

PITT Swanson School of Engineering

IRISE

Impactful Resilient Infrastructure Science and Engineering
2018-19 Annual Report

Why IRISE?

America's highway infrastructure has largely been built. The challenges of today's aging highway infrastructure are driven by the need for costly rehabilitation and renewal. The high costs and potential for such projects to cause major disruptions make it vital that these activities be performed in a more sustainable and resilient manner. Pitt's Impactful Resilient Infrastructure Science and Engineering (IRISE) consortium can help to make that happen.

Greetings

I am privileged to serve as director of the Impactful Resilient Infrastructure Science and Engineering (IRISE) research consortium here in the Swanson School of Engineering at the University of Pittsburgh. Our transportation infrastructure, so vital to the continued economic growth of our region, state, and nation, is aging and must be revitalized.



Vandenbossche

Transportation is a critical aspect of everyone's life, and major interruptions in service can severely compromise the quality of life in our communities.

Because we live in a time of constrained public investment, new, more innovative approaches to designing, building, and maintaining infrastructure must be developed and implemented. These approaches must focus on producing more durable and resilient facilities that are able to cope with the increased risks posed by more severe weather events.

I'm especially pleased to have supported the establishment of IRISE as a public/private research consortium in which both sectors can work together with University researchers to solve transportation infrastructure challenges that are of such critical importance to the region and state.

We are proud of the history and tradition of civil and environmental engineering education and research at Pitt. In that spirit, we look forward to growing the IRISE consortium and applying the University's expertise in producing practical, innovative solutions that will lead to a more cost-effective use of available public investment funds in providing a resilient and efficient transportation infrastructure system.

I invite your active participation in helping us to ensure that our research addresses the right problems in a manner that produces impactful products. I look forward to the opportunity to work together to address these pressing transportation infrastructure challenges.

Julie M. Vandenbossche, PhD, PE
Director, IRISE

“We are proud of the history and tradition of civil and environmental engineering education and research at Pitt. In that spirit, we look forward to growing the IRISE consortium and applying the University's expertise in producing practical, innovative solutions... .”

—Julie M. Vandenbossche



Why IRISE?

The IRISE consortium was established in the Department of Civil and Environmental Engineering at the University of Pittsburgh Swanson School of Engineering in spring 2018 to address these challenges. Specifically, IRISE was established to conduct research that will:

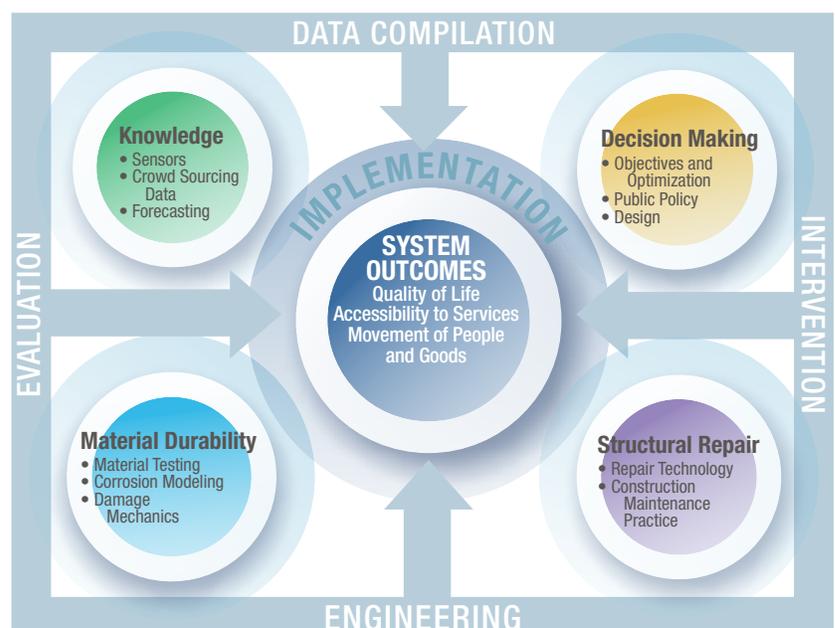
- produce longer-lasting, more viable transportation infrastructure resulting in increased serviceability and lower life cycle costs;
- reduce the number of major disruptions to the movement of people and goods due to compromised infrastructure; and
- attain a better quality of life through a more reliable and resilient transportation system.

The four pivotal areas that are the focus of IRISE research are knowledge, decision making, material durability, and structural repair. These areas involve identifying and gathering the information critical to the decision-making process, accurately assessing the condition of the infrastructure system through an integrated system analysis of the data collected for each individual component as well as an analysis of the user costs and benefits associated with deteriorating infrastructure and rehabilitation projects, and

identifying innovative construction materials and design and construction methods that will produce a more viable infrastructure system.

In conducting this research, IRISE is guided by the following principles:

- Improve mobility, accessibility, and quality of life during and after infrastructure project completion. This encompasses minimizing life cycle cost, including user costs, and increasing sustainability and resiliency.
- Address challenges with a systems approach. The optimization of the infrastructure system must be considered when addressing weaknesses in individual components (e.g., roads, bridges, and geotechnical structures).
- Provide innovative answers to relevant highway infrastructure issues through a collaborative effort. The public agencies that own and operate the infrastructure and the private companies that design and build it work together along with the academics to develop creative solutions for overcoming the transportation infrastructure challenges being faced. To this end, IRISE is a research consortium with funding and support from both the public and private sectors.
- Provide solutions that can be implemented and meet the needs of its members. IRISE also provides a means for facilitating dialogue between all of the entities (public and private sectors and academics) working to achieve a reliable, cost-effective, resilient transportation infrastructure.



The IRISE Partnership

During its first year, the IRISE consortium included the three public and two private organizations shown below. They pledged a total of \$425,000 in annual funding for research projects for a five-year period. IRISE administrative costs were covered by the University of Pittsburgh to demonstrate its commitment.

Allegheny County, Pa.

Golden Triangle Construction

Michael Baker International

Pennsylvania Department of Transportation

Pennsylvania Turnpike Commission

Participation in IRISE is enabling these organizations to identify and address priority research issues, participate in and shape research projects as they are being conducted, have immediate access to research results and products, and interact with other IRISE members and University of Pittsburgh researchers and students.



McKain

“Allegheny County is excited to be a part of the IRISE partnership and looks forward to applying its innovations in managing the county’s roads and bridges.”

—William D. McKain, Allegheny County Manager



Niederriter

“Golden Triangle prides itself on providing the highest level of quality service to our customers and we’re very pleased to be working with our partners in IRISE to help us do an even better job in the future.”

—Chuck Niederriter, Chief Operating Officer, Triangle Construction

IRISE is guided by a steering committee of individuals representing each of the public and private partner organizations. The steering committee members have substantial influence on the research topics

to be addressed by virtue of their continuing participation and support, and as a result, they have a vested interest in implementing the research results.







Projects, Activities, and Accomplishments



Transportation professionals gather for the first IRISE brainstorming session.

Brainstorming

In the fall of 2018, IRISE conducted the first of what is planned to be an annual brainstorming session that kicks off the process of identifying issues and problems that the following fiscal year's research program will address. More than 35 transportation engineering professionals from the public, private, and academic sectors came together to present and discuss highway transportation infrastructure problems, issues, and research possibilities. A wide range of problems and issues was presented and discussed, including understanding infrastructure life cycle costs, structural health monitoring, performance of various types of pavement designs and overlays, bridge corrosion, landslide predictability, compliance with new stormwater requirements, and reducing road closure time.

Fiscal Year (FY) 2018–19 Project Initiation

In order to initiate research activity during its first year, IRISE began three projects based on discussions with its members while conducting the full program planning cycle for the following year's research program in parallel. The three projects initiated are as follows:

- **Review of Steel Bridge Corrosion Prevention, Mitigation, and Rehabilitation Strategies**

This project is evaluating important issues related to corrosion in steel bridges to identify state-of-practice and novel methods for addressing corrosion prevention, mitigation, and rehabilitation in Pennsylvania. Knowledge gaps and shortcomings in current practice and research will be identified to provide direction to future research thrusts. The final report

for this project is scheduled to be completed midyear.

- **Pavement and Bridge Rehabilitation Using Material-Compatible Repairs**

This project is investigating rapid repair methods for concrete infrastructure to increase durability and provide high flexural and bond strength and low shrinkage. A goal of the project is to increase longevity of the repair by identifying repair materials that are compatible with the material used to construct the existing structure. The work includes a comprehensive literature review, identifying aggregates and/or supplements that provide desirable internal curing properties, establishing performance criteria based on the application (e.g., bridge or pavement applications), developing mixture designs that meet the established performance

Projects, Activities, and Accomplishments



Dr. Vandenberg leads a tour of Pitt's Pavements Mechanics and Materials Laboratory.

criteria, and performing material tests. Technical memorandums summarizing the literature review and performance criteria were prepared. The project is scheduled to be completed at the end of 2019.



“The Mascaro Center is very pleased to partner with IRISE to investigate sustainable practices that will also produce more durable and resilient transportation infrastructure.”

—Melissa Bilec, Deputy Director,
Mascaro Center for Sustainable Innovation

- **Development of a Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements**

This project will provide an effective, localized design tool for pavement engineers in Pennsylvania that is compatible with the AASHTOWare Pavement ME Design program. The product of the research will accelerate the implementation of the American Association of State Highway and Transportation Officials *Mechanistic-Empirical Pavement Design Guide*, simplify further

enhancements and local calibrations of the *Design Guide* for Pennsylvania conditions, and reduce the potential for design errors from the improper use of the AASHTOWare Pavement ME software. A technical memorandum containing a list of input parameters and recommended default values and ranges was prepared and reviewed by the steering committee member representatives. The project is scheduled to be completed at the end of 2019.

Partnership with the Mascaro Center for Sustainable Innovation

IRISE also seeks to expand its research funding base by working with other universities and with other research centers within the University of Pittsburgh. This year, IRISE and the Swanson School of Engineering's Mascaro Center for Sustainable Innovation established a partnership and agreed to jointly fund a project called the Feasibility of Using



Benedum Hall houses Pitt's Swanson School of Engineering.

PHOTO © ED MASSERY

Microbes for Sustainable Construction Materials. This project aims to examine and explore the use of microbes to provide self-healing properties to prevent water and chloride ingress through structural and/or environmental cracking in reinforced concrete structures. The project was initiated in the spring of 2019 and is scheduled to be completed in the spring of 2020.

FY 2019–20 Program Planning

As research needs were identified and projects were initiated for the past fiscal year, IRISE members worked in partnership with IRISE staff to identify the topics that will be addressed under the FY 2019–20 program. University researchers prepared project scopes of work, including task descriptions, schedules, and

budgets, for the topics identified by the steering committee. The FY 2019–20 program will be finalized by the steering committee following the IRISE annual meeting on May 13.

Faculty and Students



Julie Vandebossche, PhD, PE, serves as the IRISE director. Vandebossche is an associate professor with

25 years of professional experience, including 17 years as a civil engineering professor at Pitt. She previously served as a senior engineer with the Minnesota Department of Transportation. Vandebossche has collaborated extensively with state agencies, industry, contractors, and suppliers. These collaborations have been the foundation of her research to ensure that end products are relevant and innovative and can be implemented.

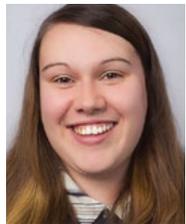
Vandebossche is engaged in the Material Compatible Repairs project. Her research expertise is in the design, analysis, and rehabilitation of concrete pavements and in cementitious materials.



Gary Euler serves as the associate director of IRISE, with day-to-day management responsibilities.

Euler has 40 years of experience in both the public and private sectors, including time as a senior program manager in the U.S. Department of Transportation's Federal Highway Administration and as a business development manager for prominent engineering companies.

Through its FY 2018–19 projects, IRISE engaged four full-time faculty members:



Sarah Haig, PhD, is the principal investigator for the Feasibility of Using Microbes for Sustainable Construction

Materials project. She has broad microbial ecology expertise, with experience in isolating microbial degraders of emerging contaminants using both culture-based and molecular methods.



Lev Khazanovich, PhD, serves as the principal investigator for the Pennsylvania Rigid Pavements project.

Khazanovich has been involved in various aspects of concrete

pavement research, design, and evaluation, including performance prediction modeling, nondestructive testing, and finite element modeling.

“As a researcher, it’s satisfying to know that IRISE research will provide solutions to practical problems and produce immediate benefits.”



Steven Sachs, PhD, is engaged in both the Material Compatible Repairs and Feasibility of Using Microbes

for Sustainable Construction Materials projects. Sachs’ research interests include pavement design and analysis, finite element modeling, and experimental characterization of structures and materials.



Max Stephens, PhD, is the principal investigator for the Bridge Corrosion and Material Compatible Repairs projects.

His research interests include resilient bridge systems, which facilitate rapid construction, and retrofit and repair strategies for damaged components and structures.



Over the past year, two postdoctoral and three graduate students were supported by IRISE research.

Kosar in the Pavements Mechanics and Materials Lab

“The experience of working on the Material Compatible Repairs project has helped me better understand how research innovations can help practitioners do their jobs better.”

—Katelyn Kosar, graduate student, Department of Civil and Environmental Engineering

The Future of IRISE



The goal of IRISE is to be the place where those involved in designing, building, and maintaining transportation infrastructure come when they have issues or questions to be explored and need innovative solutions to be implemented.

With the foundation established in our first year and guided by the perspective offered by our public/

private consortium approach, IRISE will seek to strike a balance between short-term, tactical research studies and longer term, more strategic and systems-oriented research with promise of higher payoffs.

To achieve these ambitions, growth is essential. IRISE will increase its recruiting efforts in both the public and private

sectors as well as with industry associations. It also will look to establish partnerships with other universities and organizations involved in transportation infrastructure research in pursuit of sponsored research of interest to IRISE members.



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