The Intend of this Town Hall

• To stimulate discussion and help determine a strategic direction for the college.
• To Identify areas with the greatest potential for interdisciplinary collaboration.
Agenda

• **Background**
  • Shahram Pezeshk, Civil Engineering
  • Stephanie Ivey, Civil Engineering
  • Alexander Headley, Mechanical Engineering
  • Sabya Mishra and Mihalis Golias, Civil Engineering
  • Mohd Hasan Ali, Electrical and Computer Engineering
  • Discussion
Infrastructure
Air Ports

World’s Largest Cargo Airport

Source: Phyllis J. Steckel
Five Class 1 Railroads
- BNSF
- CSX
- UP
- NS
- CN
River Transportation – Memphis

• Second-largest port on the Mississippi
• First in foreign import tonnage
• 28% of all US waterborne commerce
• $6.7 billion economic impact
• 5,500+ direct and 9,900+ indirect jobs

Source: Phyllis J. Steckel
Inland Waterways
4th largest Port on Inland Waterway system

Source: Phyllis J. Steckel
Interstate Highways....

- Interstate 40 – busiest trucking corridor in US
- Interstate 55
- 490 trucking terminals

Source: Phyllis J. Steckel
TN General Assembly Passes Gov. Lee’s Landmark Transportation Bill

$3.3B Transportation Modernization Act to prepare rural & urban Tennessee for continued growth

Thursday, March 30, 2023 | 03:54pm

NASHVILLE, Tenn. - Today, the Tennessee Department of Transportation (TDOT) marked the legislative passage of the Lee administration’s Transportation Modernization Act, a landmark bill that will create a new strategy and invest $3.3 billion to accommodate Tennessee’s record growth, address traffic congestion and meet transportation needs across rural and urban communities. This historic legislation has received support from dozens of organizations across Tennessee and will now head to the Governor’s desk to be signed into law.
Infrastructure Investment and Jobs Act

• The Senate’s passage of the Infrastructure Investment and Jobs Act, the **largest long-term investment in our infrastructure** and competitiveness in nearly a century.

• **Tennessee** would expect to receive **$5.8 billion for federal-aid highway** apportioned programs and **$302 million for bridge replacement and repairs**.

• **Tennessee** can also compete for the **$12.5 billion Bridge Investment Program for economically significant bridges** and nearly **$16 billion** of national funding in the bill dedicated to major projects that will deliver substantial economic benefits to communities.
Infrastructure

• Tennessee would expect to receive $630 million over five years under the Infrastructure Investment and Jobs Act to improve public transportation options across the state.

• Under the Infrastructure Investment and Jobs Act, Tennessee would expect to receive $88 million over five years to support the expansion of an EV charging network in the state. Tennessee will also have the opportunity to apply for the $2.5 billion in grant funding dedicated to EV charging in the bill.

• Tennesseans will also benefit from the bill’s historic $3.5 billion national investment in weatherization which will reduce energy costs for families.

• Under the Infrastructure Investment and Jobs Act, based on the traditional state revolving fund formula, Tennessee will expect to receive $697 million over five years to improve water infrastructure across the state and ensure that clean, safe drinking water is a right in all communities.
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Shahram Pezeshk Expertise Highlight
Transportation and Resilient Infrastructure

- **Transportation**
  - Bridges;
  - Transportation safety;
  - Passenger and freight rail;
  - Highway and pedestrian safety;
  - Airports;
  - Power and grid reliability and resiliency;
  - Resiliency;
  - Electric vehicle charging;
  - Big data;
  - Multimodal and freight transportation
  - The potential societal benefits of improving the efficiency of traffic systems
  - How to replace the gas tax revenues due to the increase in electric vehicles
  - Workforce

- **Resilient Infrastructure**
  - Resiliency with recovery from natural hazards such as *floods, tornados, ice storms, and earthquake*
  - Resilience educational programs
  - Water and sewer system
  - Structural system
  - Multi-hazard resiliency
  - Community resiliency and infrastructure recovery following extreme events
  - Resilient cities
  - Utility systems
  - Performance-based design and construction
Pezeshk’s Experience

• Seismic Hazard
• Earthquake Engineering and Geophysical Field Testing
• Machine Learning and Optimization
• Engineering Seismology
• Transportation Related Research and Bridges
$12.5 billion Bridge Investment Program for *economically significant bridges*
Alternative Mississippi River Crossings

• I-40 Bridge
  • Constructed in 1960’s
  • East-west Interstate
  • Major Route for Truck Traffic (35 to 40 percent)

• I-55 Bridge
  • Constructed in 1940’s
  • North-south Interstate

Interstate 40 – busiest trucking corridor in US
Alternate I-55 Crossing
I-55 Masonry Pier
Location of the I – 40 Bridge
Seismic Instrumentation Project of Dr. Pezeshk
Future work

Center for Innovative Research in Bridge Engineering
https://www.memphis.edu/cirbe/
Big Data

- Time of crack detection – I-40 Bridge

Data Analyses from Seismic Instrumentation Installed on the I-40 Bridge

Determination of When Crack Occurred on the Hernando de Soto I-40 Bridge

Research Final Report from the University of Memphis | Shahrzad Pezeshki, Charles Camp, Ali Kashani, and Mohsen Akhani | October 31, 2021
Meta-heuristic optimization algorithms

• Camp and Pezeshk
Computer Vision & Machine Learning

Delineating cracks in concrete
Computer vision & machine learning
Delineating cracks in asphalt pavements
Computer vision & machine learning

Delineating cracks in asphalt pavements

Major roads are updated on a regular basis.
Computer vision & machine learning

Delineating cracks in asphalt pavements

Final GSV Results
Improving resilience of networks in West Tennessee

- The effect of multi-hazard
  - earthquake,
  - hurricane,
  - flood and man-made hazard
  - improve network vulnerability and resilience
Seismic Hazard
Seismic Hazard

0.2 sec Spectral Accel. (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary

Nov. 1996

U.S. Geological Survey
National Seismic Hazard Mapping Project
Machine learning in ground motion prediction

Training Algorithm

- $M_e$
- $V_{330}$
- $R_{300}$

Machine Learning Algorithm

Input ground motion data

Random effect calculation

- Predicted IM
- Event terms ($\Delta B_i$)
- Site terms ($\Delta S_i$)

Measured IM

Iteratively learned for $\ln(IM_e) - \Delta B_i - \Delta S_i$ until likelihood is maximized

Denormalization

Iteration until convergence

Likelihood maximization

Random Effect terms ($\Delta B_i$ and $\Delta S_i$)
Center for Disaster Recovery and Resiliency

• The Center for Disaster Recovery and Resiliency is a multidisciplinary center promoting infrastructure resiliency and recovery from natural hazards such as floods, tornados, ice storms, and earthquakes.

• The CDRR builds collaboration among city and town managers, disaster managers, local EMS agencies, university researchers, and city planners to develop strategies to recover from natural hazards and build more resilient infrastructure.
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Transportation Planning and Policy

- Community livability
- Complete Streets Capability Maturity Model
- Infrastructure equity assessments
- Fleet electrification
Transportation-Workforce

- Gender Equity
- Knowledge Management
- ITS Professional Capacity Building
- ‘New Mobility’ workforce
- TSMO Workforce
CAESER DTL and SETWC

- caesar.memphis.edu
- memphis.edu/setwc
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Too much of a good thing?
Trends in NSF/DOE Focus

• LARGE investments in major demonstrations
  • $8B for hydrogen hubs

• Increased focus on installations and implementation
  • Not just looking at basic research, but also pathways widespread use

• Energy Equity
  • How do you transition the energy infrastructure without leaving some people behind?
  • Justice 40

• Interdisciplinary focus
  • Technical and social science interconnections

• Workforce development
Research Areas:
• Thermofluid / Electrochemical System Modeling
• Optimization and Control
• Battery Safety Analysis
• Hydrogen Integration

Research Applications:
• Electric Grid Modernization
  • System planning and control
  • Technoeconomic analysis
• Fire Safety
• Alternative Fuel Production and Use

Research Sponsors:
• Sandia National Laboratories
  • BattCav: Modeling heat transfer in grid scale energy storage from Li-ion battery thermal runaway
• US Department of Energy (Co-PI)
  • Building partnerships for development of sustainable energy systems with atmospheric measurements
  • SMART Second-life Battery Project
• USDA
  • MidSouth Energy Efficiency and Clean Energy Audit Program
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Connected, automated, and emerging vehicle technologies, Electric vehicles, and alternative energy

Roadway, and work zone safety

Last mile deliveries

Traffic Simulation & Human factor studies
Example Projects / Center Statistics

• Building human-technology safety partnerships in roadside work zones (NSF)
• Quantitative Evaluation of Truck Caravanning (US DOT)
• Modeling household e-commerce delivery rates and freight travel impacts (US DOT)
• Informed Safety, Mobility, & Driver Comfort (FedEx and TDOT)
• Optimal refueling gas station locations in post-evacuation conditions (US DOT)
• Evaluating the adoption and impacts of autonomous delivery modern technologies (US DOT)
• Accelerating Innovative Mobility (FTA and MATA)
• Center for Electrified and Autonomous Transportation (NSF)
• Assessing Commercial Motor Vehicles' Situation Awareness after Transition from Automated to Manual Driving (US DOT)
Website: https://www.memphis.edu/ctier/

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Prof. Mihalis Golias
Co-Director, C-TIER
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Electric Power and Energy

Current Research Interests

• Cybersecurity issues and solutions to modern power grids
• Electric vehicle charging station and system
• Smart grid/microgrid controls
• Renewable/Alternative energy systems (mainly wind and solar) and Fuel cell system
• Energy storage systems
• Load forecasting in smart building systems

Collaborators:  1) Dr. Dipankar Dasgupta (Computer Science)
                2) Dr. Myounggyu Won (Computer Science)
                3) Dr. Sabyasachee Mishra (Civil Engg)
                4) Dr. Mihalis Golas (Civil Engg)
                5) Dr. Alexander Headley (Mechanical Engg)
                6) Dr. Sanjay Mishra (Physics & Material Science)
Current Funded Research


[6] Mohd Hasan Ali (Co-PI), IUCRC Planning Grant The University of Memphis: Center for Electrified and Autonomous Transportation in Agile Freight Supply-Chains (CEATAFS), National Science Foundation (NSF), Amount: $20,000 [August 2022 to July 2023].

PV specs
• 1.065 kW capacity
• MPP: 36.75 V, 29 A
• Irradiance: 1000 W/m², 25 °C

BES specs
• 48V nominal voltage
• 100 Ah rated capacity

5G-Enabled EVCS Cyber-Physical Architecture

Fig. 1. EVCS Prototype.
Dynamic Wireless Charging of Electric Vehicles

Benefits of DWC

• Energy transfer by contactless manner.
• Eliminates heavy charging chords and connectors.
• Insulation and worn conductor issues will be solved, weather resistant.
• High operational flexibility with power supply.
• Vehicles can be charged up anytime.
• Short range problems will be solved.
• Long charging time can be replaced by DWC.

Fig. 2. Detailed block diagram of segmented primary charging pad.

Fig. 3. Diagram of a DWPT System.

Fig. 4. Mobile Energy Disseminator (MED) Based DWC for ETs.
Anticipated Areas for Expansion/Growth

• Grid Modernization

• Grid Resiliency

• Electric Vehicle Charging Station and System

Key Inter/Multidisciplinary Opportunities

• Cybersecurity Issues and Solutions to Modern Power Grids

• Electric Vehicle Charging Station and System

• Energy Storage Systems (Battery, Supercapacitor, Fuel Cell)
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