking at about 45 percent of fatalities being unbelted, and yet 94 percent of people are belted," Steve Gent said. "If we're ever going to get to zero, we need to be dealing with the safety culture aspects."

The Traffic and Safety Forum was hosted by the Iowa DOT and InTrans.

2019 MID-CONTINENT TRANSPORTATION RESEARCH SYMPOSIUM

The 2019 Mid-Continent Transportation Research Symposium held in August at the Gateway Hotel and Conference Center in Ames, Iowa, attracted more than 250 attendees interested in hearing the latest in transportation research.

The key takeaway? Now is a great time to be a transportation engineer.

Keynote speaker Bo Wang, a mobility analytics manager at the Global Data Insight & Analytics (GDIA) organization at Ford Motor Company, offered a nuanced take on mobility.

Paraphrasing Charles Dickens' "A Tale of Two Cities," Bo Wang said, "It is the best of times. It is the worst of times. It is the age of autonomous driving. It is the age of connected vehicles. It is the epoch



Bo Wang, a mobility analytics manager at Global Data Insight & Analytics (GDIA) organization at Ford Motor Company delivers the keynote speech to kick off the 2019 Symposium

of densification. It is the epoch of big data. ...Welcome to the dawn of the mobility revolution."

While the first speakers of the two-day event highlighted the opportunities and challenges facing mobility in transportation, the symposium continued its practice of offering different tracks on safety, sustainability, various technologies, and innovation, as well as mobility. A poster presentation at the end of the first day also offered opportunities to learn more about current research.

STUDENT AWARDS

TSA wins best student chapter award 7 years in a row

The Iowa State Transportation Student Association (TSA) earned the Outstanding Student Chapter Award of the Missouri Valley Section Institute of Transportation Engineers (MOVITE) for the seventh year in a row. MOVITE aims through its awards and scholarships to "recognize excellence in transportation by making awards to members whose contributions and achievements benefit our profession." A few notable 2018-2019 events helping the Iowa State TSA stand out include the fall and spring Roadside Clean-Up Events; R Workshops led by Ashirwad Barnwal, PhD student and InTrans research assistant; and multiple opportunities to learn and network with industry professionals.



InTrans graduate student wins Women in Transportation Award

InTrans doctoral candidate Bahar Bazargani was one of two women in 2019 to receive the president's scholarship from the regional chapter of WTS International, an organization dedicated to supporting women in the transportation industry. Bazargani, who is researching intelligent infrastructure engineering, was among seven women who received various scholarships from the WTS Greater Chicago Area Chapter. Iowa State University women have won scholarships from WTS Greater Chicago Area Chapter in each of the last four years.

REACTOR Lab students finalists in TRB competition

A team of Real-Time Analytics of Transportation Data Laboratory (REACTOR Lab) graduate students was one of five finalists in a transportation-forecasting competition led by the Transportation Research Board (TRB). The competition challenged teams to use a massive dataset to predict traffic data as close as possible to real-world data. The teams had to develop traffic-forecasting models to predict the average speed at five-minute intervals. The team consisted of Archana Venkatachalapathy, Pranamesh Chakraborty, Subhadipto Poddar, and Tongge Huang, all of whom were InTrans students at the time. •

FACULTY AND STAFF AWARDS



REACTOR Lab codirectors Anuj Sharma, Neal Hawkins, and Skylar Knickerbocker showing Cyclone pride ahead of game day

InTrans director recognized by Regents

Shauna Hallmark, Institute for Transportation (InTrans) director and professor of civil, construction, and environmental engineering, was one of five Iowa State University faculty members in 2019 who received the Regents Award for Faculty Excellence. The award is presented by the Iowa Board of Regents to recognize tenured faculty members who are outstanding university citizens and have rendered significant service to Iowa State University or the state of Iowa.

InTrans faculty affiliate Sri Sritharan recognized by Iowa State University

InTrans faculty affiliate Sri Sritharan, who is also the Wilkinson Professor of Interdisciplinary Engineering and a professor of civil, construction, and environmental engineering, was one of two Iowa State faculty to receive the Outstanding Achievement in Research award from the university. The award recognizes tenured faculty who have a national or international reputation for contributions in research and have influenced the research activities of students. Nominees have documented evidence of outstanding research and its impact, among other criteria, and were judged on the body of their work since their terminal degree.

InTrans faculty affiliate Charles Jahren recognized by Iowa State University

Charles Jahren, the W.A. Klinger Teaching Professor and a professor of construction engineering, was recognized with the title of Morrill Professor and was one of two Iowa State faculty members recognized for this university award in 2019. The title is awarded to faculty members who have exhibited excellence in their teaching or outreach and who have demonstrated outstanding performance in another area of faculty responsibility. The nominees must hold the rank of professor and have at least five years on the Iowa State faculty. They retain the title for the remainder of their career at the university.

InTrans' Sharma appointed Pitt-Des Moines Inc. Professor in Civil Engineering Anuj Sharma, research scientist at the InTrans, was named the Pitt-Des Moines Inc. Professor in Civil Engineering by Iowa State University's Department of Civil, Construction, and Environmental Engineering (CCEE), where he is also an associate professor. The company has contributed \$1 million to the Iowa State University Foundation to establish the endowed professorship. The endowed faculty position was the first for CCEE.

InTrans' Knickerbocker wins Young Transportation Professional Award

InTrans Research Engineer Skylar Knickerbocker earned the Young Transportation Professional of the Year Award from the Missouri Valley Section Institute of Transportation Engineers (MOVITE) in late 2018. His recognition was due in part to the work he's done since 2016 on the Intelligent Work Zone program to develop and advance the work zone performance monitoring web-based interactive visualization system that gives the Iowa Department of Transportation real-time information about any traffic issues in critical work zones.



RESEARCH REPORTS SHOWCASE INTRANS' SCOPE OF WORK

One way to appreciate the depth and breadth of research conducted by InTrans faculty, staff, and graduate students is to scan the list of research reports published during this reporting period.

2019

DECEMBER

Biofuel Co-Product Use for Pavement Geo-Materials Stabilization Phase II: Extensive Lab Characterization and Field Demonstration Implementation of Best Practices for Concrete

Pavements: Guidelines for Specifying and Achieving Smooth Concrete Pavements

Midwest Cross-Jurisdictional Image Verification Quantifying Pavement Albedo

NOVEMBER

Evaluation of Speed Limit Policy Impacts on Iowa Highways

Development of Granular Roads Asset Management System

Petrographic and Petrophysical Analysis of Decades-Old Iowa Portland Cement Concretes Feasibility of an Iowa Urban Service Bureau

OCTOBER

Optimizing Maintenance Equipment Life-Cycle for Local Agencies

Performance-Based Evaluation of Cost-Effective Aggregate Options for Granular Roadways Calibrating the Iowa Pore Index with Mercury Intrusion Porosimetry and Petrography – Phase II

SEPTEMBER

Evaluation of Alternative Abutment Piling for Low-Volume Road Bridges

Connection Details and Field Implementation of UHPC Piles – Phase II

Relationships between Weather and Roadway Safety

AUGUST

Investigation of Exterior Girder Rotation and the Effect of Skew during Deck Placement

JULY

Laboratory and Field Evaluation of an Alternative UHPC Mix and Associated UHPC Bridge

JUNE

Determination of U-Bolt Connection Load Capacities in Overhead Sign Support Structures Iowa LTAP Work Zone Sign Package Program Road Authority Practices in Data Storage Survey Smart Work Zone Activity App (SWiZAPP) Assessing the Impact of Game Day Schedule and Opponents on Travel Patterns and Route Choice Using Big Data Analytics These 73 reports were the products of research efforts that spanned all aspects of the nation's transportation system: pavements, bridges, traffic safety, asset management, mobility, urban transit, rural roads, and more.

Copies of these reports are available for download from the InTrans website at the URL: intrans.iastate.edu/research/completed/.

MAY

Preparing Local Agencies for the Future of Connected and Autonomous Vehicles Optimized Joint Spacing for Concrete Overlays with and without Structural Fiber Reinforcement Effectiveness of Pavement Preservation Techniques

APRIL

Investigation into Shrinkage of High-Performance Concrete Used for Iowa Bridge Decks and Overlays – Phase II Shrinkage Control and Field Investigation

Recommended Resistance Factors for Load and Resistance Factor Design of Drilled Shafts in Iowa

Construction of New Substructures Beneath Existing Bridges

Fiber-Reinforced Concrete for Pavement Overlays: Technical Overview

MARCH

Automating Near-Miss Crash Detection Using Existing Traffic Cameras

Performance Characteristics of Modern Recycled Asphalt Mixes in Missouri, Including Ground Tire Rubber, Recycled Roofing Shingles, and Rejuvenators

Optimal RAP Content for Minnesota Gravel Roads Overview of Fiber-Reinforced Concrete Bridge Decks

FEBRUARY

Investigation and Evaluation of Iowa Department of Transportation Bridge Deck Epoxy Injection Process

Laboratory and Field Evaluation of a Composite Glued-Laminated Girder to Deck Connection

Management of Bridges Considering Aging Mechanisms and Extreme Events

JANUARY

Integral Abutment Connection Details for Accelerated Bridge Construction

On-Board Prediction of Remaining Useful Life of Lithium-Ion Battery

Effective Production Rate Estimation Using Construction Daily Work Report Data—Phase I Extended Life Concrete Bridge Decks Utilizing Internal Curing to Reduce Cracking

2018

DECEMBER

Inspection and QA/QC for ABC Projects Investigation of Wrong-Way Driving Guide to Life-Cycle Data and Information Sharing Workflows for Transportation Assets Technology Transfer of Concrete Pavement Technologies

Validation Study for Detection and Quantification of Corrosion in Bridge Barrier Rails

NOVEMBER

The Interrelationships between Speed Limits, Geometry, and Driver Behavior

Assessing Bridge Characteristics for Use and Importance as Roosting Habitats for Bats Field Investigation of Stabilized Full-Depth Reclamation (SFDR)

Use of Biocementation for Slope Stabilization of Levees

OCTOBER

Hybrid Concrete for Advancing Pavement Performance

Operational Data to Assess Mobility and Crash Experience during Winter Conditions Precast Concrete Bridge Barriers for Accelerated Bridge Construction Integral Abutment Connection Details for

Accelerated Bridge Construction SEPTEMBER

Integration of Structural Health Monitoring (SHM) into Multilayer Statewide Bridge Maintenance and Management Practices – SHM-Facilitated Condition-Based Maintenance (SHM-CBM) Prioritization System

An Integrated Project to Enterprise-Level Decision-Making Framework for Prioritization of Accelerated Bridge Construction

MASH 2016 Evaluation of a Non-Proprietary Type III Barricade

Implementation Support for Second Strategic Highway Research Program (SHRP2) Renewal R06E Real-Time Smoothness Measurements on Portland Cement Concrete Pavements During Construction

AUGUST

Enhancing the Fundamental Knowledge and Use of Asphalt Emulsions Using Systematic Scientific and Engineering Approaches

Initial Characterization of Geopolymer-Based UHPC Material Properties

Extension of Safety Assessment Tool For Construction Work Zone Phasing Plans

Performance-Based Operations Assessment of Adaptive Control Implementation in Des Moines, Iowa

Analysis of Dynamic Advisory Messaging – Phase II

Evaluation of the Mechanical and Environmental Performance of Biofuel Co-Product Stabilized Unpaved Roads Accelerated Innovation Deployment (AID) Demonstration Project: Testing, Performance Evaluation, and Documentation of the Little Silver Creek Bridge

Data-Driven Health Management of Electrical Vehicle Battery Systems

Data-Driven Highway Infrastructure Resilience Assessment

Risk and Failure Resilience of Interdependent Transportation Systems

Effect of Coupling on A-Walls for Slope Stabilization

Intelligent Highway Management System for the City of Wichita

JULY

Asset Utilization Potential of Building a Trucking and Rail Intermodal Hub in the Saint Louis Region Driver Crash Causation Study by Gender— Missouri, Iowa, and Illinois Comparison

Visual Analysis of Pavement Performance and Related Factors

Visualization and Communication in Pavement Performance

Portable Multi-Sensor System for Intersection Safety Performance Assessment •

INTRANS BY THE NUMBERS

Reports below reflect figures and activities from the fiscal reporting period of July 2018–June 2019

FUNDING SOURCES	2015	2016	2017	2018	2019	TOTAL	TOTAL FUNDING FROM ALL SOURCES				
lowa DOT	42%	41%	41%	44%	50%		\$17,428,487	\$18,607,317	\$20,603,906	\$20,247,968	
Other Iowa Govt. Agencies	1%	1%	1%	1%	1%	35					
Other State Agencies	5%	4%	2%	2%	9%	216,1:					
Other (conferences, fees, misc. services, etc.)	12%	13%	12%	15%	14%	\$16,					
Industry	3%	4%	5%	7%	9%						
Federal Agencies	37%	37%	39%	31%	17%	2015	2016	2017	2018	2019	



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REACTOR LAB, IOWA DOT PARTNERSHIP STILL STRONG AFTER 5 YEARS

Google video highlights collaborative work using big data for safety

Five years ago, the Traffic Operations Laboratory was founded with the mission to share data between the Institute for Transportation (InTrans) and the Iowa Department of Transportation (DOT) to enhance real-time traffic operations. Since that time, the possibilities have grown exponentially.

The laboratory, now called Real-Time Analytics of Transportation Data (REACTOR), aimed to bridge the gap between collecting massive amounts of transportation data and delivering real-time traffic updates to drivers.

Now, researchers associated with the REACTOR Lab are studying everything from work zone operations to crash data to asset management to the future of connected and autonomous transportation systems.

The partnership between the Iowa DOT and InTrans to form the lab officially got underway five years ago at a ribbon-cutting ceremony on Oct. 15, 2014.

"We're trying things with artificial intelligence and machine learning for superpractical applications on behalf of the Iowa Department of Transportation," said Hawkins, who is also codirector of the REACTOR Lab. "We all want to keep roads safe and get our products to market."



Members of the lowa DOT pose with InTrans staff at the REACTOR Lab ribboncutting ceremony on Oct. 15, 2014

REACTOR Lab Codirectors Neal Hawkins, left, and Anuj Sharma, right Photo by Christopher Gannon

The work that InTrans and Iowa DOT engineers engage in to get useful and actionable information out of the sea of data has earned recognition from Google as it sought to highlight how researchers use artificial-intelligence tools for social good.

The multinational technology company has produced a video that underscored how the Iowa DOT's and InTrans' collaborative efforts help improve safety and mobility, particularly during winter conditions.

Although the lab's tasks have expanded over the years, its mission to work as a partnership for innovation using data to help drivers arrive at their destinations efficiently, conveniently, and safely has remained the same.

Students also have been an integral component since the lab's founding, but REACTOR Lab Codirector Anuj Sharma said the advances in technology in the past five years have allowed the lab to welcome civil engineering students to play a larger role in the research.

In fact, to date the REACTOR Lab has had 71 students working on projects ranging from determining when to call out snowplows to using cameras to understand driver behavior to saving monarch butterflies by tracking milkweed. After graduating, those students have gone on to work at Facebook, Motorola, Amazon, NVIDIA, Microsoft, BASF, and Ford Motor Co., among many others.

Sharma, who had recently joined InTrans at the time of the lab's grand opening, stresses that work has accelerated in the last five years, thanks in part to the fact that the cost of equipment has gone down while computerprocessing speeds have increased, along with the ability to use social media to crowdsource information.

"Transportation is going to look completely different in the next five years," Sharma said. "So, I think in the next five years, we should make sure that our students are positioned so that they can tackle these questions, even if they don't have the solutions right now, but they have the skills and tools that they can answer these questions."

The Google-produced video is available at https://www.news.iastate.edu/news/2019/01/22/intransai-ml.



CP TECH CENTER RELEASES NEXT-GENERATION INTEGRATED MATERIALS AND CONSTRUCTION PRACTICES (IMCP) MANUAL

The CPTech Center has also produced several other major publications in past year

Concrete research today centers on making pavements more sustainable, longer lasting, and high quality. Put another way, the science behind concrete has become increasingly complex.

Thus, the ability to turn that complexity into information and guidelines that everyday practitioners can use is increasingly the endeavor of the National Concrete Pavement Technology (CP Tech) Center.

Their efforts toward that objective were especially noteworthy in 2019 when several years-long research projects concluded with major publications, most notably its next-generation *Integrated Materials and Construction Practices* (IMCP) manual.

The manual, first published in 2006, had the goal of bridging the gap between recent research and concrete pavement production practices. The 2019 edition updated and refreshed the original by incorporating the newest information available, including the innovations implemented into practice during the past 13 years.

This edition, led by principal investigator and CP Tech Center Director Peter Taylor, adds a chapter on sustainability and offers significant updates on the development of test methods that evaluate the concrete mixture and new pavement for the properties demonstrated to govern performance.



Cover snapshots of the Integrated Materials and Construction Practices (IMCP) manual (left) and Guide to Concrete Trails (right)

"The aim of this volume is to provide a useful start-to-finish guide of the best technology for anyone involved in design and construction of concrete pavements," said Peter Taylor.

Although the IMCP manual, sponsored by a Transportation Pooled Fund, brought together more than a decade of advancements in concrete paving technologies, it was far from the only prominent publication the CP Tech Center has produced in the past year.

CP Tech Associate Director Gordon Smith led the development of the *Guide to Concrete Trails*, sponsored by the Ready Mixed Concrete Research and Education Foundation, to offer industry professionals comprehensive guidance for constructing concrete trails, which have been growing in popularity over the past three decades.

The center also worked with the Federal Highway Administration (FHWA) to update the administration's 23 Pavement Preservation Checklists that guide state and local highway preservation/maintenance and inspection staff on the use of innovative pavement preservation techniques.

As part of an ongoing project, the center also produced a new spreadsheet tool, with accompanying research reports, to help pavement engineers use fiber-reinforced concrete in their pavement applications, and it also recently released guidelines and best practices for implementing real-time smoothness techniques.



Checklists 17 through 23 of the updated FHWA Pavement Preservation Checklist Series

OUR UNIVERSITY TRANSPORTATION CENTER GRANT: FOUR ACTIVITIES RESULT IN LASTING IMPACT

Over the past six years, the Institute for Transportation (InTrans) has successfully managed the Midwest Transportation Center (MTC) by addressing regional issues related to its theme of Data-Driven Performance Measures for Enhanced Infrastructure Condition, Safety, and Project Delivery, focusing on the overall goal of "State of Good Repair."

According to MTC Director Shauna Hallmark, "Our success has relied on collaboration."

In fact, over the six-year grant period (from 2013 to 2019), the MTC has collaborated with 23 colleges, departments, and centers at Iowa State University and 81 external partners from various sectors of government, university, and industry. These connections have resulted in 83 completed projects, including 4 innovative research projects focusing on advances in the design, construction, instrumentation and monitoring, modeling, and management of highway-related projects.

The work performed by MTC researchers—nationally known scientists and engineers at the top of their fields—is paramount and will continue to impact the transportation community for years to come.

Researchers include faculty and staff from the MTC's lead institution, the Institute for Transportation, as well as from MTC partner universities— University of Missouri-Columbia, University of Missouri-St. Louis, Wichita State University, Creighton University, and Harris-Stowe State University.

The work performed under the following four activities constitute the body of effort that the MTC has accomplished over the grant period.

RESEARCH

Iowa State University may have been the lead institution spearheading the research of the MTC, but the volume and quality of the work would not have been possible without the partner institutions and organizations that joined the grant. In fact, half of the MTC's 83 completed projects were led by the five partner universities.

As an example, researcher Fatemeh Zakery from Harris-Stowe State University developed a sustainable asset management transportation system model for a target area in St. Louis, Missouri. In Kansas, at Wichita State University, researcher Pingfeng Wang conducted theoretical and experimental investigations into the development of a self-cognizant dynamic system with the potential to predict and prevent failures of critical battery systems used in the increasingly popular electric and hybrid electric vehicles.

Researchers from InTrans' Real-Time Analytics of Transportation Data (REACTOR) Lab, formed five years ago, focus on interpreting data and supporting departments of transportation (DOTs) in their efforts to better assist motorists. Many REACTOR researchers have also worked on MTC projects. One such project was led by REACTOR Codirector Anuj Sharma that focused on a vision system that could be used to better understand baseline driving behaviors (i.e., driver performance and trip characteristics), identify risk factors that contribute to hazardous situations, and improve the ability to develop safety countermeasures for road design.



Field outing to a bridge repair site during 2019 Teaching in the Fast Lane: Summer Workshop for Elementary School Teachers



Application of MTC-sponsored high friction surface treatment for high crash locations



Anuj Sharma, standing, meets with transportation researchers in the REACTOR Lab Photo by Christopher Gannon

OUTREACH/TECHNOLOGY TRANSFER

From the Innovations in Transportation Conferences, which attracted a total of 400 participants, to the Mid-Continent Transportation Research Symposium that brought best practice to the Midwest along with over 300 participants each year from local, state, and federal agencies, as well as from industry and universities from 11 states and Canada, not much more can be said about the reach of the MTC.

That is, except that the variety of additional events held each year have also propelled the research of the MTC forward into the hands of transportation professionals. Such events included a Transportation Safety Webinar Series entitled "Moving Research into Implementation" and the Midwest Traffic Incident Management Safety Summit.

EDUCATION

Knowing well the impact of education on the workforce of tomorrow, the MTC has offered a number of opportunities for students to learn, experiment, and become leaders. One of the most popular was the MTC's Study Abroad program, which led a total of 82 students on five study abroad opportunities. In 2015 it was Turkey, in 2016 and 2018 it was Italy, and in 2017 and 2019 it was Great Britain and Scotland. The trips provided students with an international understanding of the impact different historical, cultural, environmental, and political factors have on transportation and infrastructure projects.

In addition, InTrans coordinated TRANS 691: Seminar in Transportation Planning. Held annually from 2015 through 2019, the seminar impacted 427 student participants, bringing in over 50 notable speakers from across the country.

WORKFORCE DEVELOPMENT

Since its start, the MTC has teamed with the Iowa DOT to bring transportation education to K–12 teachers and students. In the summer of 2015, three educational workshops were offered with the goal of educating students on engineering concepts and transportation-related professions while providing teachers the tools to stimulate team building, critical thinking, and interest in the transportation field. Because of their success, each workshop was expanded and offered again, and each year the programs became more focused and tailored to better address the needs of educators.

The workshops included the Teaching in the Fast Lane Workshop for Elementary Teachers (with an average of 20 participating teachers each year), the Transportation Institute for High School Educators (which eventually became a three-week professional development workshop), and the *GO*! Further Workshop for High School Students (which was expanded in 2016 to a two-week, multisponsored event).

Other notable MTC K–12 programs include the Ready, Set, Build!—Bridge-Building Challenge, which in 2018 included over 180 participants and 52 teams; GO!—MTC's premier K–12 Magazine; as well as many others. ●



Portland cement concrete engineer and professor Kejin Wang discusses research at the 2018 Innovations in Transportation Conference



2018 study abroad students with leader and CTRE director Omar Smadi in Rome, Italy

The complete report on the details of the UTC grant is available at https:// intrans.iastate.edu/app/ uploads/2019/10/MTC-UTC-Grant-Summary-Report_2up.pdf.

HEATED PAVEMENT TESTS ADVANCING

On a frigid February morning in 2019, pavement slabs on the Iowa Department of Transportation (DOT) campus began to heat up, and soon steam started to rise. Everything was going exactly as Halil Ceylan had expected.

Ceylan, the director of the Program for Sustainable Pavement Engineering and Research (PROSPER), has been researching the potential and the practicalities of electrically conductive heated pavements since 2013.

The tests have scaled up from laboratory slabs in 2015 to two, 15-by-13.5-foot test slabs at the Des Moines International Airport in 2016, to the newly poured 10 heated slabs totaling 75 feet long and 24 feet wide at the Iowa DOT campus.

While the slabs at the Iowa DOT were poured in late 2018, Ceylan tested their success a few months later when the Iowa winter was in full chill. As he looked at the ice melting on the concrete, Ceylan said it was no surprise that the new and smarter system was already working well.

Unlike the earlier airport test slabs, which were located to avoid most airport traffic, the new test slabs carry traffic and feature a concrete mix that meets highway specifications.

"There is a lot of heavy traffic. This will help us learn about pavement performance under heavy truck loads, as well as heating performance and the cost to heat," Ceylan said. "This is a much richer test section than in Des Moines. It's more complex. We'll learn a lot more here."



System of heated pavement slabs being installed at the Iowa DOT facility in Ames



Heated test slabs installed at the Des Moines International Airport



Halil Ceylan (center) with research team Photo by the Iowa State University News Service

Ceylan's initial project was the first for the Federal Aviation Administration's Partnership to Enhance General Aviation Safety, Accessibility, and Sustainability (PEGASAS). His current project is sponsored by the Iowa DOT and Iowa Highway Research Board and is expected to continue through spring 2020.

The primary objective of the current research is to do a full-scale field demonstration of the electrically conductive concrete technology and its efficient deicing benefits for Iowa city and county roadways and state highways. Expected benefits from this research include the following:

- A cost-effective methodology for producing electrically conductive concrete for Iowa pavement snow and ice removal applications
- An understanding of electrically conductive concrete at different scales (cement paste, mortar, and concrete) and their properties
- Detailed insights into the challenges and issues faced during the full-scale construction of electrically conductive concrete

Though the concrete can be poured and constructed using typical paving equipment, the process is slightly more complicated than building a typical roadway.

The Iowa State engineers have developed the special concrete containing 1.25 percent carbon fiber by volume. The tiny fibers—just a quarter inch long and about 7 millionths of a meter across—conduct the electricity supplied by the electrodes, but there's some electrical resistance in the fibers, and that creates heat throughout the pavement. The technology has already produced four patent applications.

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AMPP RESEARCH ON GREEN SOLUTIONS IN SPOTLIGHT

Asphalt Materials and Pavements Program (AMPP) Director Chris Williams has been studying the use of recycled and bio-based materials in pavement production and maintenance for more than a decade. In 2019, those long-time efforts to make more sustainable and costeffective pavements have yielded some much-deserved attention.

Early in the year, *Energy & Fuels*, a publication of the American Chemical Society, published a paper and highlighted the results of research on a new technology developed by Williams and two researchers in Iowa State University's Department of Chemical and Biological Engineering. Williams, with Eric Cochran and Nacu Hernandez, developed a method to reduce the separation of ground tire rubber (GTR) in asphalt by mixing the GTR with a polymer additive before blending it with asphalt.

The new technology has the potential to reduce carbon dioxide emissions and energy use while recycling thousands of metric tons of both discarded tires and rubber each year. Right now, the United States generates 270 million waste tires each year, about 10 percent of which is put in landfills and other disposal areas. The technology also has an economic benefit, as using GTR is less costly than asphalt alone and virgin styrene-butadiene-styrene (SBS) elastomers.

GTR is just one of the recycled materials that Williams has studied for use in asphalt pavements. He has also conducted previous and ongoing research on using other recycled materials, including asphalt pavement content and asphalt shingles.



Paving an asphalt parking lot at Iowa State's BioCentury Research Farm using a soy-based binder



Closeup of bio-based asphalt at a test site in Grimes, Iowa



Eric Cochran (left) and Chris Williams (right) at the Bio-Polymer Processing Facility

In addition to his research on recycled materials, Williams' work on using biobased materials, particularly soybean oil, also earned recognition in 2019.

While his work on using bio-based polymers in asphalt is ongoing, Williams received local media attention, as well as that of agriculture circles, when the researchers held an open house to highlight a newly paved parking lot that used the soy-based binder. Williams also conducted the work with the bio-based material in concert with Cochran.

The project initially got underway in 2014 with special funding from the Iowa Highway Research Board and concluded with a ton-per-day pilot plant built at Iowa State University's BioCentury Research Farm, the site of the bio-based parking lot. The second phase of the project that includes field trials on at least six test sites is ongoing.

This research could have substantial impact on the Iowa economy through job creation, future tax revenue, and the export of a high-value specialty product, which has also shown success in numerous other applications, including adhesives, coatings, and packaging materials.

"We've been at the forefront not only in Iowa, but nationally and internationally, in developing new materials derived from vegetable coproducts," Williams said. "We can use those components to not only improve asphalt's performance but make it more economical, and it's something we can do here in Iowa that develops our economy in Iowa and creates value to the state of Iowa and the people that live here." ●

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