



USDOT Tier 1 University Transportation Center

FAST ACT Program Progress Performance Report #3

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Center Director: Heather Nachtmann, Ph.D., Professor, Department of Industrial Engineering, University of Arkansas, hln@uark.edu, 479.575.6021

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Maritime Transportation Research & Education Center (MarTREC)

MarTREC is a USDOT Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under the FAST Act, MarTREC is working to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education.

Made up of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development, the MarTREC consortium are University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; University of New Orleans (UNO), New Orleans, LA; Texas A&M University/Texas Transportation Institute (TAMU/TTI), College Station, TX; and Vanderbilt University (VU), Nashville, TN.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research

Goal: MarTREC will conduct research that contributes to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure.

Objectives:

- Conduct research projects related to MarTREC's research goal
- Engage a diverse set of faculty and students in MarTREC research activities
- Disseminate research findings

Accomplishments:

Research Effectiveness Metrics	PPPR Progress
# of peer-reviewed journal articles (published, accepted, submitted)	16
# of conference presentations given	20
# of students participating in transportation research projects funded by UTC	27

1.1.2 Leadership

Goal: MarTREC will become the premier source for expertise on maritime transportation research, education, and workforce development.

Objectives:

- Demonstrate academic leadership towards MarTREC's leadership goal
- Demonstrate industry leadership towards MarTREC's leadership goal

Accomplishments:

Leadership Effectiveness Metrics	PPPR Progress
# of national and regional leadership positions held	28
# of invited talks given	3
# of leadership and research awards received	9

1.1.3 Education and Workforce Development

Goal: MarTREC will develop educational resources to elucidate scientific and engineering practices involved in maritime and multimodal transportation systems and practices.

Objectives:

- Conduct education and workforce development (EWD) projects related to the goal
- Educate college students within MarTREC theme
- Conduct workforce development related to MarTREC theme
- Conduct outreach activities related to MarTREC theme

Accomplishments:

Education and Workforce Development Effectiveness Metrics	PPPR Progress
# of transportation-related courses offered	45
# of technician certification programs offered	6
# K-12 outreach programs offered	10

1.1.4 Technology Transfer

Goal: MarTREC consortium institutions will participate in national, regional, and local education and workforce development outreach to provide state-of-the-art knowledge to private and public transportation organizations and provide a forum where government employees, academic researchers, and private sector can exchange ideas on current issues.

Objectives:

- Transfer MarTREC outcomes into practice
- Develop products in support of MarTREC technology transfer goal

Accomplishments:

Technology Transfer Effectiveness Metrics	PPPR Progress
# of project deliverables submitted	2
# of technical briefs	1
# of editorial journal positions held	12

1.1.5 Collaboration

Goal: MarTREC will continue our existing partnerships with maritime and multimodal transportation stakeholders and develop new partnerships at the consortium, institution, and project levels to facilitate our planned research, leadership, education, workforce development, and technology transfer activities.

Objectives:

- Develop external partnerships related to MarTREC's collaboration goal
- Develop collaborative products related to MarTREC's collaboration goal
- Engage faculty and students in achieving MarTREC's collaboration goal

Accomplishments:

Collaboration Effectiveness Metrics	PPPR Progress
# of existing collaborative partnerships	32
# of new collaborative partnerships formed	9

1.1.6 Plans for Next Reporting Cycle

MarTREC has 22 active research projects during this reporting period. The faculty researchers will continue to engage with industry experts to ensure that these projects are making transformational contributions. The consortium will continue to expand our collaborative partnerships to support this. We will continue to emphasize educational and technology transfer activities. MarTREC will be hosting its semi-annual Dan Flowers Distinguished Lecture on November 15, 2018. Our speaker is Tianjia Tang, Chief of the Travel Monitoring and Surveys Division for the Federal Highway Administration. Our Annual Professional Advisory Board meeting is set for November 16, 2018.

1.2 Project-Level Accomplishments

1.2.1 Maritime and Multimodal Logistics Management Projects

Development and Application of a Methodology for Maritime-Truck Shipments Generation Analysis

Mario Monsreal, PhD

Jim Kruse, MS, MBA

Texas A&M Transportation Institute

December 2017-February 2019

Accomplishments: 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. The project team has made progress on the selection and acquisition of the simulation software package. Specifically, the project team has undergone training on the software package and developed first general simulations. Information on Freeport for model building has been collected and is currently being analyzed. Immediate next steps are to prepare PortVision data sets for the statistical analysis and perform such analysis.

Project Plans: This data set is currently being acquired and analyzed, The research team expects to reach out to port authority staff and private-industry representatives, after analyzing available information from secondary sources. The research team is preparing to initiate the statistical analysis. The research team is preparing to initiate simulations.

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

Bethany Stich, PhD

University of New Orleans

March 2018-February 2019

Accomplishments: Since the passage of the National Environmental Protection Act in 1969, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation coupled with public participation demands have revealed innumerable

problems associated with the use of outdated techniques. 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. Therefore, 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.

Project Plans: 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.

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

Bethany Stich, PhD

University of New Orleans

March 2018-February 2019

Accomplishments: Containerized shipping, which accounts for approximately 60 percent of all world seaborne trade while generating approximately 12 trillion United States dollars in 2017, links trading partners between the water, rail, and air modes (as well as on-time distribution points and retail outlets). Therefore, according to Lane (2015), the international chassis is, in turn, "...the linchpin of today's international commerce". The University of New Orleans Transportation Institute (UNOTI) will examine the issues surrounding the current state of international chassis utilization in the United States. An overview of the state of and effects of international shipping container chassis regulatory environment on the US trucking/motor carrier industry has been completed. Evidence-based analysis highlighting the economic impact of the existing ocean liner legacy based organizational structure and regulatory environment of chassis ownership and leasing on the US motor carrier industry has also been completed.

Project Plans: An overview and recommendations for chassis safety concerns regarding use on US roadways will be completed. Preliminary findings will be presented at the 2019 TRB annual conference.

Learning from USACE Open Data for Locks

Justin Chimka, PhD

University of Arkansas

August 2018-August 2020

Project Plans: Now that USACE Open Data is coming online, there is great opportunity to leverage key resources for statistical learning. MarTREC is well positioned to lead the way in this particular activity by showing what kinds of analysis could be done with the newly published Corps Locks Queue Archive and Public Lock Unavailability Detailed Report. Using this recent investment in data access to its greatest advantage should be of general interest to USACE and maritime transportation researchers. Identifying USACE Open Data as something which could introduce interesting new challenges to the field of applied regression would also bolster maritime transportation as an important context for engineering statistics education.

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, PhD

Justin Chimka, PhD

University of Arkansas

August 2018-August 2020

Project Plans: The inland waterway freight system is a tremendous and underutilized asset within the United States' transportation system, providing an economical and environmentally sound mode for moving cargo. However, the system is challenged with aging infrastructure and limited operations and maintenance budgets, which can cause transportation delays and economic losses. We will utilize 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. We will also develop statistical models and decision support tools to provide expanded information about the system and its current and future behavior. This research will provide new data analytics and knowledge that can guide future investment, operations, and maintenance decisions.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

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

Brianne Glover, JD

Jim Kruse, MS, MBA

Texas A&M Transportation Institute

September 2017-August 2018

Accomplishments: This project reviewed existing literature on the economic value of the GIWW, reviewed the importance of the GIWW to the energy industry, examined the overall economic impact of the GIWW to the states it serves, and estimated the increases in transportation costs resulting from an immediate closure in the GIWW. Overall, this report estimates that the GIWW has an economic impact of \$61.5 billion annually, supports 143,000 jobs, and saves up to \$4.3 billion in transportation cost savings annually.

Completed project: Conducted by TTI, this project was completed in August 2018. Final project report was submitted on time and distributed as per grant guidelines.

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

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

March 2018-February 2019

Accomplishments: The goal of this research is to assess if the use of 3D virtual and augmented reality as a policy deliberation tool for improved coastal planning, engineering and design by deepening the understanding of sea level rise impacts among the business and tourism industries in Waikiki, Hawaii. During this reporting period, the research team held a kick-off meeting and identified the resources needed to develop the holograms for Waikiki engagement based on lessons learned from the year 1 project. The research team also began gathering the resources needed to develop the holograms and post-surveys for the community meetings.

Project Plans: The team will seek to visualize the differences between King Tide, storm surges, tsunami and sea level rise. The team will utilize three-dimensional (3D) imaging utilizing virtual

and augmented reality to serve as a policy deliberation tool to better discuss coastal planning, engineering and design solutions.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures

Danuta Leszczynska, PhD

Jackson State University

March 2018-February 2019

Accomplishments: 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 storm water runoff from the roads. A series of lab-scale experiments are being used to optimize biochar's microscopic structures and to determine its adsorption capacities. The particular source material, and applied techniques for obtaining biochar may influence its final properties; therefore, the initial set of experiments are on testing properties of biochar manufactured by different techniques, temperature set-ups and oxygen-free environments.

Project Plans: 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 additive to pervious concrete or asphalt.

A Multimodal Network Approach to the Inland and Coastal Waterway System

Bruce Wang, PhD

Texas A&M University

July 2017-November 2018

Accomplishments: 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 has developed a multimodal freight network model that includes both waterway landside components in order to analyze the impact of waterway operations. The goal is to enhance the entire network efficiency. Algorithms are complete.

Project Plans: Apply the model that will accommodate delay/congestion and other network restraints. This research builds on earlier work of the PI that studied the Ohio River network system. The difference is that this proposed work will focus on the network efficiency.

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

Accomplishments: Water erosion causes a variety of infrastructure problems such as bridge scour and roadway shoulder erosion. Nearly two-third of bridge failure cases is related to bridge scour. To address MarTREC's quest towards sustainable and resilient transportation infrastructure preservation and building upon its experience and expertise in the area, this project is examining the feasibility of using biocementation through MICP as an erosion countermeasure.

Project Plans: The rainfall simulator will be tested.

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

Bethany Stich, PhD

University of New Orleans

March 2018-February 2019

Accomplishments: 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. While the Trump administration is taking strides to loosen policy set by the Federal Energy Regulatory Commission (FERC) in order to streamline U.S. LNG export facility permitting, UNOTI has reasoned that policy focused too heavily on LNG as an export is misguided. A more robust energy policy acknowledges the higher value of natural gas to the petrochemical manufacturing industries as well as the development and commercialization of new LNG technologies in the maritime industry, particularly as a marine fuel.

An overview of the anticipated effect of FERC regulatory changes as a result of new commission appointees in 2017 on the state of LNG export facility and shale play pipeline permitting in the US has been completed. In addition, an analysis of the anticipated growth and value of LNG as a marine fuel as well as water and shore side LNG fuel bunkering to US coastal and river system port facilities has been completed.

Project Plans: Evidence-based analysis highlighting the value of Short Sea Shipping as a transportation alternative to pipelines and trucking as it relates to the natural gas and LNG industry and its potential effects on the US roadway, trucking and maritime systems is in progress. Preliminary finding will be presented at the 2018 TRB annual conference.

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

Sadik Kahn, PhD, PE

Jackson State University

September 2018-August 2018

Project Plans: The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. Each year, fixing the pavement requires significant maintenance budget of MS DOT. Due to the shrinkage and swelling behavior of the Yazoo clay, the hydraulic conductivity varies over the different season and has higher vertical permeability during the dry season. With high vertical permeability, the rainwater can easily percolate in the pavement subgrade, which accelerates the failure. Moreover, for the existing pavements on top of Levee, changes in the hydraulic permeability opens the top of the levee, which creates an easy passage for rainwater to saturate the levees. However, no study is available on the change in hydraulic permeability of Yazoo clay soil. The current study intends to conduct basic research to investigate the change in unsaturated vertical and horizontal permeability and its effect on the maritime and multimodal infrastructures such as pavement subgrade's moisture variation.

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

Gary Prinz, PhD, PE

University of Arkansas

August 2018-August 2020

Project Plans: This research project will address multi-mode fatigue cracking within critical lock gate pintle locations. The lock gate pintle is a ball-and-socket joint that is crucial for proper gate operation but is subject to frequent fatigue cracking. Fatigue crack repair within pintle locations

is particularly challenging due to the complex multi-axial loading conditions (combined axial and torsional loads) that occur during gate opening and closing. The project proposed herein will analytically investigate multi-axial stress demands within common pintle geometries during operation, and develop bonded fiber reinforced polymer (FRP) retrofits capable of controlling multi-mode fractures (fractures that originate from both tensile and shear stresses).

Trade-Off Analytics for Infrastructure Preservation

Greg Parnell, PhD

Ed Pohl, PhD

University of Arkansas

August 2018-August 2019

Project Plans: The objective of this project is to develop a course that can 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 be packaged into a webinar that could be delivered on-line for practicing professionals. This course will build on existing best practices defined by the International Council on Systems Engineering. The course builds on ongoing work that uses Value Focused Thinking (VFT) and Multiobjective Decision Analysis (MODA) to structure complex program portfolio decisions requiring trade-offs between stakeholder objectives. The course will focus on identifying stakeholders, framing decisions, developing objectives and value measures, generating alternatives, prioritizing the objectives, developing a value model, developing a cost model, evaluating alternatives, analyzing the model, making meaningful trades between cost, value and risk, and communicating the results. The course will build their cases and examples based on the types of problems and trade-offs current maritime engineers are facing with their infrastructure and 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, PhD

Michelle Bernhardt-Barry, PhD, PE

University of Arkansas

August 2018-August 2020

Project Plans: The health and performance of maritime transportation infrastructure is critical to the nation's economic and social prosperity. Much of this infrastructure has well exceeded its 50-year design life and is often in need of repair. Because waterway transportation structures are difficult to detour, the time taken by repairs is of critical importance. The fastest repair techniques should be developed in order to minimize the time out of service. The objective of this research is to investigate the properties and behavior of Calcium Sulfoaluminate-Belite (CSA) cement mixtures for waterway repair applications.

1.2.3 Disaster Response and Transportation Planning for Coastal and River Valley Communities Projects

Development and Implementation of Sustainable Transportation Resilience Indicators

Mark Abkowitz, PhD

Vanderbilt University

June 2017-August 2018

Accomplishments: The intent of this project is to establish a protocol and method for evaluating a community's level of sustainable transportation resilience, such that if deficiencies exist, attention can be focused on mitigating those concerns. The protocol and method will be subsequently applied to a river valley community to demonstrate proof-of-concept.

Project Plans: Next steps in this project are to: Develop a list of sustainable transportation resilience indicators applicable to communities at risk from natural disaster events. Identify a case study area that is representative of flood risk (e.g., downstream community with high population density on the inland waterway system that is protected by an earthen levee that is frequently threatened by overtopping). Measure the level of sustainable transportation resilience in the case study area using the developed indicators.

Interdependency of Port Clusters during Regional Disasters

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-December 2018

Accomplishments: The research seeks to build upon the prior knowledge and expand the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The contribution of this research is to empirically show how port clusters rely upon each other during disruptive events to increase the overall resiliency of water bourn commerce during disruptive events. During this reporting period, the team conducted the literature review and began to prepare the experiment. The team also contacted a vendor (marinetraffic.com) to purchase the data needed for the study.

Project Plans: The contribution of this research is to empirically show how port clusters rely upon each other during disruptive events to increase the overall resiliency of water bourn commerce during disruptive events.

Utilizing Graceful Failure as an Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

May 2018-April 2019

Accomplishments: In 2011, we observed how "graceful failure" through planned damages to the Birds Point Levee by the US 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. Recent trends and future climatic projections indicate that we will have more of these "extreme" flooding situations in our future.

Project Plans: The project has 4 phases. The first phase is focused on data collection and analysis to develop the criterion for site selection with opportunities for stakeholder input. The second phase is a screening-level analysis using the available data and criterion to develop a list of probable sites to evaluate. The third phase involves a drill down evaluation of each site's

terrain, land use type, nearby population centers, available acreage for flooding, elevation, current infrastructure, and levee characteristics (as available). The final phase includes documentation of the project methodology and findings as both a final report and peer reviewed journal paper for publication. We anticipate that the results will be presented at an appropriate conference.

Visualizing Sea Level Rise Impacts in Transportation Planning

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-December 2018

Accomplishments: The goal of this research is to test and compare new technologies in community-meeting settings in South Florida to assess the effectiveness of 3D visualization technology on improving residents' understanding of the impacts of sea level rise on their communities and the transportation infrastructure. During this reporting period, the research team completed the literature review on the use of 3D virtual and augmented reality in community planning and transportation planning. In addition, the content for the community meetings, including the 2D and 3D media, and post-surveys were developed. The community meetings are currently being planned.

Project Plans: The Team will host multiple meetings of neighborhoods facing impacts over the next 5-20 years from sea level rise. Some of the meetings will use traditional methods, such as verbal presentations and 2D mapping and visualizations whereas other meetings will include 3D technologies to visualize the impacts of sea level rise on their streets. Attendees will be surveyed immediately after the meeting and 3 – 4 months after the meeting to determine if the 3D visualization technologies have had a significant impact on the meeting attendees to have a deeper understanding of the issues and become more engaged in community planning activities.

Exposure to STEM: Diversity in Maritime Transportation

Rick Coffman, PhD, PE

University of Arkansas

August 2018-August 2019

Project Plans: 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.

Informing Post Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks

Sarah Nurre, PhD

Kelly Sullivan, PhD

Ben Runkle, PhD

University of Arkansas

August 2018-August 2020

Project Plans: Agriculture supply chains are of utmost importance for the function of society. Agriculture supply chains 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. When functioning, the U.S. transportation network provides a backbone that enables the transport of ag inputs (e.g., chemicals, seeds) and outputs (e.g., raw/processed goods). Our overall aim is to develop the necessary methodology to describe ag-sector and transportation-sector interdependence at the component level (e.g., so as to capture the effect of disruptions to specific transportation links on entities in ag supply chains) and then determine how to best select from available modes for transporting ag commodities and how to most effectively restore transportation infrastructure after a disruption has occurred.

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

Brian Wolshon, PhD, PE, PTOE

Nelida Herrera

Louisiana State University

August 2018-June 2019

Project Plans: 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, for example, unknown road conditions (e.g. road blockages, traffic incidents) and environmental conditions (e.g. implement weather). Therefore, the transportation system plays an integral role in the performance of the evacuation. 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. This research seeks to assess and develop low-cost technologies, strategies and methods to help to maximize resilience practices of coastal and river valley communities within their budget constraints. This research will also assist these communities in their emergency planning efforts.

2. Products

2.1 Publications

Journal Articles

1. Chatterjee, Riya, Baharak Sajjadi, Daniell L. Mattern, Wei Yin Chen, Tetiana Zubatiuk, Danuta Leszczynska, Jerzy Leszczynski, Nosa O. Egiebor, Nathan Hammer, "Ultrasound Cavitation Intensified Amine Functionalization: A Feasible Strategy for Enhancing CO₂ Capture Capacity of Biochar", *Fuel*, (2018), 225, 289-298
2. Chimka, Justin R, Adrian Fernandez De Luis (student) and Grace W McGee (student), "Statistical Effects of Waterway Lock Unavailability and Commodity Flow," *Quality Technology and Quantitative Management* (under review)
3. Delgado-Hidalgo, Liliana, and Heather Nachtmann "A Heuristic Approach to Managing Inland Waterway Disruption Response," *Engineering Management Journal* (under review)
4. Delgado-Hidalgo, Liliana, Chase Rainwater, and Heather Nachtmann, "A Computational Comparison of Cargo Prioritization and Terminal Allocation Problem Models," *Computers & Operations Research* (under review)
5. Gedik, Ridvan, Gokhan Egilmez, Chase Rainwater, Kenneth Ned Mitchell, and Heather Nachtmann, "A Perspective on Scheduling Optimization for Maintenance Dredging of the U.S. Marine Transportation System." *Transportation Research Part E: Logistics and Transportation Review* (under review)
6. Gillespie-Marthaler, Leslie (student), Kahterine S. Nelson (student), Hiba Baroud, David S. Kosson and Mark Abkowitz (2018), "An Integrative Approach to Conceptualizing Sustainable Resilience", *Sustainable and Resilient Infrastructure*, DOI: 10.1080/23789689.2018.1497880
7. Khan M. S., J. Ivoke, M. Nobahar, S. Samir, and P. Stanley, "Impact of Wet-Dry Cycles on the Stability of Highway Slope Made of Yazoo Clay" *Transportation Research Record: Journal of Transportation Research Board*, Washington D.C., (under review)
8. Khan M. S., M. Nobahar, J. Ivoke, and F. Amini, "Progressive Change in Stability of a Highway Slope Made of Yazoo Clay," *Transportation Research Record: Journal of Transportation Research Board*, Washington D.C., (under review)
9. Khan M. S., M. Nobahar, J. Ivoke, and F. Amini, "Rainfall Variation Effect on Slope Made of Expansive Yazoo Clay Soil," *Transportation Infrastructure Geotechnology* (under review)
10. Miao, Q. (student), Y. Li, X. Wang, 2018, "A Generalized Decomposition Algorithm for Real-time Truck Routing Problems", *Pesquisa Operacional*, Brazilian Operations Research Society, (accepted)
11. Price, J., J Datta, B. Mofarraj Kouchaki, Michelle Bernhardt-Barry, Clint Wood, "Predicting Soil Type from Non-destructive Geophysical Data Using Statistical Methods," *Engineering Geology*, (under review)
12. Price, J., J. Datta, Michelle Bernhardt-Barry, Clint Wood, "Bayesian Shrinkage and Selection for Supervised Classification of Soil-type from Resistivity Data," *Statistics and Its Interface*, (under review)
13. Tarhuni, Abir, "What Impacts Policies for Parks and Open Spaces to Achieve their Goals," *SECoPA 2018* (under review)
14. Tong, Jingjing and Heather Nachtmann, "A Tabu Search Approach to the Cargo Prioritization and Terminal Allocation Problem," *International Journal of Shipping and Transport Logistics*, (accepted)

15. Wang, X., K. Yin (student), and H.X. Liu, 2018, "Vehicle Actuated Signal Performance under General Traffic at an Isolated Intersection", *Transportation Research Part C: Emerging Technologies*. 95 582-598
16. Wang, X., Y. Li, L. Quadrioglio and K. Yin (student), 2018, "Distribution Product Packaging to Maximize the Net Revenue." *Computers & Industrial Engineering*, (accepted)

Conference Papers

1. Gong, H., S. Dent, F. Wang, and B. Zhou. "Application of Random Effects Negative Binomial Models with Clustered Dataset for Vehicle Crash Frequency Analysis", TRB meeting. August 2018, (under review)
2. Guang Tian and Maryam Izadi (student), "Does Bicycle Infrastructure Help to Increase Ridership", A case of the city of New Orleans, 2019 TRB annual meeting, (under review)
3. Guang Tian, "Internal Traffic Generated by Mixed-use Developments", 31-region study using consistent built environment measure, 2019 TRB annual meeting, (under review)
4. Khan M. S., J. Ivoke, M. Nobahar, and G. Kibria, "Effect of Wet-Dry Cycle on the Void Ratio of Expansive Yazoo Clay Soil", *Geo-Congress*, 2019, (accepted)
5. Khan M. S., J. Ivoke, M. Nobahar, and G. Kibria, "Progressive Change in Shear Strength of Yazoo Clay Soil", *Geo-Congress*, 2019, (accepted)

Conference Presentations

1. Abkowitz, Mark, "Building Community Resilience and Adaptive Capacity Using an Integrated Assessment Framework", *Adaptation Futures* 2018, June, 2018
2. Allen, Maddy (student), "Flood Scenario Modeling", *Vanderbilt Undergraduate Research Poster Session*, August, 2018
3. Burton, M., C. Philip, T. Black, 2018, "Estimating the Supply Chain Impacts of Maritime System Disruptions, *International Transportation and Economic Development Conference*" (I-TED), Washington, DC
4. Delgado Hidalgo, Liliana (student speaker), Heather Nachtmann, and Chase Rainwater, "Dantzig-Wolfe Decomposition Approach to Inland Waterway Disruption Routing," *Industrial and Systems Engineering Research Conference*, May, 2018
5. Ebersole, Bruce, Thomas Richardson, and Robert Whalin, "Omission of a Western Dike Section in the USACE Tentatively Selected Plan (Alternative A) Leads to an Increase in Storm Surge, Inundation, and Flood Risk throughout the Houston-Galveston Region" , 10th Annual Texas Hurricane Conference, University of Houston, August, 2018, Houston, TX
6. Kermanshah, A., H. Baroud, and M. Abkowitz, "Cyber-Physical Applications for Maritime Freight Transportation Systems", *Fifth Biennial Marine Transportation System Research and Technology Conference*
7. Nachtmann, Heather, "Women in Engineering Management Panel," *Industrial and Systems Engineering Research Conference*, May, 2018 (invited talk)
8. Philip, C. and D. Calhoun, 2018, "Consequences of an Interrupted Supply Chain: Measuring Shipper Impacts", *IMX Inland Marine Expo*, St. Louis, MO
9. Philip, C. and M. Burton. 2018 "Network Consequences of Local Disruption: Measuring Shipper Supply Chain Impacts", *PIANC World Congress*, Panama City, Panama
10. Philip, C. and M. Burton, 2018, "Measuring the Network Impacts of Local Disruptions: An Inland Waterways Case Study", *CMTS R&D Conference*, Washington, DC
11. Philip, C. and P. Johnson, "The Maritime Safety Journey: An Unlikely and Remarkable Story, *Marine News*", May, 2018

12. Prinz, Gary, "Controlling Fatigue and Fracture in Steel and Composite Structures During Extreme and Repeated Loading," Zurich, Switzerland, August, 2018 (invited talk)
13. Prinz, Gary, "Methods and Results from Lock Gate Fatigue Retrofit Strategies", US Army Corps of Engineers (ERDC), August, 2018
14. Stefanko, Ana Uroic (student), Danuta Leszczynska, " Evaluation of FTIR Spectra of Biochar Produced from Material Collected at Different Locations", Southern School on Chemistry and Engineering August, 2018, Oxford, MS
15. Stefanko, Ana Uroic (student), Danuta Leszczynska, "Alteration of biochar material to fit environmental applications", Modeling & Design of Molecular Materials 2018, June, 2018 (poster), Poland
16. Stefanko, Ana Uroic (student), Danuta Leszczynska, "Physiochemical assessment of pine straw and corn leaves-derived biochar and its efficiency of removal pollutants from stormwater and surface water", Conference, USBI Biochar 2018, August, 2018, Wilmington, DE
17. Stich, Bethany, MS ASCE Section Meeting, Vicksburg, MS, LECTERN Presentation Title: "Impact of Wet-Dry Cycles on the Stability of Highway Slope Made Of Yazoo Clay Soil", September, 2018
18. Stich, Bethany, Seminar for the Paulson Institute Mayor Training Program, Inspiration Management Consulting (Bejing) Co. Ltd., New Orleans, LA, September, 2018.
19. Stich, Bethany, "Panama Canal and Gulf Coast Energy Transportation", Panama Workshop in conjunction with Universidad Technologica de Panama, Panama City, Panama, September, 2018. (Invited)
20. Tong, Jingjing, Heather Nachtmann, and Justin Chimka, "Inland Waterway Disruption Response under Uncertain Conditions," Industrial and Systems Engineering Research Conference, May, 2018

Books/Other One-Time Publications

- Lindell, M., Murray-Tuite, P., Wolshon, B., and Baker, E. Large-Scale Evacuation: The Analysis, Modeling, and Management of Emergency Relocation from Hazardous Areas. 1st Edition, 2018, Publisher: CRP Press, In Print
- Renne, J., Wolshon, B., Murray-Tuite, P., Pande, A., Kim, K. Creating a Resilient Transportation System: Policy, Planning and Implementation, In Progress
- Nachtmann, Heather, "Contributions of Women to Multimodal Transportation Systems," Women in Industrial and Systems Engineering (1st Edition; Switzerland: Springer, TBD). (accepted)
- Delgado-Hidalgo, Liliana, "Barge Prioritization, Assignment, and Scheduling During Inland Waterway Disruption Response," University of Arkansas Dissertation, August 2018.

2.2 Websites

Website Title	Web Address
MarTREC	http://martrec.uark.edu/
Institute for Multimodal Transportation	http://www.jsums.edu/imtrans/
Gulf Coast Center for Evacuation and Transportation Resiliency	http://www.evaccenter.lsu.edu/
Merritt C. Becker Jr. UNO Transportation Institute	http://transportation.uno.edu/
Texas A&M Transportation Institute	https://tti.tamu.edu/
Vanderbilt Center for Transportation and Operational Resiliency (VECTOR)	http://www.vanderbilt.edu/vector/

2.3 Technologies or Techniques

Nothing to report

2.4 Inventions

Nothing to report

2.5 Other Products

Nothing to report

3. Participants & Collaborating Organizations

3.1 Collaborative Partnerships

Existing Partnership Name	Location	Collaboration
US Army Corps of Engineers	Vicksburg, MS	research collaborator
Dr. John Renne, Florida Atlantic University	Boca Raton, FL	research collaborator
Port of New Orleans International Freight Forwarders & Customs Brokers Assn. of New Orleans World Trade Center Transportation Committee Ports Assn. of Louisiana GNO Port Safety Council Propeller Club of New Orleans New Orleans Regional Planning Commission MS Valley Trade & Transport Port of South LA Port of Plaquemines Coastal Cargo Triple G. Express Jefferson Transit Regional Innovation Alliance.	New Orleans, LA	Industry networks
TN Department of Transportation TN Department of Economic and Community Development American Bureau of Shipping	TN	research collaborator
ISL, Germany	Germany	software
National Marine Transportation Center	Wuhan, China	resource
Dr. Scott Parr, Embry-Riddle Aeronautical University	Florida	research collaborator
Christine Lozano/ERDC - Information Technology Laboratory Dr. Guillermo A. Riveros, P.E./ERDC Dr. Kenneth Mitchell/ERDC - Coastal and Hydraulics Laboratory Dr. Simon R. Goerger/ERDC - Institute for Systems Engineering Research Dr. Stanley Woodson/ERDC Graduate Institute	Vicksburg MS	research collaborator

Deidre Smith, Executive Director, AR Waterways Commission, Little Rock, AR	AR	research collaborator
Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University, Cape Girardeau, MO	MO	research collaborator
Chad Johnston, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Arkansas District	AR	research collaborator
Glenn Moore, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Oklahoma District	OK	research collaborator
Dr. Furkan Oztanriseven, Assistant Professor of Data Analysis, LeMoyne College	NY	research collaborator

New Partnership Name	Location	Collaboration
Dr. Mohammad Barik, a researcher in University Space Research Association (USRA)	AL	research collaborator
Professor Ming Zhong, Wuhan University of Technology in China, Director of Intelligent Transportation System Center	China	research collaborator
YouthForce NOLA	New Orleans, LA	Outreach Activity
Supply Chain Transportation Council	Baton Rouge, LA	Industry networks
University of Memphis, Tennessee Department of Economic and Community Development, Federal Emergency Management Agency	TN	research collaborator
Dr. Marek Jozwiak	Poland	research collaborator
Dr. Shahadat Hossain, Professor, Department of Civil Engineering, UT Arlington	TX	research collaborator
Henry Liu, Professor at Civil Engineering, University of Michigan, Ann Arbor	MI	research collaborator
National Waterway Foundation	DC	resource

4. Impacts

4.1 Principal Disciplines

Nothing to report

4.2 Other Disciplines

Nothing to report

4.3 Human Resources (Transportation Workforce Development)

K-12 Programs

1. Discover Engineering explores the many exciting areas of engineering while participating in fun hands-on activities. This camp offers a non-residential week-long program designed specifically for students who have just completed 5th and 6th grade. 13 attendees
2. Explore Engineering provides an opportunity for students to explore different fields of engineering around a central theme through a variety of engaging, hands-on activities. This is a non-residential week long program for students who have just completed the 7th or 8th grade. 23 attendees
3. GirlTREC - hosted 15 fifth and sixth grade girls for one week in July at our GirlTREC summer camp. 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.
4. Inside Engineering camps offered to students who have just completed 5th through 8th grades. During this non-residential, week long, full day program students will have the opportunity to apply engineering concepts from multiple fields to a real world problem. 81 attendees
5. Soaring High in Engineering (SHE) is a girls only camp developed specifically for young women who have just completed 7th and 8th grades. During this full day camp, attendees participate in engaging, hands-on activities designed with a real world theme to expose them to everything a girl can do as an engineer. 40 attendees
6. The Engineering Summer Academy (ESA) is a one-week residential engineering academy for students who have recently completed 9th, 10th, or 11th grade. This intensive summer academy provides students with the opportunity for in-depth exploration into a concept that crosses engineering disciplines. 67 attendees
7. 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
8. The Mississippi Transportation Institute (MSTI) Program 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 programs prime sponsor is MSDOT and one of the co-sponsors is MarTREC. July 8-27, 2018
9. UNO Transportation Institute five week Internship with "YouthForce NOLA", 2 high school students, 6/25/18 - 7/27/18
10. Xploration Camp Inspiring Tomorrow's Engineers (XCITE) summer camp; July 2018; 37 female students; LSU campus. The session consisted of a hands-on activity in which the students planned, designed and built a city using toothpicks and gummies. The students also used paper roads to create a transportation system that provided accessibility and connectivity.

4.4 Physical, Institutional, and Informational Resources

Leadership Positions

1. Advisory Council for Transportation Research Member, ARDOT
2. Chair, AISC Methods of Design Committee
3. Chair, Freight Modeling Subcommittee, AT015 TRB
4. Chair, TRB Special Task Force on Climate Change
5. Co-advisor, Institute of Transportation Engineers Student Chapter at LSU
6. Committee Member, ASCE Infrastructure Resilience Division
7. Faculty advisor, UofA chapter of the Institute of Industrial and Systems Engineers
8. Group Chair, Marine Transportation Research Board
9. Member, Advisory Council for Transportation Research, ARDOT
10. Member, AISC Fatigue and Fracture Committee
11. Member, ASCE Committee for American's Infrastructure
12. Member, Lt. Gov.'s Port Advisory Board
13. Member, Marine Transportation System National Advisory Committee
14. Member, Supply Chain Transportation Council, Baton Rouge LA
15. Member, Transportation Research Board, Technical Advisory Council
16. Member, TRB Intermodal Freight Committee
17. Member, TRB Logistics of Disaster Committee
18. Membership Coordinator, TRB Inland Waterway Committee
19. Past President, American Society for Engineering Management
20. President, Society for Reliability Engineers
21. Representative, INFORMS Subdivisions Council
22. Sub-committee chair, ABG20- Transportation Training and Education
23. Technical Member, TRB AFP 30 Soil and Rock Properties Committee
24. Treasurer, Ocean and Marine Division, American Society for Engineering Education
25. US representative, World Association for Waterborne Transport Infrastructure (PIANC) Task 193
26. Vice Chair, Engineering Infrastructure Specialty Group, Society for Risk Analysis
27. Vice Chair, Geo-Institute Soil Properties and Modeling Technical committee
28. Vice President, Geo-Institute Geophysics Committee

Leadership Awards

1. Ben Runkle, NSF CAREER Award, Fall 2018
2. Gary Prinz, NSF CAREER Award, Fall 2018
3. Heather Nachtmann, 2018 Wellington Award, Engineering Economy Division, Institute of Industrial and Systems Engineers, May 2018
4. Janey Camp, Org. of Black Grad. & Pro. Students, Distinguished Faculty Award, May, 2018
5. Janey Camp, Provost Research Studios Award, 2017-2018, Vanderbilt University
6. Kelly Sullivan, NSF CAREER Award, Fall 2018
7. Michelle Bernhardt, NSF CAREER Award, Fall 2018
8. Mohammad Sadik Khan, "2018 Engineer of the Year" , ASCE MS Section
9. Sarah G. Nurre Pinkley, INFORMS Moving Spirit Award, 2018

4.5 Technology Transfer

Transfer of Results

- Vanderbilt University, Influencing the development of resilience programs within State DOT

Technical Brief

- Jim Kruse, Dong Hun Kang, Ph.D., David L. Schrank, Ph.D., William L. Eisele, Ph.D., P.E., PMP, "Developing and Implementing a Port Fluidity Performance Measurement Methodology Using Automatic Identification System (AIS) Data", September 2018

Project Deliverables

1. Final Report, TTI, *Economic Impact of the Gulf Intracoastal Waterway on the States It Serves*
2. Vanderbilt University, GIS datasets collected/created as part of the levee project

Editorial Journal Positions

1. Advisory board member, Transportation research Part E: Logistics Review
2. Area Editor, The Engineering Economist
3. Area Editor, Transportation Research D, Journal of Transportation Safety System Security
4. Associate Editor, IEEE Transaction on Reliability
5. Associate Editor, Journal of Military Operations Research
6. Associate Editor, Journal of Risk and Reliability
7. Associate Editor, Operations Research Letters
8. Co-Editor, Journal of Engineering Management
9. Editorial Board, Stochastics and Quality Control
10. Editorial Board, Systems and the IEEE Transaction on Engineering Management
11. Editor-in-Chief, Engineering Management Journal
12. Reviewer, Transportation Research Part D: Transport and Environment

4.6 Society beyond Science and Technology

Distinguished Lectures

1. Brian Wolshon, *Resilience Overview: Transportation Perspectives*, 2018 Pacific Risk Management 'Ohana (PRiMO) Conference, August 2018, Honolulu, HI, 40 attendees.
2. D. Leszczynska, *Development of Nanosensors Based on Graphene*, plenary speaker at the conference Modeling & Design of Molecular Materials 2018, June 2018, Poland, 200 attendees.
3. Dan Flowers Distinguished Lecture, Melissa Tooley, PhD, PE, *Preparing for Automated and Connected Vehicles*, April 2018, 150 attendees.
4. R. L. Dupont, Michelle Ganon, James Amdal, Peter Webb, *Rise of the Riverfront: The 300 Year Story*, May 2018, University of New Orleans, 50 attendees.
5. Elisabete Silva, Reader of Spatial Planning at University of Cambridge, 8 attendees.
6. Nelida Herrera, Institute of Transportation Engineers (ITE) Student Chapter meeting, September 2018, 20 LSU junior/senior students attendees.
7. Nelida Herrera, *Quantifying Resiliency of Marine Transportation Systems*, 2018 Pacific Risk Management 'Ohana (PRiMO) Conference, August 2018, Honolulu, HI, 40 attendees.
8. Scott Boyle, *Real Life Experiences of an Operations Engineer*, September 2018, 20 attendees.
9. Stosh Kozlowski, *The Future of Transit in the Era of Big Data*, September 2018, 20 attendees.

5. Changes/Problems

The MarTREC partners developed and submitted an approved Technology Transfer Plan to the Office of the Assistant Secretary for Research and Technology, USDOT on August 10, 2018.

6. Special Reporting Requirements

Nothing to report