



University of  
**Pittsburgh**

Swanson School  
of Engineering

**PITT** | **IRISE**

# **IRISE 2023 Annual Report**

**Joseph Szczur, IRISE Director**

**Julie Vandebossche, IRISE Director of Research**

**Dana Vidic, IRISE Associate Director**

**IRISE Annual Meeting**

**May 23<sup>rd</sup>, 2024**

# Impactful Resilient Infrastructure Science and Engineering (IRISE)

- Developing sustainable, resilient engineering solutions
- Improving worker safety
- Areas of Research
  - Bridges
  - Pavements
  - Worker Safety
  - Geotechnical
  - Stormwater Management
  - Materials
  - Other



# Unique Approach

## MISSION: Implementable Solutions

- Identify a deficiency/challenging issue
- Develop Impactful technology
- Benefit seen by all parties (buy-in)

## APPROACH...

- Get all parties involved early in the process
- Maintain their involvement throughout the process



# WE ARE INDEBTED TO OUR MEMBERS

 - Denotes Founding Members



**ALLEGHENY COUNTY**  
ALWAYS INSPIRING









**pennsylvania**  
DEPARTMENT OF TRANSPORTATION







**CDR | MAGUIRE ENGINEERING**







\*Ex-officio member



# **WE ESPECIALLY THANK OUR STEERING COMMITTEE**

- **Rich Barcaskey, CAWP**
- **Dan Cessna, CDR Maguire**
- **Chuck Niederriter, Golden Triangle Construction**
- **Joe Sutor, PA Turnpike (Edward Skorpinski)**
- **Stephen Shanley, Allegheny County**
- **Brian Wall, PennDOT**
- **John Robinson, Michael Baker International**
- **Yathi Yatheepan, FHWA (ex officio)**

# IRISE Research Recap

## Completed Projects

### Material Compatible

#### Repair

Bridge Corrosion

Microbes for Construction

PITT Rigid

Bridge Assessments

Early Opening of  
Pavements

Landslide Risks Workshop

Landslide Seminar Series

Benefits Analysis

JPCP Joint Design Opt.

Landslide Best Practices

AC Pavement Markings

Safer Pavement

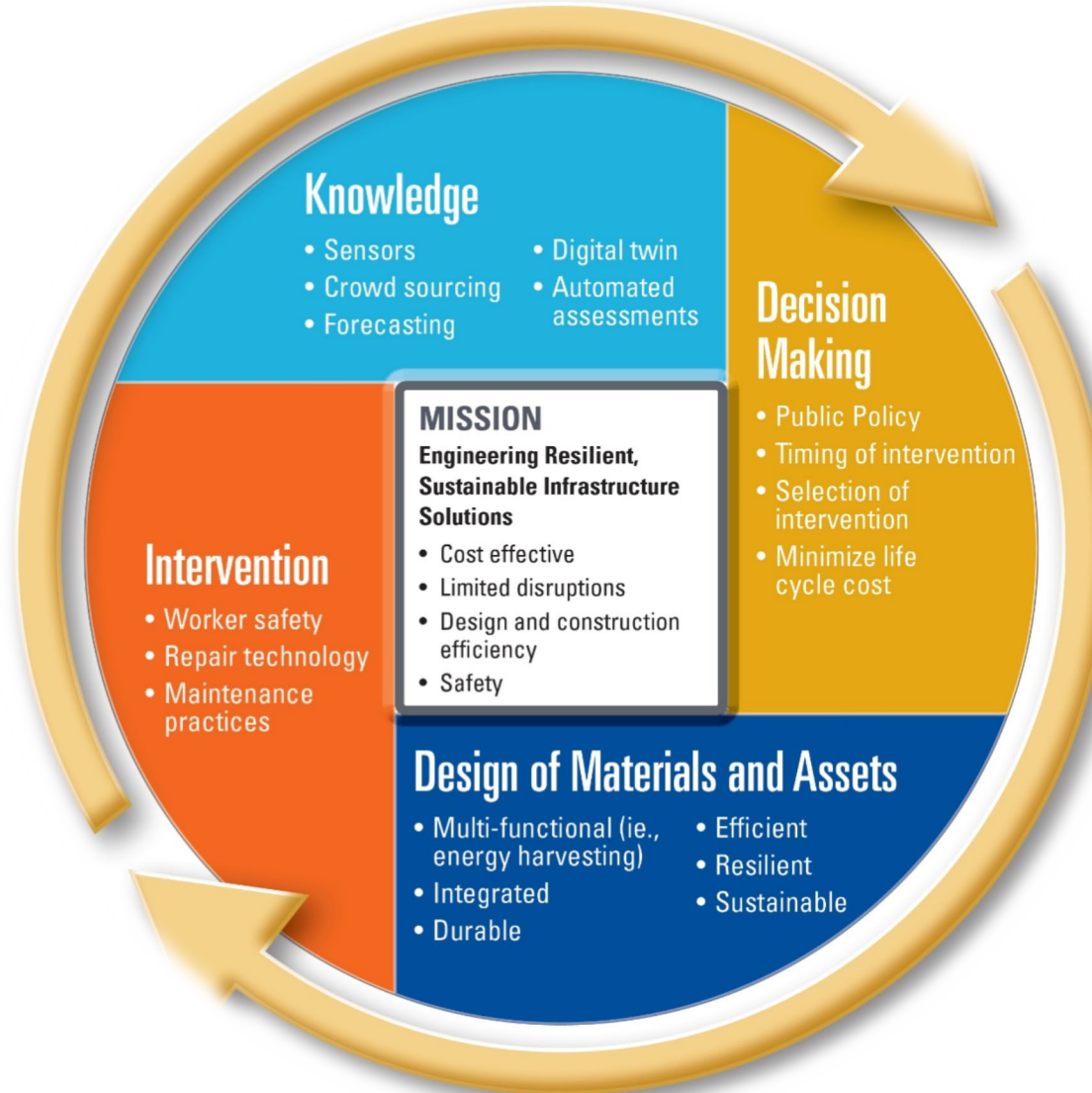
#### Construction

ABC Construction

Major Causes of  
Construction Accidents

Utility Location

Stormwater Seminar



## Ongoing Projects

MCR Implementation

Landslide Inventory

Vibration and Compaction

Bridge Decks Corrosion

Dowel Corrosion

LWC Metamaterial

Concrete

Seal Coat Best Practices

Two-lift Pavements

VR Safety Platform

Bridge Load Ratings

Reoccurring Landslides

LLM Pavement Model

Self-Heating Pavement

3D LiDAR Point Clouds

Benefits of IRISE

# Higher Risk/Higher Reward

## Completed Projects

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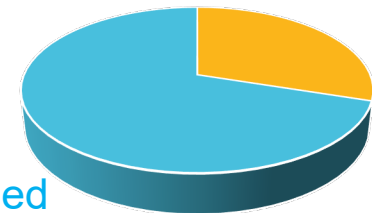
3D LiDAR Point Clouds

Benefits of IRISE



70% Applied

30% High risk/high reward



# Ongoing Research

- 15 On-going Projects During 2023, 5 Now Completed

- **Bridges**

- Additive Manufacturing and ABC **(Completed)**
- Bridge Deck Corrosion
- Bridge Load Ratings

- **Geotech/Stormwater**

- Landslide Best Practices **(Completed)**
- Data Inventory
- Stormwater Seminars **(Completed)**
- Landslide Analysis

- **Worker Safety**

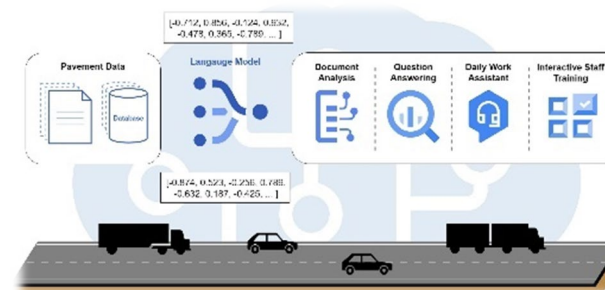
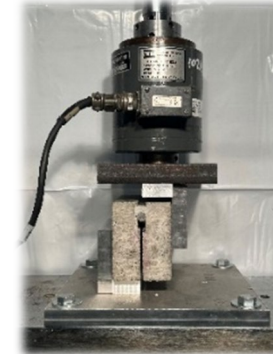
- Construction Accidents **(Completed)**
- Utility Location **(Completed)**
- VR Platform for Worker Training

- **Pavements and Materials**

- Pavement LLM
- Concrete Compaction/Vibration **(Completed)**
- Joint Sealing/Design Optimization
- Material Compatible Repairs
- Dowel Corrosion
- Metamaterial Lightweight Concrete
- Sealcoat Best Practices
- Self-Heating Pavements
- Two-Lift Pavement Construction

- **Other**

- Benefits Analysis
- LiDAR Point Clouds

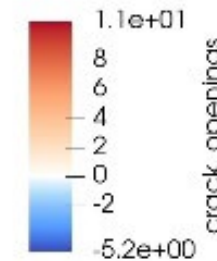
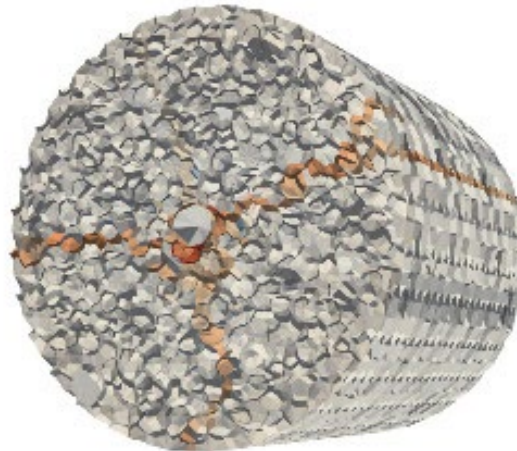







# Bridges

## On-Going Research Projects

- A Novel Methodology for Structural Optimization of Bridge Decks Against Corrosion, **Dr. Brigham**
- Bridge Load Ratings, **Dr. Rizzo**



WEIGHT LIMIT	
	25 T
4 AXLES	27 T
5 AXLES	31 T
6-7 AXLES	36 T
<hr/>	
	40 T
	40 T

## On-Going Research Projects

- Development of a Regional Landslide Inventory to Advance Hazard and Risk Estimates for Southwestern Pennsylvania, *Dr. Bain*
- Analysis of Reoccurring Landslides in SWPA to Advance Hazard and Risk Estimates, *Dr. Bain*



## On-Going Research Projects

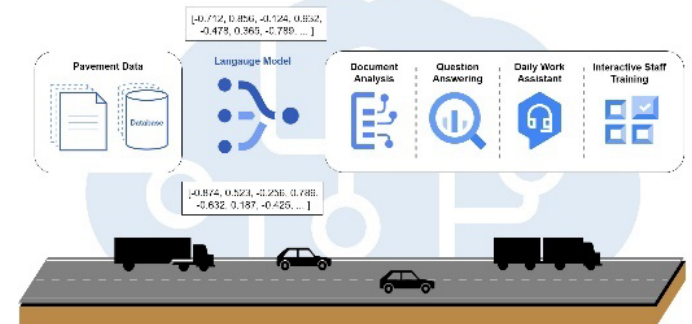
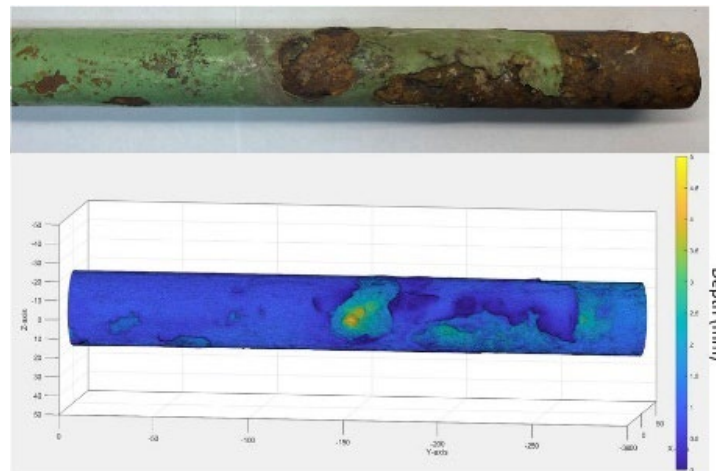
- Material Compatible Repairs Evaluation – Field Implementation, *Drs. Sachs, Khazanovich and Vandenbossche*
- Developing Light-Weight and High-Performance Metamaterial Concrete, *Dr. Alavi*



# Pavements

## On-Going Research Projects

- Joint Design Optimization for JPCP, **Dr. Vandebossche**
- Prediction of Dowel Corrosion and Effect on Performance of Concrete Pavements, **Dr. Vandebossche**
- Design and Construction of Two-lift Concrete Pavements for Pennsylvania, **Dr. Khazanovich**
- Seal Coat for Asphalt Pavements: Best Practices and Experience, **Dr. Dave**
- Adaptation of a Large Language Model for Generation of Responses to Pavement Related Questions, **Dr. Khazanovich**
- Self Heating Concrete Pavement Systems with Surface-Mounted Heating Elements, **Dr. Alavi**



# On-Going Research Projects

- A Novel Immersive VR Platform for H&S Training of Construction Workers, *Dr. Fascetti*



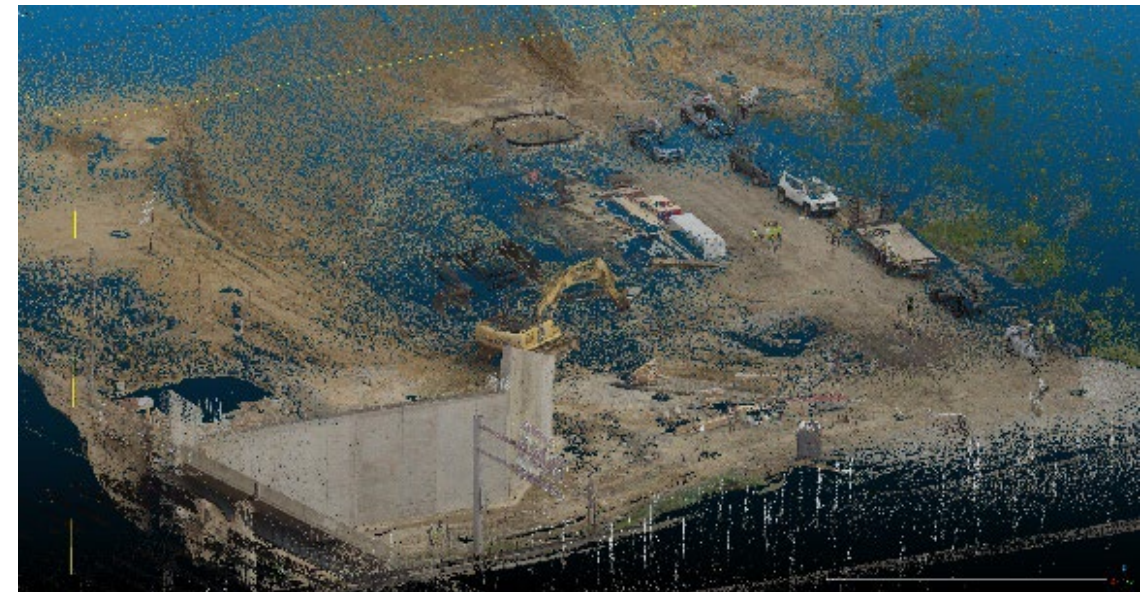
# On-Going Research Projects

- Developing and Applying Methodologies to Quantify the Benefits of IRISE Projects, *Dr. Magalotti*
- Supervised Learning for the Classification of High-Resolution LiDAR Point Clouds, *Dr. Fascetti*



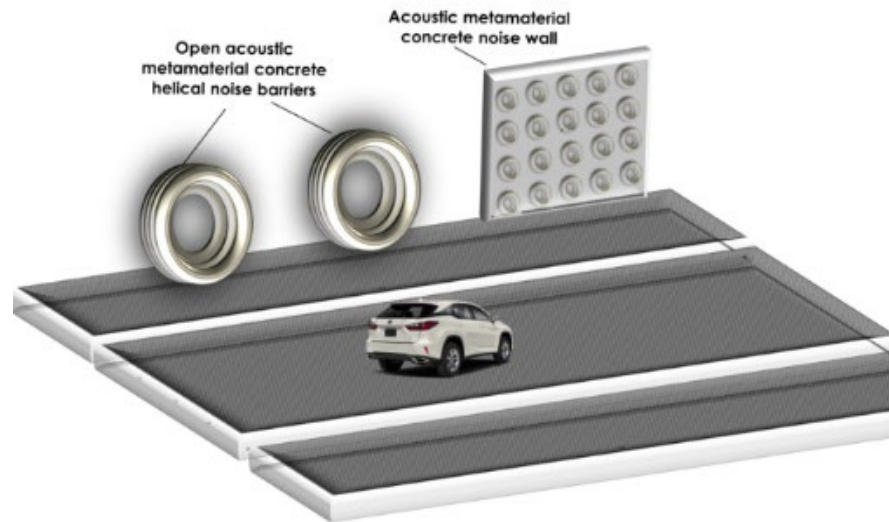
Construction Worker Injuries Can Be Avoided Through Use of New Technologies in Work Zone Areas

It is estimated that 100,000 construction workers are injured each year, with 2,000 fatalities. The construction industry is one of the most dangerous in the United States. The use of new technologies, such as LiDAR and machine learning, can help reduce the number of injuries and fatalities. This research project aims to develop a supervised learning model to classify high-resolution LiDAR point clouds of construction sites. The model will be able to identify potential hazards, such as workers in the work zone, and provide real-time alerts to construction workers. This research is part of the IRISE project, which is funded by the National Science Foundation.



# PA Turnpike Mon Fayette Test Bed

1. Metamaterial Noise Walls
2. Digital Twin
3. Electrified Roadways Strategic Plan
4. Multifunctional Geogrids for Energy Harvesting



# IRISE Year 7 Projects



1. Advancing Regional Comprehensive Stormwater Management through Cross-Jurisdictional Coordination and Cooperation
2. Concrete Mixtures with Half the Carbon Footprint
3. Concrete Pavement Life Cycle Assessment Tool for PA
4. AI Safety Assistant
5. Improved Collection of Earthwork Quantities Utilizing UAV-Based LiDAR
6. Common Sense Compaction for Soils and Embankments



# Advancing Regional Comprehensive Stormwater Management through Cross-Jurisdictional Coordination and Cooperation



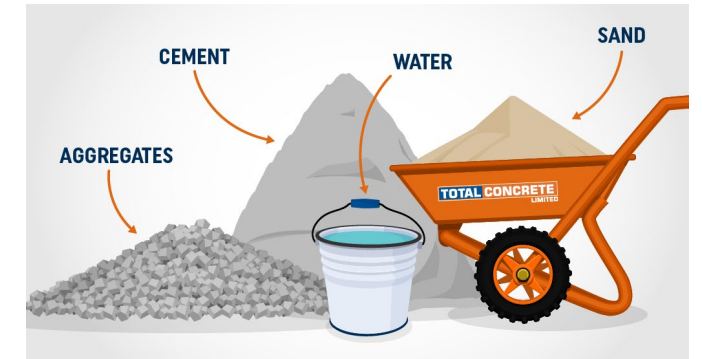
## Research Problem:

- Complex jurisdictional landscape hindering effective stormwater management.
- Limited community involvement in regional planning efforts.
- Lack of regular meetings for enhancing regional stormwater management.

## Research Objectives:

1. Coordinate a series of stormwater meetings to address identified challenges.
2. Facilitate training sessions, consensus-building meetings, and a symposium.
3. Promote cross-jurisdictional cooperation and best practices in stormwater management.

# Concrete Mixtures with Half the Carbon Footprint



## Research Problem:

- Concrete production releases significant CO<sub>2</sub>, impacting the environment.
- Many proposed solutions to reduce carbon footprint lack proper vetting.
- Early-age and long-term concrete properties must be considered for paving use.

## Research Objectives:

1. Identify and evaluate alternatives to halve the carbon footprint of PennDOT concrete paving mixtures.

# Concrete Pavement Life Cycle Assessment Tool



## Research Problem:

- Concrete pavements contribute significantly to carbon emissions.
- Existing LCA tools lack local data and specificity.
- Pennsylvania lacks a dedicated pavement LCA tool.

## Research Objectives:

1. Develop a new pavement LCA tool tailored for Pennsylvania.
2. Focus on concrete pavements to quantify and reduce carbon footprint.

# AI Safety Assistant



**Research Problem:** Existing safety practices lack efficiency and innovation, leading to a high incidence of workplace accidents.

## Research Objectives:

1. Develop an AI/LLM tool to aid safety personnel in highway construction
2. Assist in Procuring daily work activity plans with a safety focus
3. Improve the quality of accident reporting to enhance safety data analysis

**Main Deliverable:** Prototype of AI Safety Officer Assistant, a user-friendly chat-like software interface.

# Improved Collection of Earthwork Quantities Utilizing UAV-Based LiDAR



## Research Problem:

- Challenges in estimating earthwork quantities on large projects.
- Traditional surveying methods lack accuracy in capturing ground profiles.
- Balancing earthwork within projects poses cost and scheduling issues.

## Research Objectives:

1. Enhance accuracy of earthwork estimation using UAV-mounted LiDAR and RGB sensors.

# Common Sense Compaction for Soils and Embankments



## Research Problem:

- Current compaction testing methods pose challenges due to material variability and reliance on nuclear gauges.
- Safety hazards and cost implications associated with nuclear gauge usage.
- Need for alternative, accurate, and cost-effective compaction control methods.

## Research Objectives:

1. Assess suitability of DCP and LWD technologies for compaction quality control in Pennsylvania conditions.
2. Develop a specification based on alternative technologies if deemed effective.

# University Transportation Center: The Sustainable Mobility & Accessibility Regional Transportation Equity Research (**SMARTER**) Center

Regional UTC – Federal Region 3, Mid-Atlantic

**Research Priority:** Improving Mobility of People and Goods

## List of Members:

Lead – Morgan State  
Howard University  
University of Delaware  
University of Maryland  
**University of Pittsburgh**  
University of Virginia  
University of W. Virginia  
Virginia Tech.

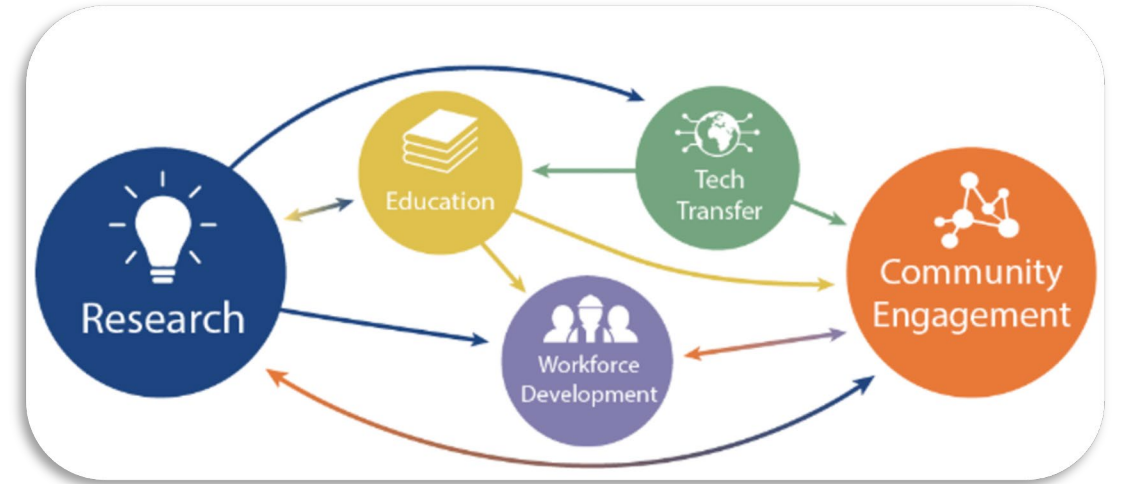


# SMARTER Center

Pitt PI: Dr. Khazanovich

Duration: 5 yrs

\$3Million/yr (Pitt share: \$300k/yr)



## Year 1 Projects:

1. Socially responsible road charging for online retailers to support disadvantaged urban communities PI: Dr. Stevanovic, \$100,000
2. Ensuring Equity in Pavement Rehabilitation Strategies PIs: Drs. Khazanovich and Vandenbossche, \$100,000
3. Implementing and Testing Multimodal Equity through Connected Everything and Traffic Signal Operations in Virtual Reality PIs: Drs. Stevanovic and Brian (UVa), \$120,000



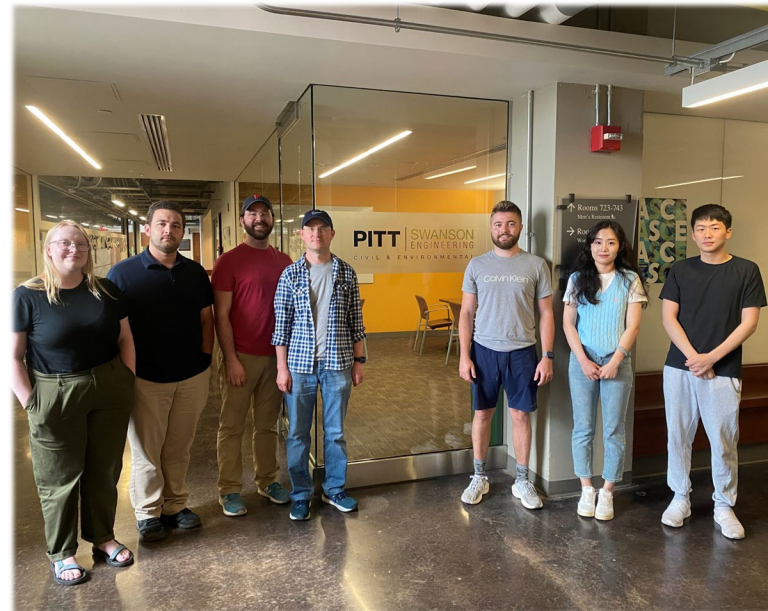
# Student Involvement

- 12 Undergraduate Students
- 11 Graduate Students
- 2 Post-Docs

## Conferences

- ACPA, TRB, Society of Engineering Annual Conference,

## Site Visits



# Other Activities

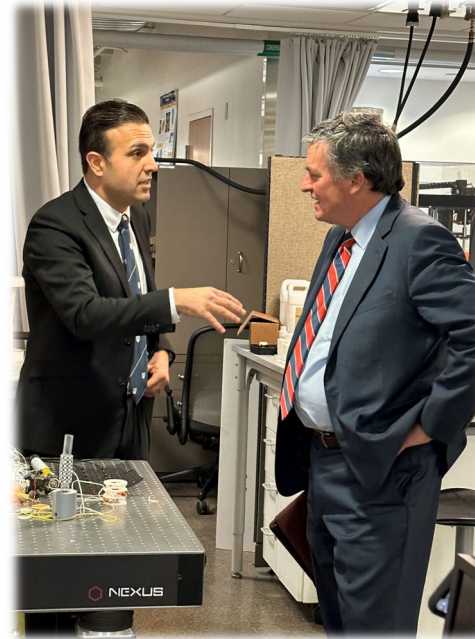
## Transportation Forum

- In conjunction with Pittsburgh Chapters of ASHE and WTS
- Attendance: 120

## APC Conference

- Joint presentation with PA Turnpike

## Hosted PennDOT ELDP



# Thank you!

Additional details can be found at...



<https://www.engineering.pitt.edu/Irise/>  
Or Google “Pitt IRISE”

Thank you for all your  
contributions this past year!



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