Mack-Blackwell Transportation Center

October 2017 - September 2018

mackblackwell.uark.edu

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MESSAGE FROM MBTC EXECUTIVE DIRECTOR

The first Canon of most engineering ethical codes emphasizes our responsibility to the public we serve: *"…hold paramount the safety, health, and welfare of the public…"*. The National Academy of Engineering (NAE), in its landmark work *The Grand Challenges for Engineering*, the United Nations, in its *Sustainable Development Goals*, and others have identified critical issues which could jeopardize the safety, health, and welfare of the public in the 21st century. In addition, we are witnessing major catastrophic natural events – storms, floods, wildfires, earthquakes – which endanger the public. A common key element in meeting our responsibility to "…hold paramount…" the public's well-being is transportation. The battle to end water scarcity and food insecurity, provide access to healthcare, and rush needed resources to disaster-struck areas is waged on the roadways and waterways comprising our transportation infrastructure. The Mack-Blackwell Transportation Center continues to seek solutions to the logistical and physical infrastructure challenges we face when trying to protect people across the globe. I am honored to work with the faculty, staff, and students associated with Mack-Blackwell and am continually amazed at their dedication to the public which we serve.

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Photo courtesy of ARDOT

HISTORY OF MACK-BLACKWELL

The Mack-Blackwell Transportation Center (MBTC) has served the state of Arkansas and the nation for over 25 years by providing state-of-the-art research, high quality transportation education, and technology transfer.

In 1987, Congress authorized the U.S. Department of Transportation (USDOT) University Transportation Center (UTC) program, which led to the establishment of ten regional UTCs, one in each of the ten federal regions. The UTC program was designed to improve transportation research and education in the United States by advancing technology and expertise across multiple modes of transportation and addressing vital workforce needs for the next generation of transportation leaders. The center was named in the Intermodal Surface Transportation Efficiency Act of 1991, which was signed into law by President George H. W. Bush. Dr. Bob Elliott coined the center name cited in the bill – the National Rural Transportation Study Center.

In 1996, the Center for Training Transportation Professionals (CTTP) program was developed in response to the federal requirement that all laboratories, along with personnel performing sampling and testing for quality control or quality acceptance (QC/QA) purposes must be 'qualified' to perform such actions. The technician training program was implemented shortly after the Arkansas Department of Transportation Department (ARDOT) published the 1996 edition of the *Standard Specifications for Highway Construction*.

In 2007, MBTC was designated as one of seven members of the U.S. Department of Homeland Security National Transportation Security Center of Excellence, in accordance with HR1, implementing the recommendations of the 9/11 Commission Act of 2007. The center fulfilled transportation security research needs for six years under this designation.

In 2013, MBTC partnered with Jackson State University, Louisiana State University and the University of New Orleans to form the Maritime Transportation Research and Education Center (MarTREC), which was competitively selected as a USDOT Tier 1 University Transportation Center under the MAP-21 transportation bill. Under this grant, MarTREC worked to build economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems. In 2016, the MarTREC consortium added Texas A&M University and Vanderbilit University and, through continued funding under the FAST Act, is working to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure.

Mack-Blackwell has been fortunate to be led by four outstanding directors over the past twenty seven years.

Dr. Walt LeFevre, Civil Engineering, 1992-1996

Rear Admiral Jack Buffington, Civil Engineering, 1996-1999

Dr. Melissa, Tooley, Civil Engineering, 1999-2006

Dr. Heather Nachtmann, Industrial Engineering, 2007-present

Pictured right: Heather Nachtmann and Melissa Tooley

DAN FLOWERS DISTINGUISHED LECTURE SERIES

Regina Hopper and Bobby Hopper, Former Arkansas Highway Commission Director

November 9, 2017

Regina Hopper, J.D.
Senior Vice President of Global Public Policy
GRIDSMART Technologies, Inc.
U of A graduate B.A. '81, J.D. '85

Lecture: Intelligent Next Generation Transportation: Integrated Mobility Through Connected and Automated Technologies

Melissa Tooley, Former Mack-Blackwell Director (1999-2006)

April 20, 2018

Melissa Tooley, Ph.D., P.E.
Director of External Initiatives
Texas A&M Transportation Institute
U of A graduate B.S. ’94, Ph.D. ‘97

Lecture: Preparing for Automated and Connected Vehicles

ONGOING MBTC RESEARCH PROJECTS

Data Simulation to Support Interdependence Modeling in Emergency Response and Multimodal Transportation Networks

Haitao Liao, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
September 2017-August 2019

Access to data on the design and operation of interdependent critical infrastructures (ICIs) is now recognized as essential for developing new data analytic, design and decision-support tools. This National Science Foundation-funded EArly-concept Grant for Exploratory Research (EAGER) project will create and make available synthetic and simulated data on ICIs by developing new data creation techniques and model-based approaches to simulating data on ICIs and human cognition and/or behavior with ICIs. It will provide research communities in broad areas, such as multimodal transportation, emergency services, wildfire and infectious disease, with tools for modeling complex ICIs involving human activities and decisions. The new knowledge will be broadly disseminated through journals and conferences in the areas of infrastructure risk management, applied statistics, reliability engineering, and spatiotemporal computation. The PIs will promote interdisciplinary education, recruit underrepresented students for maintaining workforce diversity, and expose K-12 teachers and students to cutting-edge research experiences. This project investigates a methodology for topology and data generation for ICIs. The research will (1) create a two-layer framework 2) simulate data for targeted ICIs and 3) demonstrate the feasibility of using the framework.

Evaluation of Surface Treatments to Mitigate Alkali-Silica Reaction

Micah Hale, Ph.D., P.E.
University of Arkansas
October 2013-October 2018

Alkali-silica reaction (ASR) is the most common form of alkali-aggregate reaction and has become a problem in concrete structures throughout the world. This research focuses on mitigating ASR once it has occurred. The project examines using silane and other sealers to mitigate ASR in concrete structures. In the laboratory, field exposure blocks containing reactive silica have been cast. Each block was instrumented so that expansion and relative humidity can be monitored. These blocks were also treated with silane and other sealers to determine the most effective treatment that can mitigate ASR expansion by reducing internal relative humidity. The results showed that silane was effective in reducing expansion and internal relative humidity. However, blocks treated with linseed oil expanded more than the control blocks which were left untreated. This was due to the linseed oil trapping moisture within the concrete. Current research is examining methods of measuring the relative humidity within the blocks.

Impact of Extreme Summer Temperatures on Bridge Structures

Micah Hale, Ph.D., P.E.
University of Arkansas
Royce W. Floyd, Ph.D., P.E.
University of Oklahoma
October 2013-October 2018

During the first task of this study, four full-scale segments of AASHTO I-beam girders were fabricated. Two Type II and two Type IV girders were cast. Two girders were placed in Fayetteville, Arkansas, and two were placed in Norman, Oklahoma. An additional Type V girder was cast in Fayetteville, AR. The temperatures of these girders were monitored for 12 months while constantly exposed to environmental conditions. Using internal and external thermocouples, temperature readings were collected at 29 locations throughout the cross section. The ends of each beam were insulated to prevent heat loss. Environmental data was collected concurrently to analyze impacts of factors such as daily temperature range and wind speed. Data collected from the study showed that the current AASHTO prediction models do not accurately estimate the thermal gradients in narrow flanged, prestressed bulb tee girders.

COMPLETED MBTC RESEARCH PROJECTS

Dependence of Infrastructure Restoration on Transportation Networks

Sarah Nurre, Ph.D.
University of Arkansas
May 2016-October 2017

The restoration of critical infrastructure systems after extreme events is vital. We developed an optimization model which decides on the restoration of tasks in interdependent infrastructure networks, such as power, based on the availability and restoration of transportation over time. Previous models assume that any sequential completion of restoration tasks is feasible. We removed this common unrealistic assumption through the development of our model. We tested the model on real data sets representing the transportation and power networks of a coastal area prone to hurricanes, floods, and storm surges. We made many observations about the optimal restoration of the transportation and power network over time. Additionally, we observed favorable configurations of work crew skills and preplacement within an impacted area.

Effects of Weather Events on Truck Traffic Using Fixed and Mobile Traffic Sensors

Sarah Hernandez, Ph.D.
University of Arkansas
March 2016-January 2018

Severe weather conditions can have major effects on traffic volumes. Unlike passenger vehicles, which may choose not to travel during inclement weather, freight trucks adhere to delivery schedules requiring them to alter their route rather than cancel a trip. While previous studies modeled the effects of weather on total traffic volumes, few have examined the effect of weather on truck volumes. This study applies spatial panel regression techniques to develop a predictive model that relates variations in truck traffic patterns to weather conditions. Through the random effect spatial panel model, the significant negative value of Moran's *I* explains that the change in daily truck volume is spatially dispersed. The study finds that weather variables have both direct and indirect impacts on daily truck volumes, e.g. the presence of snowfall at a station directly reduces daily truck volumes at that station by approximately 11.3% and indirectly reduces daily truck volumes at neighboring stations by 2.8%, compared to the average daily truck traffic. The model developed can assist state and regional transportation agencies in developing freight-oriented programs and policies for road and winter maintenance, structural and geometric pavement design, highway life cycle analysis, and long range transportation planning.

Rapid and Continuous Assessment of Soil Conditions along Highway Alignments

Clint Wood, Ph.D., P.E.
University of Arkansas
April 2016-July 2018

The purpose of this research was to explore the applicability of Capacitively-Coupled Resistivity (CCR) as an improvement on traditional drilling and sampling methods for subsurface soil investigations. The CCR method could be used to identify critical locations for drilling and sampling such as expansive clay layers and anomalies (sinkholes, unknown landfills, etc.) rather than uniformly sampling across a site. The resulting resistivity plots revealed continuous subsurface soil information and emphases the impact of water level when interpreting the resistivity results as significant changes in the resistivity ranges for fine and coarse grain soils are possible for different moisture conditions. The accuracy of the CCR method was assessed by identifying the number of locations where the soil type predicted by CCR matched the existing boring and CPT logs. Resistivity from CCR was able to distinguish between areas of predominantly fine-grained material and coarse-grained material but limitations exist in separating soils with similar grain sizes (silts and clays).

Final project reports available @ www.sptc.org/projects/

Development of the MASW Method for Pavement Evaluation

Clinton Wood, Ph.D., P.E.
University of Arkansas
October 2013-July 2016

Infrastructure deterioration is a major issue for transportation infrastructure in the southern plains region and around the nation. Delamination, cracking, and many other failure modes in bridge decks and pavement systems are a daily issue in the constant maintenance of transportation systems. Extreme weather further exasperates the problem of failing infrastructure by increasing the wear and tear on transportation systems through more frequent freeze-thaw cycles and larger temperature swings. Highway departments need non-destructive testing (NDT) methods to determine the condition of infrastructure. This project explored the use of the Multi-Channel Analysis of Surface Waves (MASW) as a NDT method for characterization of pavements. Tests have been conducted on concrete samples and full size pavement sections affected by alkali-silica reaction (ASR) to determine the relationship between shear wave velocity developed using the MASW method and strain increases due to ASR expansion of the concrete. Results indicate that the MASW method is capable of detecting the damage due to ASR for low to moderate damage levels in the concrete, additional work needs to be completed to determine accuracy for heavily damaged concrete.

Evaluation and Repair of Existing Bridges in Extreme Environments

Royce Floyd, Ph.D., P.E.
University of Oklahoma
Gary Prinz, Ph.D., P.E.
University of Arkansas
October 2013-July 2016

The goal of this project was to increase the longevity of existing structures through development of comprehensive strategies for evaluation and resilient repair of pre-stressed concrete and steel bridge girders subjected to extreme environments. Regarding concrete bridges, the effect of end region steel corrosion on girder capacity is examined. Regarding steel bridges, innovative corrosion resistant fatigue retrofits are explored. We identified multi-girder systems as the most prevalent steel bridge construction type within the southern plains region. Detailed finite element simulations indicate that the partial-depth cross-frame-to-girder attachments within these multi-girder systems are the most fatigue critical regions. Pre-stressed carbon fiber fatigue retrofits having specially tuned pre-stressed levels were developed to ensure infinite fatigue life within the affected connection regions. Laboratory tests equipped with the prototype retrofits were successful in shifting the mean stress in an instrumented steel beam. The result is a cost-effective and corrosion resistant “bridge band-aid” that can be applied to mitigate fatigue cracks in a wide array of steel bridge geometries.

Photo courtesy of ARDOT

Final project reports available @ www.sptc.org/projects/

CENTER FOR TRAINING TRANSPORTATION PROFESSIONALS

Frances Griffith, **Stacy Williams**, **Roselie Conley**, **Mary Fleck**, **Talley Faulkner**, **Katie Juniel**, **Austin Williams**.

Things remain busy at the Center for Training Transportation Professionals (CTTP). To date, 31 classes have been completed in 2018, with expectations to exceed last year's record-setting total of 43 classes. This level of training needs is indicative of the increased activity in the state's construction industry, which is also apparent to the traveling public. The National Pollutant Discharge Elimination System (NPDES) course requests have also increased in response to a requirement for contractor certification in this topic. Courses have been taught in Fayetteville and Little Rock to meet the additional demand, allowing contractors to meet the October 1 certification deadline. Laboratory certification requests also continue to grow, with four new labs enrolling so far this year. Currently, there are 104 laboratories participating in the program.

Online training usage has strengthened, particularly as a study aid for those attending CTTP training courses. Online training modules have been updated and additional study materials have been added to the website. These online training modules have gained national attention, and are being used in a number of states as a training aid for both state and local agencies. In addition, CTTP has begun work to incorporate the use of video footage for use in both classroom and online instructional materials.

CTTP has also been very active with the Technology Transfer (T^2) program, which is managed by the Arkansas Department of Transportation. So far this year, CTTP has instructed over 250 technicians in topics including Asphalt Pavement Maintenance, Stormwater Management, and "Guide for Traffic Signs, Markings, and Signals", which helps local agencies to ensure compliance with the latest updates to the Manual on Uniform Traffic Control Devices. Pavement management and preservation has continued to be a topic at the forefront of many agency conventions, and CTTP has launched new online tools to assist local agencies in choosing appropriate roadway treatments based on existing distresses, and network-level budget planning. More information about CTTP at www.cttp.org and www.cttp.org/ardot/t2.

MBTC STUDENT ACHIEVEMENTS

2017 Jack Buffington Outstanding Student Poster Award

Kevin Hall, Maggie Langston, Christine Lozano, Jack Buffington, and Heather Nachtmann

Awarded to Maggie Langston and Christine Lozano for their poster on "Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability." Langston and Lozano are civil engineering students under the supervision of Dr. Gary Prinz, assistant professor of civil engineering.

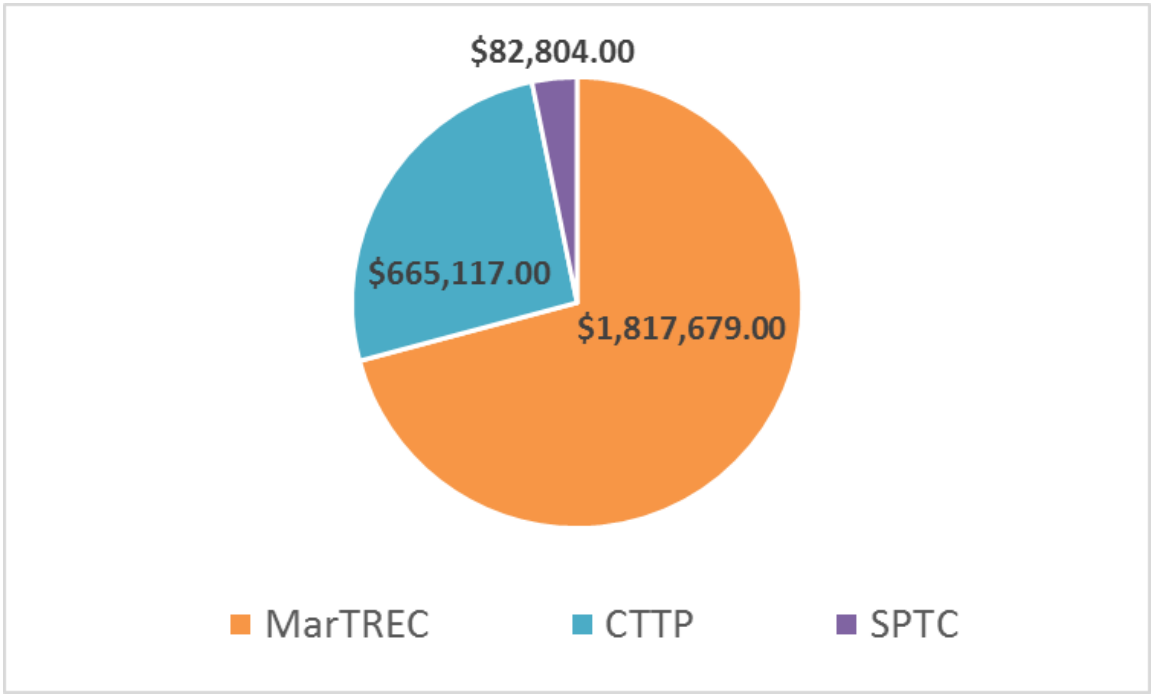
2018 Arkansas Good Roads Scholarships

Scott Bennett, Kevin Weston, Melissa Boyd, D.B. Hill

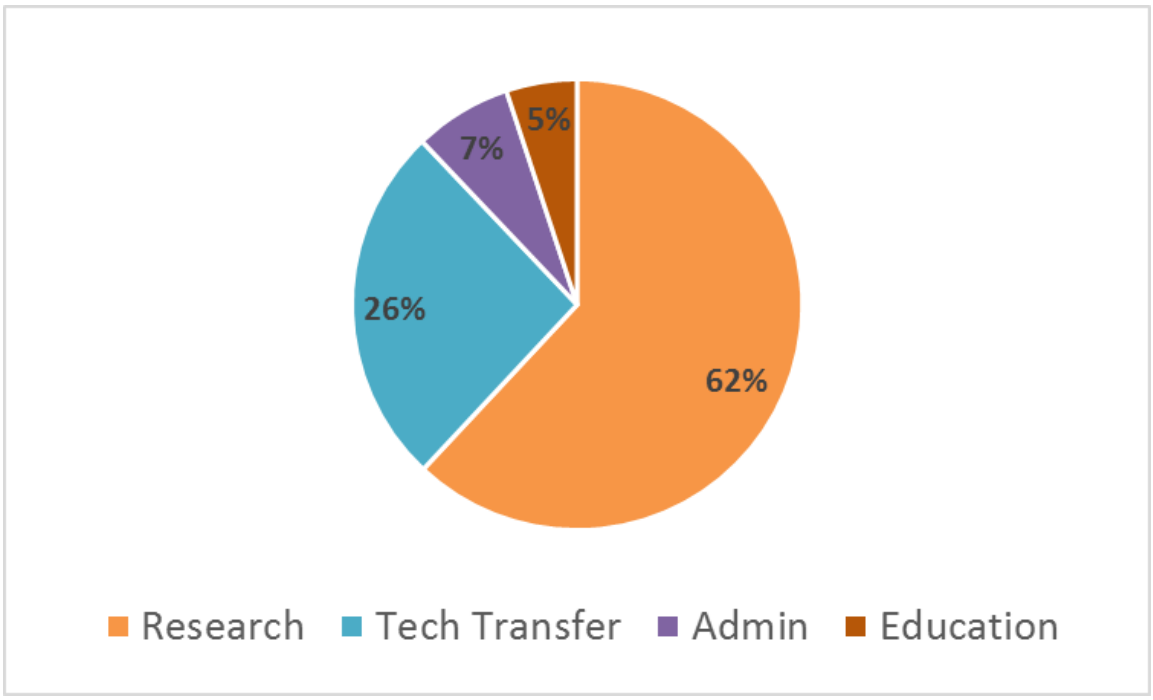
Melissa Boyd and Kevin Weston were selected as 2018 Arkansas Good Roads scholarship recipients. The organization grants scholarships to outstanding civil engineering students in their junior or senior year. Recipients of the scholarship commit to work in the transportation field in Arkansas for a minimum of one year after graduation.

MBTC FINANCIALS

Center Expenditure Breakdown
FY18 Expenditures = $2,565,600



Expenditure Activity Distribution
FY18 Expenditures = $2,565,600



MarTREC OUTREACH

MarTREC hosted 15 fifth and sixth grade girls in July 2018 at our GirlTREC summer camp on the University of Arkansas campus. The camp focused on hands-on activities related to transportation engineering from roads to rail to waterways and was designed to build courage and interest towards studying STEM fields and considering a career in the transportation industry. Our interactive programs were taught by faculty at the University of Arkansas' civil and industrial engineering departments and included activities in bridge construction, social media data during disaster response, traffic control systems, and lock and dam operations.

The Mississippi Transportation Institute (MSTI) aims at introducing a diverse group of motivated pre-college students to the transportation industry. During the three-week residential program, students will participate in academic and enhancement activities designed to improve their skills in Science, Technology, Engineering, and Mathematics (STEM) and leadership. The program's prime sponsor is the Mississippi Department of Transportation, and MarTREC is a co-sponsor.

The Gulf Coast Center for Evacuation and Transportation Resiliency hosted a session of hands-on activities for the LSU Recruiting into Engineering High-Ability Multicultural Students (REHAMS) summer camp on June 14, 2018 and the LSU Halliburton Xploration Camp Inspiring Tomorrow's Engineers (XCITE) summer camp on July 10, 2018. The REHAMS summer camp is offered every year to rising 11th and 12th grade students. The XCITE summer camp is also offered every year to rising 9th, 10th, and 11th grade female students. These summer camps provide an opportunity to explore, create, and compete in a variety of engineering and college preparatory activities to encourage interest in a career in STEM. During the sessions, the students planned, designed and built a city using toothpicks and gummies. They also used paper roads to create a transportation system that provided accessibility and connectivity. To mimic the planning and design of real cities, the students were limited by design constraints, time, and resources. For example, students needed to design their cities around hypothetical lakes, rivers, wetlands, underground pipelines, street light poles, and trees. Their structures also needed to support the weight of a book without failing.

MarTREC STUDENT ACHIEVEMENTS

For the past 25 years, the U.S. Department of Transportation has honored an outstanding student from each active University Transportation Center during the TRB Annual Meeting. Below are MarTREC's Students of the Year for 2017.

MarTREC 2017 Outstanding Student of the Year (MAP 21)
Ian Butler-Severson, University of New Orleans

Ian Butler-Severson received a Bachelor of Arts in Urban Studies from Hamline University. He spent a semester abroad at the University of Oslo, Norway studying Oslo's Transit Oriented Development planning strategies. In 2001, Ian accepted a job with the Minneapolis planning and design firm, Ingraham & Associates where he gained experience in site analysis, CAD, model building, construction documents, cost estimations, subdivision design and zoning. Ian has since graduated with a Master of Science in Transportation at the University of New Orleans (UNO). While at UNO, Butler-Severson conducted research under advisement of Dr. Bethany Stich in the areas of LNG policy, freight planning, and GIS.

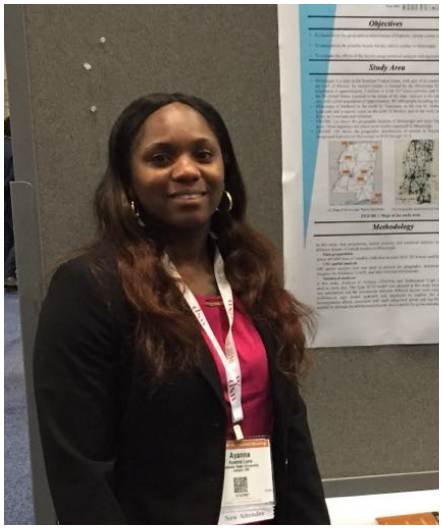
MarTREC 2017 Outstanding Student of the Year (FAST Act)
Leslie Gillespie-Marthaler, Vanderbilt University

Leslie graduated from the United States Military Academy in 1994 with a B.S. in Environmental Engineering and served for five years as an active duty Army officer. She received a M.S. in Civil Engineering from the Georgia Institute of Technology in 2002 and a Professional Degree in Engineering Management from George Washington University in 2011. She worked as a Federal employee for the U.S. Army and Environmental Protection Agency (EPA) and served two details to the White House at the Council on Environmental Quality (CEQ/OFEE) and the Office of Management and Budget (OMB). She is currently a Ph.D. student at Vanderbilt University, earning a degree in Environmental Engineering, under the direction of Dr. Mark Abkowitz. Her research is focused on community resilience.

MarTREC STUDENT ACHIEVEMENTS

The U.S. Department of Transportation Federal Highway Administration Dwight David Eisenhower Transportation Fellowship Program (DDETFP) awards fellowships to students pursuing degrees in transportation-related disciplines. This program advances the transportation workforce by helping to attract the nation's brightest minds to the field of transportation, encouraging future transportation professionals to seek advanced degrees, and helping to retain top talent in the U.S. transportation industry. Our student researchers who received 2018 DDETFP fellowships are shown below.

Maggie Langston, Casey Jones, Michael Deschenes, Sadie Smith, and Joseph Daniels
University of Arkansas



Ayanna A. Lynn,
Jackson State University

Ian Severson,
University of New Orleans

Charles Doktycz,
Vanderbilt University

2018 NSF CAREER AWARDEES

Michelle Bernhardt-Barry, assistant professor of civil engineering, for her research to expand and improve the use of soil as a building material through fundamental transdisciplinary research and the application of innovative technologies. Her research is aimed at expanding the use of soil as a building material, which would help improve construction projects in remote places.

Bernhardt–Barry has served as PI/Co-PI on MarTREC projects; Rapid and Non-Destructive Assessment of Levees for Strength and Liquefaction Resistance, Predicting Soil Type from Non-destructive Geophysical Data using Bayesian Statistical Methods, and Using CSA Cement for Novel Waterway Repair Materials.

Gary Prinz, assistant professor of civil engineering, for his research into optimizing 3D-printed metal for use in structures. His research is aimed at understanding how 3D-printed metals behave in high-impact events like earthquakes or explosions.

Prinz has served as PI on two MarTREC projects; Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability and Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi-Modal Fracture.

Benjamin Runkle, assistant professor of biological and agricultural engineering, for his research into sustainable irrigation practices for rice production. His goal is to help growers use less water and produce less methane without sacrificing rice yields.

Runkle is a Co-PI on a new MarTREC project; Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks.

Kelly Sullivan, assistant professor of industrial engineering, for his research into survivable, maintainable and adaptable sensor networks. His research centers on making sensor networks more reliable.

Sullivan has been a PI or Co-PI on MarTREC projects; Efficient Dredging Strategies for Improving Transportation Infrastructure Resilience and Informing Post -Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks.

Supporting Secure and Resilient Inland Waterways: Phase Two

Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
University of Arkansas
July 2017-August 2018

Expanding our previous research on deterministic inland waterway disruption response, we developed a Monte Carlo-based simulation optimization approach to handle uncertain parameters in the CPTAP model. Different scenarios of waterway transportation were considered, and the barge speeds were generated from real data to represent the random scenarios. Minimum value losses and corresponding solution structures can be obtained within a reasonable CPU time for small and medium size instances in one programming run. An alternative approach with multiple programming runs is adopted for large size instance to obtain the minimum value loss and its solution structure. We observe that distributions of the simulation results are getting more and more spread out but the majority of the results are close to the minimum value loss for all instances with different sizes.

Quantifying Resiliency of Maritime Transportation Systems

Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
October 2015-August 2018

This research leverages and adapts archival NAIS data for resilience analyses of coastal port operations following disruptive events. The results of the research show that an Automatic Identification System (AIS) is an excellent source of quantitative data on postdisaster measures of resiliency. The time-dependent performance models developed from these data show the cascading effects of disruptions and quantify the benefits gained by recovery efforts in a time-progressive series. One of the more interesting findings is the manner in which the data show, in quantifiable terms, reductions in performance resulting from incremental, less-publicized disruptions.

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves

Jim Kruse, M.B.A.
Brianne Glover, J.D.
Texas A&M Transportation Institute
September 2017-August 2018

This project examined the total economic impact of the GIWW across all sectors shipping goods along the waterway, in the states that it serves. Using IMPLAN, this report estimated the economic impact of the GIWW to be $61.5 billion annually. Of this, $31.8 billion was generated in Texas, $23.1 billion in Louisiana, $4.5 billion in Mississippi, $1.9 billion in Alabama, and $0.2 billion in Florida. Furthermore, the GIWW supports 143,000 jobs and generates $14.5 billion in labor income annually, with the majority of this occurring in Texas and Louisiana. The GIWW complements the highway system and rail network, requiring less additional investment to add capacity.

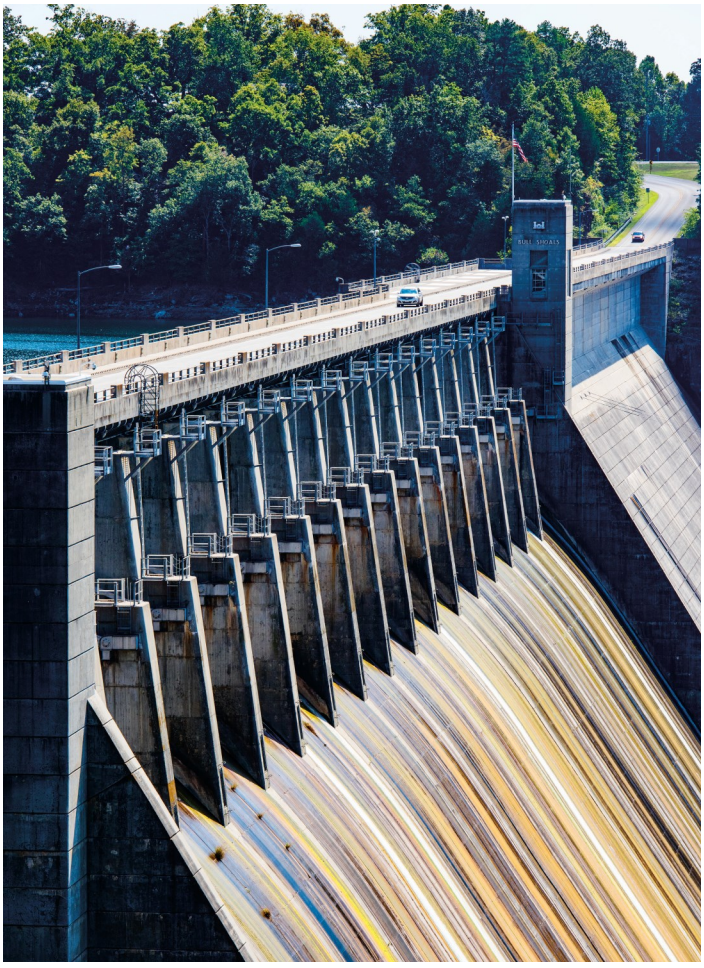


Photo courtesy of ARDOT

Final project reports are located @ martrec.uark.edu/research/index.php

and resilience planning and actions in all activities for the purpose of enhancing the resilience of our built and natural water-resource infrastructure (USACE Climate Preparedness and Resilience Policy Statement 2014). Inland waterways may experience greater floods due to changing land-use patterns and precipitation, drought can lower vessel drafts, and less ice on navigable waterways could increase seasonal windows for passage. The objective of this work was to integrate resilience planning and climate change preparedness for water-resource infrastructure.

Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability

Gary Prinz, Ph.D., P.E.
Clint Wood, Ph.D., P.E.
University of Arkansas
July 2016-August 2018

This study analytically and experimentally investigated fatigue damage within common lock gate geometries and developed fatigue mitigation strategies using tuned pre-stress levels to extend gate service-life. Detailed finite element analyses were used to identify critical lock gate fatigue regions and evaluate pre-stress effects on locally extending component fatigue life. Fatigue and fracture mechanics theories related to constant life diagrams were used to develop retrofit strategies for preventing fatigue cracking and fullscale experimental fatigue testing of a critical lock gate component was conducted to provide a baseline for evaluation of retrofit strategies. Retrofit strategies using carbon fiber reinforced polymer (CFRP) plates having optimized pre-stress levels were created and fatigue tested in laboratory conditions.

Evaluating the Performance of Intermodal Connectors

Sarah Hernandez, Ph.D.
University of Arkansas
August 2016-August 2018

The major data gap identified in this work is information on the temporal and spatial patterns of trucks accessing port areas stratified by commodity carried or industry served. Such information can help assess the impact of inland waterway ports and the need to maintain efficient connections to those ports via ICs. To close the data gap, this work developed a proof-of concept Lidar sensor bundle, capable of identifying the industry served by trucks traveling on a network link. By coupling a sensor capable of providing truck classification with truck movement data derived from truck GPS it is possible to fully characterize the usage and performance of ICs and inland waterway ports.

Supporting Secure and Resilient Inland Waterways

Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
University of Arkansas
August 2014-July 2018

Inland waterways are a cost-effective and environmentally-friendly mode of freight transportation. Natural and man-made events can disrupt navigation and may halt barge traffic. Our research provides decision support during inland waterway disruption response to mitigate negative time and value loss impacts through development of a decomposition based sequential heuristic (DBSH). The DBSH integrates the Analytic Hierarchy Process and linear programming to prioritize cargo and allocate barges to terminals. We solve thirty-five scenarios based on real-world Upper Mississippi River barge traffic data and find that our DBSH has similar performance compared to a previous approach with drastically improved computational time.

Photo courtesy of the Port of New Orleans

Final project reports are located @ martrec.uark.edu/research/index.php

Statistical Analysis of Vehicle Crashes in Mississippi Based on Crash Data from 2010 to 2014

Feng Wang, Ph.D., P.E.
Jackson State University
November 2015-July 2017

The current traffic safety situation in Mississippi has been of great concern. The Mississippi Department of Transportation crash dataset shows that more than 640,000 traffic crashes on Mississippi highways were recorded over the period from May 2010 to February 2014. The analyses showed that the frequencies of vehicle crashes in a metropolitan area are relatively high and the severities of crashes in the rural and coastal areas are relatively high. The crash distribution in MDOT maintenance districts shows that high crash severity is not correlated with high population density in a metropolitan area.

Optimal Dredge Fleet Scheduling - Phase 2 Research

Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2016-August 2017

Oversight of dredging operations is a challenging problem because a decision-maker must (i) choose from numerous potential locations that are in need of dredging and (ii) schedule selected jobs within allowable environmental windows. In its simplest form, this series of decisions can be broken into two problems: (1) job selection problem and (2) job scheduling problem. Prior research projects supported by MarTREC, a dredge scheduling methodology has already been integrated into USACE computing systems. Previous work assumes that the decision-maker has been provided a preselected set of jobs for scheduling consideration. A quantitative system for comprehensive consideration of dredge job selection does not exist. The failure to integrate the selection and scheduling process suggests that opportunity exists for significant financial and operational benefits for transportation planners. This research has adapted new quantitative tools that address this need by leveraging the expertise developed in this area by the team of investigators

Development of a Design Protocol: Sustainable Stabilization of Slope using Recycled Plastic Pins in Mississippi

Mohammad Sadik Khan, Ph.D., P.E.
Jackson State University
May 2016-October 2017

The maritime and multimodal system is an integral part of the efficient movement of the nation's freight. Slopes and embankments are a major component of maritime and multimodal transportation infrastructure, which are often subjected to shallow landslides due to the existence of expansive clay soil. As a cost effective alternative, recycled plastic pins can be used to stabilize shallow slope failures as a sustainable option and increase the economic competitiveness to maintain multimodal transportation infrastructure.

Effect of Swell-Shrink Characteristics on Landslides in Yazoo Clay

Mohammad Sadik Khan, Ph.D., P.E.
Jackson State University
July 2017-June 2018

Expansive soils cover more than 25% of the total area of the United States and are responsible for premature shallow slope failure of highway fill slopes, levee, dam, and embankments. According to Federal Highway Administration, expansive soils are a significant problem in many parts of the United States and are responsible for the application of premature maintenance and rehabilitation activities on many miles of roadway and maritime infrastructures each year. Investigation of the failure mechanism identified the critical condition of the slope failure in Mississippi. The test results of the wet-dry cycles indicated the progressive changes of the shear strength and worst-case scenario of the slope failure.

Climate Impacts on Lock Use and Performance

Justin Chimka, Ph.D.
University of Arkansas
July 2016-August 2018

It is the policy of U.S. Army Corps of Engineers (USACE) to integrate climate change preparedness

Final project reports are located @ martrec.uark.edu/research/index.php

Quantification of Multimodal Transportation Network Vulnerability: A Pilot Study in Mississippi

Himangshu Das, Ph.D., P.E.
Jackson State University
May 2016-April 2017

We developed a conceptual quantitative framework and database identifying critical transportation infrastructure and its vulnerability to natural hazards using existing data and modeling while incorporating downscaled climate scenario specific to the Mississippi Gulf Coast. It is recommended that the current inventory database should be supplemented with other critical transportation assets managed by state and metropolitan planning organizations. This enhanced database will be helpful to explore future vulnerability and sustainability of multimodal transportation and infrastructure network under a wide variety of hazard conditions. Inventory of critical transportation infrastructures that have already been developed must be linked into a network algorithm. Response and recovery of the disturbed networks were quantified through what-if scenarios.

Rapid and Non-Destructive Assessment of Levees for Strength and Liquefaction Resistance

Clinton Wood, Ph.D., P.E.
Michelle Bernhardt , Ph.D., P.E.
University of Arkansas
January 2015-June 2017

This research developed a rapid, non-destructive geophysical testing program and probabilistic framework that can be used to proactively evaluate levees. There is a clear correlation between resistivity and the degree of saturation and bulk density of a soil. An increase in either parameter is associated with a decrease in electrical resistivity. The resistivity values were found to be highly dependent on the degree of saturation up to approximately 60%, at which point increasing saturation does not result in significantly different resistivity values. When the soil is close to saturation, the effect of density or water quality on resistivity diminishes which makes the task of identifying soil type easier. It was observed that an estimate of the degree of saturation in conjunction with electrical resistivity offers the best estimate of soil type. The methods were shown to be capable of detecting many common defects in levees and earthen dams including the location of soft layers, old river meanders, inclusions or utilities, and internal erosion, any of which could lead to failure of the levee during a high water event.

Innovative Bio-Mediated Particulate Materials for Sustainable Maritime Transportation Infrastructure

Lin Li, Ph.D., P.E.
Jackson State University
November 2015-June 2017

The results of this study show that microbial induced calcite precipitation (MICP) treated material was weak at wet-dry durability and freeze-thaw durability. MICP-treated beach sand material was better at resisting these two weather conditions possibly because of its irregular shaped particles. The use of fiber or multiple treatments during the MICP treatment can provide resistance to the weathered deteriorations of MICP-treated soil. The MICP treatment is a cost-effective and in situ improvement of the engineering properties of sandy soils in coastal area for maritime transportation infrastructure construction.

Measurement of Traffic Network Vulnerability for Mississippi Coastal Region

Feng Wang, Ph.D., P.E.
Jackson State University
November 2015-July 2017

Hurricanes are one of the most catastrophic events resulting in severe consequences including loss of life and property damage. This project studied the vulnerability of the coastal transportation network. The study shows that evacuees are more prone to taking flooding risks in selecting evacuation routes as they are more sensitive to the travel time or cost on the routes. The analysis of the evacuation network in Mississippi coast area using the proposed method suggests that links near the evacuation destinations tend to be more critical, and important traffic corridors such as I-10 in the evacuation network has a high degree of criticality.

Final project reports are located @ martrec.uark.edu/research/index.php

Dynamic Decision Modeling for Inland Waterway Disruptions

Shengfan Zhang, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2014-December 2016

There is much uncertainty associated with inland waterway transportation. Natural or man-made disruption on the inland waterway system can have widespread economic and societal impacts, and their consequences can be significant. We developed the framework of the decision making process and devised the supporting tool for practitioner. It shows the sequential procedure of decision making and elements of each stage including specific techniques and tools applied. The decision making support tool was developed. It reads and manages data through spreadsheets; calculates expected delivery cost; and gives several resources to support decision making.

Efficient Dredging Strategies for Improving Transportation Infrastructure Resilience

Kelly Sullivan, Ph.D.
University of Arkansas
August 2014-December 2016

The viability of the inland marine transportation system is dependent upon highly random processes including weather, shoaling, and lock degradation. This project, seeks to determine efficient uses of maintenance dollars. Results demonstrate the tradeoff between investment in maintenance dredging and both the network's overall capacity for transporting commodities and risk associated with having insufficient budget to complete emergency projects.

Vulnerability of Fuel Distribution Systems to Hazards in Coastal Communities

John Pardue, Ph.D., P.E.
Louisiana State University
May 2015-December 2016

Coastal communities are vulnerable to disruptions in fuel availability for their transportation networks due to their susceptibility to flooding and storm surge events. Fueling station design criteria do not change in coastal communities and supply chains rely on road networks that lack the redundancy present in more inland areas. This study examined fuel distribution disruptions from past storms and the time for restoration of fuel availability after coastal hazard events. We developed extensive network model of coastal Louisiana communities capturing roads, fueling stations, and bulk terminals. The combined fueling station and road network constructed for this project is the first spatial representation of this system for a Louisiana coastal parish.

Evaluating Coastal and River Valley Communities Evacuation Network Performance Using Macroscopic Productivity

Scott Parr, Ph.D., E.I.T.
Louisiana State University
May 2015-April 2017

Coastal and river valley communities are particularly vulnerable to catastrophic events due to their proximity to large bodies of water. A robust and resilient transportation system is therefore imperative in these communities to mitigate the added risk of flash flooding, hurricanes, storm surge, and sea-level-rise. The findings demonstrate the application of a novel performance and computational technique to assess the operation of traffic networks, system-wide, independent of their size or duration of analysis. This technique is ideal for evacuation planning and alternative comparison in megaregions. Emergency management and transportation decision-makers can use "trip completion" as a measure of evacuee departures out of a threat area. This permits a systematic and qualitative basis for assessing evacuee demand management to improve regional mass evacuations.

Photo courtesy of ARDOT

Final project reports are located @ martrec.uark.edu/research/index.php

In-Situ Monitoring and Assessment of Post Barge-Bridge Collision Damage for Minimizing Traffic Delay and Detour

Wei Zheng, Ph.D., P.E.
Jackson State University
July 2014-June 2016

Piers of bridges across major navigation waterways frequently suffer from barge collisions, resulting in the closure of both bridges and waterways to traffic for assessing the potential damage. This project developed an efficient in-situ monitoring and data processing scheme for assisting bridge professionals to reliably assess the barge-bridge collision damage and make prompt and informative decision on the operation the bridge and navigation waterways. Once a barge-bridge collision event happens, field dynamic measurements can be collected from the collided bridge structure with the sensor network. The best feature vectors were extracted and input into the best classification models of each of the trained classifiers. With the identified threshold of each classifier, the prediction probability of the damage locating in each of the sub-regions were determined.

Economic Impacts of Lock Usage and Unavailability

Justin R. Chimka, Ph.D.
University of Arkansas
August 2014-June 2016

Freight statistics should provide an objective baseline for transportation policy decisions, and national economic benefits of maritime transport necessitate improving inland waterways infrastructure. The research objective was to estimate annual tons locked by commodity group and lock, as a function of lock usage and unavailability (1993-2013). Usage data includes average delay and processing time, barges empty and loaded, flotillas and vessels, lockages, and percent vessels delayed. Unavailability data includes scheduled and unscheduled lock unavailabilities, and unavailable times. Twenty-two out of the 42 datasets resulted in at least one useful subset where we could employ our alternative to stepwise regression to find a linear model which is efficient and appropriate according to our definitions of those characteristics.

National Inventory and Analysis of Transit Oriented Development in Proximity to Coasts and Port Facilities

John L. Renne, Ph.D., AICP
University of New Orleans
October 2013-September 2017

There is often a tension between the development of mixed-use transit oriented developments and heavy industry near coastal areas and major rivers and near port facilities. This study quantified and examined the number of jobs and residents in station areas near coastal areas, major rivers and near port facilities across the U.S. and forecasts future development and job potential of underbuilt station areas, which could become TODs over the next several decades.

Optimal Dredge Fleet Scheduling within Environmental Work Windows

Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
University of Arkansas
August 2014-August 2016

The USACE annually dredges hundreds of navigation projects through its fleet of government dredges and individual contracts with private industry. This project examined the decision of allocating dredge resources to projects system-wide under necessary constraints including environmental restrictions concerning when dredging can take place due to migration patterns of turtles, birds, fish, and other wildlife, dredge equipment resource availability, and varying equipment productivity rates that affect project completion times. We expanded optimization tools to allow for multiple dredge resources to work on a single job. The impact of the implementations are measured quantitatively. Of equal importance is the impact on the future of decision analysis within USACE. The main impact of the project is that every concern presented by USACE has now been addressed from a modeling perspective. The decision makers understand that optimization tools can be flexible and extendable and, with the appropriate amount of attention, complex challenges can be modeled.

Final project reports are located @ martrec.uark.edu/research/index.php

Regional Economic Impact Study of the McClellan-Kerr Arkansas River Navigation System

Heather Nachtmann, Ph.D.
University of Arkansas
April 2014 -August 2015

In this research, funded by the Arkansas Department of Transportation as a MarTREC match project, we implemented a multiregional social accounting matrix framework to estimate the economic impacts of the McClellan-Kerr Arkansas River Navigation System (MKARNS) activities on the study regions of AR, OK, KS, MO, TX, and the rest of the United States. Our study considers economic impacts from 1) Hydropower Energy Generation, 2) USACE O&M Expenditures, 3) Private Sector Investment Expenditures, 4) Port Activities, 5) Shippers' Activities, 6) Transportation Cost Savings, and 7) Recreation Benefits. We combined our analysis with a 2014 Oklahoma Department of Transportation study led by Dr. Dennis Robinson of University of Arkansas - Little Rock and found that the total economic impacts of the MKARNS nationwide are $8.5 billion in sales, $4.3 billion in gross domestic product (GDP), and $2.5 billion in labor income. In addition, 55,872 jobs are created due to the activities related to the MKARNS.

LNG Bunkering for Marine Vessels at the Port of New Orleans: Siting and Facility Components

Bethany Stich, Ph.D.
James R. Amdal
University of New Orleans
April 2014-January 2016

The team was approached by the Port of New Orleans in 2014 to develop an assessment of best practices regarding the construction of shore-side Liquefied Natural Gas (LNG) bunkering facilities and the overall feasibility of the LNG fueling facility. When this request was made, the maritime industry was expected to convert their fleets from diesel to LNG, due to fuel cost savings and in compliance with planned environmental regulations. However, when OPEC began dramatically decreasing the price of crude oil in the mid-2010s, these cost incentives ceased to exist, especially the economic factor. The best recommendation that can be made from this research is for the Port of New Orleans to join with the International Chamber of Shipping in encouraging the International Maritime Organization (IMO) division of the United Nations to continue taking the lead in globally-applied emissions standards. Therefore the Port is best advised to aggressively support an IMO-derived driven global implementation of policies.

Exploration of Novel Multifunctional Open Graded Friction Courses for In-situ Highway Runoff Treatment

Yadong Li, Ph.D., P.E.
Lin Li, Ph.D., P.E.
Jackson State University
July 2014-June 2016

Pollutants on roadways and parking lots can come from various sources. Storm water runoffs from roadways contain both organic and inorganic contaminants of which large portions are eventually conveyed to the nearby water bodies such as rivers and lakes. Copper (Cu) and Zinc (Zn) have been identified to be the major inorganic contaminants in roadway runoffs. The results of this study bring an important conclusion that not only can the pervious concrete pavement (PCP) bring traffic-related benefits but also environmental benefits because of its long-term removal capacities for Cu and Zn, which are the major heavy metal contaminants in roadway runoffs. The use of PCP in roadways and parking lots brings positive impacts for environmental protection.

Photo courtesy of the Port of New Orleans

Final project reports are located @ martrec.uark.edu/research/index.php

COMPLETED MarTREC PROJECTS

Multimodal Transport and TransLoad Facilities in Arkansas

Justin R. Chimka, Ph.D.
University of Arkansas
July 2014-December 2014

Multimodal transport may require added transload facilities where freight is moved from truck to railcar or vice versa. Greater than 550 short line and regional railroads operating in 49 states account for almost 30% of the U.S. rail network. These small businesses compete and cooperate with trucking interests to cost-efficiently connect local economies with the larger Class I railroad system. With three Class I railroads and 24 short lines in Arkansas, research finds the state may be poised to ease state highway congestion, safeguard the environment, and support local economies by adding transload facilities.

Identifying High-Risk Roadways for Infrastructure Investment Using Naturalistic Driving Data

Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
October 2013-June 2015

The state-of-the-practice for most municipal traffic agencies seeking to identify high-risk road segments has been to use prior crash history. Recently researchers are developing predictive crash methods based on "abnormal driving events." These include abrupt and atypical vehicle movements thought to be indicative of crash avoidance maneuvers and/or near-crashes. Statistical analyses revealed that clusters of high magnitude jerk events while decelerating were significantly correlated to long-term crash rates at these same locations. These significant and consistent relationships between jerks and crashes suggest that these events can be used as surrogate measures of safety and as a way of predicting safety problems before even a single crash has occurred.

Road Sign Recognition during Computer Testing versus Driving Simulator Performance for Stroke and Stroke+Aphasia Groups

Neila J. Donovan, Ph.D.
Louisiana State University
July 2014-June 2015

Brain damage from stroke can affect physical mobility, sensorimotor, cognition, communication, visual perception, and visual processing which are all critical processes needed for driving. A recent study tested road sign interpretation tasks among groups of healthy and poststroke older drivers assessed the effects of poststroke aphasia on driving. Results showed that aphasia significantly impacted accuracy and response time of road sign interpretation. As language and symbol complexity increased on road signs, the aphasia-affected drivers performed with less accuracy and required more time.

Development of a Large-Scale Traffic Simulation Model for Hurricane Evacuation of Mississippi Coastal Region

Feng Wang, Ph.D., P.E.
Jackson State University
July 2014-July 2015

This study developed an optimization model to obtain improved traffic flow assignment with a minimization of the total travel cost in a localized no-notice evacuation network. The following observations were made: (1) numerical results show that the implementation of a gate control strategy could effectively decrease the total travel cost and reduce the degree of conflicts related to traffic movements and trip routes, (2) experimental results show that in a no-notice or short notice evacuation, the number of nodes selected for a gating strategy may also impact the evacuation performance, and (3) traffic simulations of an evacuation scenario with a large scale network show that applying the gate control strategy could improve evacuation performance.

Final project reports are located @ martrec.uark.edu/research/index.php

Utilizing Graceful Failure As An Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure

Janey Camp, Ph.D., P.E.
Craig Philip, Ph.D.
Vanderbilt University
May 2018-April 2019

In 2011, we observed how "graceful failure" through planned damages to the Birds Point Levee by the U.S. Army Corps of Engineers was enacted to alleviate extreme flooding on the Mississippi River. This action, while flooding croplands as planned in the past, actually reduced flooding and damage to waterway infrastructure and communities downstream. The objective of this project is to identify areas presently protected by levees that could be utilized for floodwater attenuation and storage along inland waterway navigation channels and associated tributaries to protect communities and infrastructure downstream. We intend to address needs for flood mitigation thus reducing disaster response needs for the inland waterway navigation system and river valley communities.

Visualizing Sea Level Rise Impacts in Transportation Planning

Brian Wolshon, Ph.D., P.E., PTOE
John L. Renne, Ph.D., AICP
Louisiana State University
January 2018-June 2019

Transportation planners regularly engage communities through public meetings to seek input and engagement on planning for the future including impacts of sea level rise on streets and neighborhoods. New media options allow for three-dimensional (3D) imaging utilizing virtual and augmented reality. Such 3D visualizations are increasingly affordable and accessible to display on glasses that connect to smartphones, such as Samsung Gear VR. This project will test and compare new technologies on individuals in community-meeting settings in South Florida to test if 3D technology helps residents better understand the impacts of sea level rise on transportation infrastructure and communities.

ONGOING MarTREC PROJECTS

Development and Implementation of Sustainable Transportation Resilience Indicators

Mark Abkowitz, Ph.D.
Vanderbilt University
June 2017-March 2019

Much has been discussed about resilient transportation infrastructure as well as sustainable practices, but only recently have their interdependencies been brought to light in terms of a community's ability to develop sustainable (economic, social and environmental) resource capacity necessary to be resilient in the face of natural hazard events that could lead to catastrophic consequences. In order to evaluate whether a community has achieved an acceptable level of sustainable transportation resilience, it requires performance indicators that are both relevant and measurable. This project will establish a protocol and method for evaluating a community's level of sustainable transportation resilience.

A Multimodal Network Approach to the Inland and Coastal Waterway System

Bruce Wang, Ph.D.
Texas A&M University
July 2017-November 2018

The national marine highway initiative intends to position waterways in the context of multimodal transportation system. Maintenance and capacity of each element of the waterway system has its implication to the multimodal network. This project will develop a multimodal freight network model that includes both waterway land side components in order to analyze the impact of waterway operations. The goal is to enhance the entire network efficiency. Algorithms will be proposed. The model will accommodate delay/congestion and other network restraints. This research will build on earlier work of the PI that studied the Ohio River network system and will focus on the network efficiency.

Shipping Container Chassis in the US: The Legacy of Ocean Carriers

Bethany Stich, Ph.D.
University of New Orleans
March 2018-February 2019

Containerized shipping, which accounts for approximately 60 percent of all world seaborne trade while generating approximately 12 trillion United States (US) dollars in 2017, links trading partners between the water, rail, and air modes. The University of New Orleans Transportation Institute (UNOTI) is examining the issues surrounding the current state of international chassis utilization in the United States. The international chassis system in the U.S. is unique compared to global chassis utilization where the motor carriers, the freight customers, or off-site terminals provide chassis.

Towards Integrating Resilience into Everyday Transportation Practices of Coastal and River Valley Communities

Brian Wolshon Ph.D., P.E., PTOE
Nelida Herrera, M.S.C.E., E.I.T.
Louisiana State University
August 2018-June 2019

Coastal and river valley communities have become increasingly vulnerable to sea level rise, hurricanes and other natural disasters. In many cases, these events force the communities to evacuate in a relatively unpredictable way. Emergency evacuations require safe and effective mobilization of the public from hazardous areas while facing uncertainty. This research will leverage from new or existing low-cost technologies such as traffic simulation to help transportation agencies entities maximize their resilience practices within their budget constraints. It is also anticipated that this research will lead to future development of new or enhanced tools and methods that can be easily transferred to coastal and river valley communities.

Trade-Off Analytics for Infrastructure Preservation

Greg Parnell, Ph.D.
Ed Pohl, Ph.D.
University of Arkansas
August 2018-August 2019

The objective of this project is to develop a course that could be taught to civil engineers, industrial engineers, and the maritime and multimodal infrastructure community on the use of trade-off analytics as a tool to assist them in their infrastructure preservation efforts. This course will also be packaged into a webinar that could be delivered on-line for practicing professionals and will be constructed so that it could be taught as a short course for working professionals or as a special topics graduate or undergraduate course.

Using CSA Cement for Novel Waterway Repair Materials

Cameron Murray, Ph.D.
Michelle Bernhardt, Ph.D., PE
University of Arkansas
August 2018-August 2020

Calcium Sulfoaluminate-Belite (CSA) cement is a rapid setting hydraulic cement capable of strengths exceeding 4 ksi in 2 hours or less. Due to its rapid hardening characteristics and lower shrinkage and creep compared to typical portland cement, it is an ideal candidate as a repair material. The goal of this work is to develop new mixtures utilizing CSA cement that can be applied to waterway repairs. A grout mixture capable of setting up rapidly underwater and a soil-cement mixture that can rapidly stabilize slopes and waterway structures will be developed.

Photo courtesy of ARDOT

Large Scale Evaluation of Erosion Resistance of Biocementation against Bridge Scour and Roadway Shoulder Erosion

Farshad Amini, Ph.D., P.E.
Jackson State University
March 2018-February 2019

Water erosion causes a variety of infrastructure problems such as bridge scour and roadway shoulder erosion. Nearly two-third of bridge failures are related to bridge scour. This project studies using Microbiologically induced calcium carbonate precipitation(MICP) as an erosion countermeasure. MICP is a natural phenomenon where calcite precipitation occurs as a consequence of microbial metabolic activity. The biocemented geomaterials may provide previously unexplored opportunities as cost-effective and sustainable preserving materials for erosion mitigation.

Learning from USACE Open Data for Locks

Justin Chimka, Ph.D.
University of Arkansas
August 2018-August 2020

In August 2017, the U.S. Army Corps of Engineers (USACE) began to enable unprecedented data access by publishing its USACE Open Data for Navigation online. This project's objectives include the following: 1) Explore the new USACE Open Data for Locks, describe its relevant datasets, and inventory their contents, 2) Identify responses or variables of interest across relevant datasets, and treat them to statistical analysis which may suggest that datasets should be divided into more usable subsets, and 3) Diagnose efficient statistical models of the usable subsets in order to make general statements about Corps Locks data and Public Lock Unavailability.

Liquefied Natural Gas Phase III: Export Competition in a Well Supplied, Flow-Shifting Global Economy

Bethany Stich, Ph.D.
University of New Orleans
March 2018-February 2019

With trillions of cubic feet of shale reserves, the United States' abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. Furthermore, U.S. energy independence fueled by shale mining could potentially alter how the U.S. acts in the global market place. This project analyzes anticipated growth and value of LNG as a marine fuel and anzlyze the value of short sea shipping as a transportation alternative to pipelines and trucks.

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
University of Arkansas
August 2018-June 2020

The inland waterway transportation system of the United States handles 11.7 billion tons of freight annually and connects the heartland of the United States with the rest of the world. The system is challenged with aging infrastructure and limited operations and maintenance budgets which can cause transportation delays and economic losses. This work utilizes our previously developed Maritime Transportation Simulator (MarTranS) which integrates agent-based modeling, discrete-event simulation, and system dynamics to further explore the relationship between inland waterway transportation system components and regional economic impact factors.

Photo courtesy of TXDOT

Exposure to STEM: Diversity in Maritime Transportation

Rick Coffman, Ph.D., P.E.
University of Arkansas
August 2018-August 2019

The goal of this education and workforce development project is to develop an educational/mentoring/advising model to open doors to all students, regardless of socio-economic background, who want to pursue careers in fields related to maritime and multimodal transportation. The project will include visits to the respective institutions and field trips/visits of the participants to local maritime navigation structures. The PI will collaborate with the teachers to develop classroom instruction modules that tie daily lesson objectives with real world STEM and more specifically with maritime, related applications.

Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi-Modal Fracture

Gary Prinz, Ph.D., P.E.
University of Arkansas
August 2018-August 2020

Lock gates are an important part of the transportation infrastructure within the United States, having many economic, safety, and environmental benefits over rail and highway transportation systems. Many existing lock gates throughout the U.S. have reached or exceeded their initial design life and require frequent repairs to remain in service. This project seeks to improve lock gate reliability by identifying and developing fracture mitigation strategies for multi-mode fatigue issues that arise near key pintle locations.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures

Danuta Leszczynska, Ph.D.
Jackson State University
March 2018-July 2019

The aim of this study is to produce and investigate a carbon-based substance, namely biochar, as a new material for the in-situ adsorption of pollutants carried by the stormwater runoff from the roads. A series of lab-scale experiments will be designed to optimize biochar's microscopic structures and to determine its adsorption capacities. The long-term spin-offs from proposed research are aimed toward (a) development of the new substance based on biochar that could be used for the emergency recovery of spills and (b) exploring possibilities of using biochar as an addictive to pervious concrete or asphalt.

Interdependency of Port Clusters During Regional Disasters

Brian Wolshon, Ph.D., P.E., PTOE
Scott Parr, Ph.D.
Louisiana State University
January 2018-August 2019

External disruptions to a port may result from storms, such as Hurricane Mathew and Super Storm Sandy, as well as terrorism and oil/hazardous spill. The impact of a disruption on a port is a function of vulnerability of the port and the severity of the disruption. The resiliency of ports and inland waterways is critical for maintaining the flow of essential goods throughout the United States and is critical to national security and defense readiness (Sturgis, 2014). This research will show how port clusters rely upon each other during disruptive events to increase the overall resiliency of waterborne commerce during disruptive events.

Informing Post-Disaster Restoration Through Modeling Interdependent Agriculture and Transportation Networks

Sarah Nurre, Ph.D.
Kelly Sullivan, Ph.D.
Benjamin Runkle, Ph.D.
University of Arkansas
August 2018-August 2020

Agriculture supply chains are of utmost importance for the function of society and are inherently complex due to their interdependency with critical infrastructure systems including energy, water, and maritime and multimodal transportation. This complexity is increased due to the dependence on time-sensitive and capital-intensive operations, uncertain natural events, and volatile commodity markets as well as their position within rural and low socioeconomic communities. This project will develop models that determine how to effectively use transportation to make agriculture supply chains more resilient.

NEW MarTREC PROJECTS

Changing Trade and Transportation Patterns: NAFTA, Cuba, and the US Gulf Coast

Bethany Stich, Ph.D.
University of New Orleans
March 2018-February 2019

Since the passage of the National Environmental Protection Act in 1969, transportation planning became a complex, interdisciplinary challenge. In order to satisfy the current regulations and public policies, the transportation planning process can no longer solely rely on the basics of engineering; it is now forced to find the way in a sea of data, values, and actors towards a comprehensive and integrated solution. As a consequence, not only the variety of data, but also the quality and vast amount of data to be processed has become one of the big issues for transportation practitioners. This project will provide an assessment of the variety, quality, and quantity of transportation data as it applies to transportation professionals' ability to make informed decisions and arrive at best practices and suitable transportation policy.

Developing and Applying a Methodology to Identify Flow Generation Influences between Vessel and Truck Shipments

Mario Monsreal, Ph.D.
Jim Kruse, M.B.A.
Texas A&M Transportation Institute
December 2017-February 2019

Truck activity is logically connected to, and generated by, vessel activity at a port. In turn, vessel activity is generated by truck shipments. Although one might expect a 1-to-1 relation between the two types of shipments, that is unlikely the case. For instance, many maritime containers carry consolidated cargos that have multiple (and different) final destinations. Furthermore, different truck capacities and regulations play a critical role in determining the actual relation between these two shipment modes. A clearer and quantitative understanding of the relationship between vessel and truck shipments enables agencies and organizations to develop a system for managing trucks that maximizes efficiency for industry. The information from a Port Freeport case study will benefit public-sector and private-sector decision makers in activities such as investment planning, resource allocation, and operations management in general.

Effect of Permeability Variation of Expansive Yazoo Clay at the Maritime and Multimodal Transportation Infrastructure in Mississippi

Sadik Khan, Ph.D., P.E.
Jackson State University
September 2018-August 2019

The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. This study investigates the change in unsaturated vertical and horizontal permeability and its effect on the maritime and multimodal infrastructures such as pavement subgrade's moisture variation. The analysis will help to improve the design of the undercut of the pavement, which is critical to control the deformation and continuous deterioration of the highway/roadway pavement in many miles of maritime and multimodal transportation infrastructure in Mississippi.

Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Transportation Infrastructure in Waikiki, Hawaii

Brian Wolshon, Ph.D., P.E., PTOE
John L. Renne, Ph.D., AICP
Louisiana State University
March 2018-September 2019

This study will build upon another related UTC project that focuses on visualizing sea level rise impacts to transportation infrastructure in South Florida and extend this research to Waikiki, located in Honolulu, Hawaii and focus on the business and tourism industry community. Waikiki is facing major impacts from sea level rise, and transportation and community planners will engage with stakeholders through meetings to seek input and engagement on planning for the future including impacts of sea level rise on streets, buildings and neighborhoods.

MarTREC

Maritime Transportation Research & Education Center

ABOUT

MarTREC is a U.S. Department of Transportation Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under MAP-21, MarTREC built economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems. MarTREC, through continued funding under the FAST Act, is working to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure.

VISION

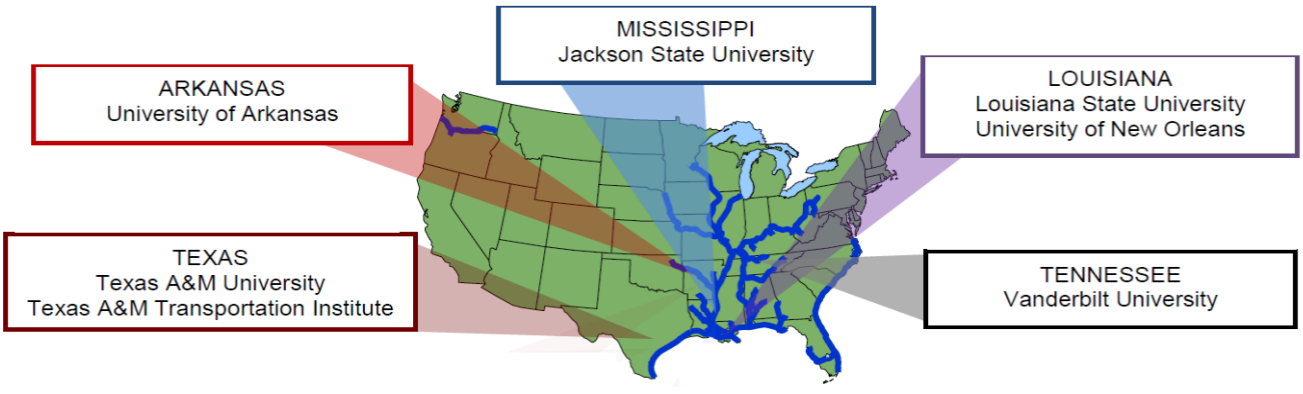
Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education. The MarTREC consortium consists of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development.

CONSORTIUM

Our consortium includes the University of Arkansas (UARK), Jackson State University (JSU), Louisiana State University (LSU), Texas A&M University/Texas A&M Transportation Institute (TAMU/TTI), University of New Orleans (UNO), and Vanderbilt University (VU). Each consortium member is strategically located to support MarTREC's theme: UARK, JSU, LSU, and UNO are located along the Mississippi River; VU along the Cumberland River; and JSU, LSU, UNO, and TAMU/TTI along the Gulf Coast.

RESEARCH

MarTREC conducts research activities in three topic areas: 1) Maritime and Multimodal Logistics Management to expand decision support and facilitate improved operations within the Nation's multimodal supply chain networks; 2) Maritime and Multimodal Infrastructure Preservation to advance state-of-the-art resilient multimodal transportation infrastructure preservation, repair, design, and construction; and 3) Disaster Response and Transportation Planning for Coastal and River Valley Communities to enable the resilience, safety, efficiency, and effectiveness of multimodal transportation systems during disaster response or other major events.



MESSAGE FROM MarTREC DIRECTOR

As you will read in this annual report, MarTREC had a great year. We have research projects actively contributing across the Nation. Four of our MarTREC researchers received National Science Foundation (NSF) CAREER awards in 2018, which is NSF's most prestigious early-career grant. Eight of our student researchers received Dwight David Eisenhower Transportation Fellowships this year, indicating the future of our transportation workforce is bright. All of our faculty and student researchers are dedicated to transferring our research into practice. The MarTREC consortium is extensively networked through existing stakeholder partnerships and dedicated to implementable research. Established and new partnerships are essential to effective technology transfer of research outputs, educational resources, and workforce development programs. I hope you enjoy reading this year's report.

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Photo courtesy of ARDOT

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MarTREC

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