USDOT Tier 1 University Transportation Center

Program Progress Performance Report #10

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Project Title: Maritime Transportation Research and Education Center (MarTREC)

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Signature:

Maritime Transportation Research & Education Center (MarTREC)

MarTREC is a USDOT Tier 1 University Transportation Center funded in September 2013 under MAP-21. Our consortium consists of the University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; and University of New Orleans (UNO), New Orleans, LA. Each institution is strategically located to support the MarTREC theme and consists of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development.

MarTREC's theme is building economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research
Goal: MarTREC will conduct research that contributes to building economic competitiveness through efficient, resilient, and sustainable maritime and multimodal transportation systems.
Objectives:
R1) Conduct research projects related to MarTREC's research goal
R2) Engage a diverse set of faculty and students in MarTREC research activities
R3) Disseminate research findings

Accomplishments:

Metric	Achieved PPPR#10	Objective Addressed
# of ongoing projects in all MarTREC research area	7	R1
# of peer-reviewed journal articles (published, accepted, submitted)	15	R3
# of conference presentations	10	R3
# of tenure track faculty who conduct MarTREC research activities	13	R2
# of external partners involved in center research activities	27	R3
# of research activities that impact diversity through participants and/or outcomes	7	R2
# of UG/G students participating in transportation research projects funded by UTC	22	R2
# of MS/PhD transportation-related advanced degree programs	8	R2
# of MS/PhD graduate students supported by MarTREC	12	R2
# of MS/PhD students supported by MarTREC who received degrees	7	R3

1.1.2 Leadership
Goal: MarTREC will become the premier source for expertise on maritime transportation research, education, and workforce development.
Objectives:
L1) Demonstrate academic leadership towards MarTREC's leadership goal
L2) Demonstrate industry leadership towards MarTREC's leadership goal

Accomplishments:

Metric	Achieved PPPR#10	Objective Addressed
# of national and regional leadership positions held	11	L1
# of conference planning positions held	10	L1
# of invited talks given	2	L1
# of leadership and research awards received	4	L1
# of impactful research citations by stakeholders	0	L2
# of UG/G students participating in transportation research projects funded by UTC	22	L1
# of junior faculty mentored	2	L1
# of leadership workshops held	0	L2
# of external grant proposals submitted	4	L2

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:

EWD1) Conduct education and workforce development (EWD) projects related to the goal
EWD2) Educate college students within MarTREC theme
EWD3) Conduct workforce development related to MarTREC theme
EWD4) Conduct outreach activities related to MarTREC theme

Accomplishments:

Metric	Achieved PPPR#10	Objective Addressed
# of projects in MarTREC educational and workforce development areas	0	EWD1
# of UG/G transportation-related courses associated with UTC	33	EWD2
# of distinguished lectures & seminars offered	1	EWD3
participant count of distinguished lectures & seminars offered	150	EWD3
# of short courses and workshops offered	6	EWD3
participant count of short courses and workshops offered	113	EWD3
# of *times* technician certification programs are offered	22	EWD3
participant count of technician certification programs offered	393	EWD3
# of educational modules and case studies developed	0	EWD2
# of student-authored publications	3	EWD2
# of student-presented presentations	2	EWD2
# of K-12 programs offered	22	EWD4
participant count of K-12 programs (events) offered	352	EWD4
% of female participants in K-12 programs	40%	EWD4
% of minority participants in K-12 programs	60%	EWD4
# of pre-college programs offered	42	EWD4
participant count of pre-college programs offered	2272	EWD4
# of online K-12 educational resources posted	1	EWD4

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:

TT1) Transfer MarTREC outcomes into practice

TT2) Develop products in support of MarTREC technology transfer goal

Accomplishments:

Metric	Achieved PPPR#10	Objective Addressed
# of peer-reviewed journal articles (published, accepted, under review)	15	TT2
# of conference presentations	10	TT2
# of technical briefs	0	TT2
# of guidebooks	0	TT2
# of short courses and workshops offered	6	TT1
participant count of short courses and workshops offered	113	TT1
# of conference planning positions held	10	TT1
# of editorial journal positions held	3	TT1
# of technician certification *programs* offered	22	TT1
participant count of technician certification programs offered	393	TT1

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:

C1) Develop external partnerships related to MarTREC's collaboration goal

C2) Develop collaborative products related to MarTREC's collaboration goal

C3) Engage faculty and students in achieving MarTREC's collaboration goal

Accomplishments:

Metric	Achieved PPPR#10	Objective Addressed
# of collaborative partnerships formed	27	C1
# of collaborative activities conducted	7	C2
# of collaborative deliverables completed	7	C2
# of collaborative team events	2	C1
# of collaborative outreach events held	2	C2
# of faculty involved in collaborative activities	13	C3
# of students involved in collaborative activities	22	C3

1.1.6   Plans for Next Reporting Cycle

This is our last reporting cycle on this grant. The faculty researchers engaged with industry experts to ensure that these projects are making transformational contributions, and the consortium expanded our collaborative partnerships to support this. We emphasized educational, workforce development, and technology transfer activities throughout the life of the grant. Our 2018 annual Advisory Board meeting is planned for November 16, 2018.

1.2 Project-Level Accomplishments

MarTREC had seven active research projects during this reporting period. All projects were completed.

1.2.1 Maritime and Multimodal Logistics Management Projects

Dynamic Decision Modeling for Inland Waterway Disruptions
Shengfan Zhang, Ph.D.
Heather Nachtmann, Ph.D.
August 2014-December 2016
Accomplishments: Collected and studied lock and dam closure reports, with a focus on unscheduled, weather-related disruptions. Reasons for closure and duration of disruptions were recorded. A Markov Decision Process (MDP) model was developed from the barge owner perspective that considers the uncertainty in the status of the closed or partially closed lock and dam as well as the traffic and safety status of barges remaining on the waterway.
Completed project: Conducted by U of A, this project was completed in December 2016. Final project report was submitted on time and distributed as per grant guidelines.

Economic Impacts of Lock Usage and Unavailability
Justin Chimka, Ph.D.
August 2014-June 2016
Accomplishments: The research objective is to estimate annual tons locked by commodity group and lock, as a function of lock usage and unavailability (1993-2013). Results include effects of lock usage and unavailability on tons locked by commodity group. 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 practically appropriate according to our definitions of those characteristics. We are currently extending the project to study Climate Impacts on Lock Use and Performance.
Completed project: Conducted by U of A, this project was completed in June 2016. Final project report was submitted on time and distributed as per grant guidelines.

Efficient Dredging Strategies for Improving Transportation Infrastructure Resilience
Kelly Sullivan, Ph.D.
August 2014-December 2016
Accomplishments We developed an optimization model for this problem that incorporates uncertainty due to unpredictable amount of budget required for emergency dredging. Our mathematical model was used to explore inland dredging strategies that are efficient with respect to cost and ensuring minimum disruption to freight transportation. We produced a case study that illustrates the application of our model to the U.S. inland waterway network. We showed how our model and algorithms could be used at a variety of resource levels to allocate district maintenance budgets. These results demonstrated the tradeoff between available maintenance budget and system-wide performance.
Completed project: Conducted by U of A, this project was completed in December 2016. Final project

report was submitted on time and distributed as per grant guidelines.

Multimodal Transport and TransLoad Facilities in Arkansas
Justin Chimka, Ph.D.
July 2014-December 2014
Accomplishments: This project is based on the theory regional and short line railroads are underutilized, and a key to unlocking greater economic value in Arkansas is additional TransLoad Facilities that enable Multimodal Transport. Determined what should be the locations and capabilities of additional facilities, and producing a guidebook for people interested in developing a TransLoad Facility.
Completed project: Conducted by UA, this project, funded by the Arkansas Economic Development Commission as a MarTREC match project, was completed in January 2015. Final project report was submitted on time and distributed as per grant guidelines.

Regional Economic Impact Study of the McClellan-Kerr Arkansas River Navigation System
Heather Nachtmann, Ph.D.
April 2014-August 2015
Accomplishments: The project implemented a multiregional social accounting matrix framework to estimate the economic impacts of the McClellan-Kerr Arkansas River Navigation System (MKARNS) 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.
Completed project: Conducted by UA, this project, funded by the Arkansas State Highway and Transportation Department as a MarTREC match project, was completed in August 2015. Final project report was submitted on time and distributed as per grant guidelines.

Supporting Secure and Resilient Inland Waterways
Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
August 2014-September 2018
Accomplishments: This project studied cargo prioritization and terminal allocation problem for inland waterway navigation under disruptive response. This problem integrates two decisions, the assignment of the disrupted barges to terminals where the cargo is off-loaded and the scheduling and order in which the barges are served by the assigned terminals. To solve this problem, we developed a decomposition based sequential heuristic (DBSH) that consists of three decision components; a cargo prioritization model, an assignment model, and a scheduling model.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

Supporting Secure and Resilient Inland Waterways Phase Two
Heather Nachtmann, Ph.D.
Justin Chimka, Ph.D.
July 2017-September 2018
Accomplishments: 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. We applied the optimization-simulation CPTAP model to small, medium and large size problem instances. 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.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

1.2.2 Building Resilient and Sustainable Multimodal Infrastructure Projects

Climate Impacts on Lock Use and Performance
Justin Chimka, Ph.D.
July 2016-September 2018
Accomplishments: It is the policy of U.S. Army Corps of Engineers (USACE) to integrate climate change preparedness 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.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability
Gary Prinz, Ph.D., P.E.
Clint Wood, Ph.D., P.E.
July 2016-September 2018
Accomplishments: 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. In this study, 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.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

Development of a Design Protocol: Sustainable Stabilization of Slope using Recycled Plastic Pin in Mississippi
Sadik Khan, Ph.D., P.E.
May 2016-October 2017
Accomplishments: In Mississippi, the shallow slope failure is induced by the climatic (temperature and rainfall) variation that cause shrink-swell behavior of expansive Yazoo clay soil, and require significant budget to repair. As a cost effective alternative, Recycled Plastic Pins (RPP) can be utilized to stabilize shallow slope failures, to offer a sustainable option and increase the economic competitiveness to maintain multimodal transportation infrastructure. The Recycled Plastic Pin (RPP) can be an attractive choice to stabilize the shallow slope failure in Mississippi. The current study investigated the effect of

rainfall on the slope failure, numerically investigates different RPP configuration and developed a design protocol to stabilize Mississippi slopes using RPP.

Completed project: Conducted by JSU, this project was completed in October 2017. Final project report was submitted on time and distributed as per grant guidelines.

Effect of Swell-Shrink Characteristics on Landslides in Yazoo Clay
Mohammad Sadik Khan, PhD, PE
July 2017-June 2018
Accomplishments: Slope failures are frequent in highway embankments as well as in waterway infrastructures (levees) on expansive Yazoo clay in Mississippi, which cause significant maintenance problems and require millions of dollars to fix. After construction, the strength of the high plastic clay degrades due to the seasonal temperature and moisture variation, major factor of slope failure. The test results of the wet-dry cycles investigate the progressive changes of the shear strength and worst-case scenario of the slope failure. This test data will help to identify when the slope failure on expansive soil may occur, which will help to manage their maintenance budget better to restrict/repair slope failure.

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

Evaluating the Performance of Intermodal Connectors
Sarah Hernandez, Ph.D.
August 2016-September 2018
Accomplishments: This project focused on evaluating the performance of Intermodal Connectors (IC) - critical "last mile" roadways connecting intermodal freight facilities such as maritime ports to the National Highway System (NHS). The study identified data gaps that hinder a comprehensive evaluation of the performance of port intermodal connectors (ICs) in Arkansas. 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. The non-intrusive, point-based sensor was coupled with truck GPS data to infer the geographic extent and temporal patterns of each port area serving an inland waterway port in Arkansas. By coupling a sensor capable of providing robust truck classification with truck movement data derived from truck GPS it is possible to fully characterize the usage and performance of ICs and, consequently, inland waterway ports.

Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

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.
July 2014-June 2016
Accomplishments: The goal of this study was to examine the removal of the major heavy metals Cu and Zn in roadway runoffs through PCP and Modified PCP (MPCP) and by adding innovative additives to Open Graded Friction Courses (OGFC) to create a new material that has high heavy metal removal capacities. The results of this study bring an important conclusion that not only can the pervious concrete pavement 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 the sake of environmental protection.

Completed project: Conducted by JSU, this project was completed in June 2016. Final project report was submitted on time and distributed as per grant guidelines.

Identifying High-Risk Roadways for Infrastructure Investment Using Naturalistic Driving Data
Brian Wolshon, Ph.D., P.E.
October 2013-June 2015
Accomplishments: The final report reveals that clusters of high magnitude jerk events while decelerating were significantly correlated to long-term crash rates at these same locations, and 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.

Completed project: Conducted by LSU, this project was completed in June 2015. Final project report was submitted on time and distributed as per grant guidelines.

In-Situ Monitoring and Assessment of Post Barge-Bridge Collision Damage for Minimizing Traffic Delay and Detour
Wei Zheng, Ph.D., P.E.
July 2014-June 2016
Accomplishments: 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.

Completed project: Conducted by JSU, this project was completed in June 2016. Final project report was submitted on time and distributed as per grant guidelines.

Innovative Bio-Mediated Particulate Materials for Sustainable Maritime Transportation Infrastructure
Lin Li, Ph.D. P.E.
November 2015-June 2017
Accomplishments: The primary objective of the proposed research project is to develop bio-mediated particulate materials to enhance the resilience and protection of maritime transportation infrastructure elements. All these results indicate that the bio-mediated particulate material based on MICP can provide an effective solution for problematic cases of sandy soil in the coastal area and beach sands. It is recommended that a pilot scale test be further performed to more closely simulate the real-life durability condition of MICP-treated soils in coastal area.

Completed project: Conducted by JSU, this project was completed in June 2017. Final project report was submitted on time and distributed as per grant guidelines.

LNG Bunkering for Marine Vessels at the Port of New Orleans: Siting and Facility Components
Bethany Stich, Ph.D.
April 2014-January 2016
Accomplishments: 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. The best recommendation 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. As the shipping industry is committed to the

most rapid reduction possible of its share of greenhouse gas emissions, the transfer of the global shipping fleet to LNG is the most efficacious way to attain this end. The Port is best advised to aggressively support an IMO-derived driven global implementation of policies, which would make this fleet conversion more cost effective than continued reliance upon cheap diesel as a marine fuel.
Completed project: Conducted by UNO, this project was completed in January 2016. Final project report was submitted on time and distributed as per grant guidelines.

Optimal Dredge Fleet Scheduling within Environmental Work Windows
Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
August 2014-August 2016
Accomplishments: After initial success with the base model, maritime professionals were intrigued by the use of operations research to aid in their decision process. The potential of the initial tool was met with concern over the fact that many realistic components were not considered. The main impact of this project is that every concern presented by USACE has now been addressed from a modeling perspective. The decision makers now understand that optimization tools can be flexible and extendable and, with the appropriate amount of attention, complex challenges can be modeled.
Completed project: Conducted by U of A, this project was completed in August 2016. Final project report was submitted on time and distributed as per grant guidelines.

Optimal Dredge Fleet Scheduling - Phase 2 Research
Chase Rainwater, Ph.D.
Heather Nachtmann, Ph.D.
August 2016-September 2017
Accomplishments: 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.
Completed Project: Conducted by UofA, this project was completed in September 2017. Final project report is being submitted on time and distributed as per grant guidelines.

Quantifying Resiliency of Maritime Transportation Systems
Brian Wolshon, Ph.D. P.E.
Scott Parr, Ph.D.
October 2015-September 2018
Accomplishments: This research leverages and adapts archival NAIS data for resilience analyses of coastal port operations following disruptive events. As part of this effort, archival vessel position reports will be used to establish a baseline of channel operations under "routine" non-event conditions. Despite efforts to mitigate the risks and effects of catastrophic events, disruptions will continue to cause significant losses to maritime infrastructure and efficiency. For this reason, MTS stakeholders must continue making improvements to the design and operation of port and waterway facilities and their associated infrastructure to minimize losses and maintain functionality in cases of disruption and major disasters. A key aspect in improving system resiliency is the ability to identify robust and objective performance evaluation methods.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

Rapid and Non-Destructive Assessment of Levees for Strength and Liquefaction Resistance
Clint Wood, Ph.D. P.E.
Michelle Bernhardt, Ph.D.
January 2015-June 2017
Accomplishments: A small earthen dam tested using surface wave methods and resistivity in association with Natural Resource Conservation Service (NRCS Overall, the combined use of resistivity and Vs from CCR and surface wave methods provides a rapid and near continuous means to evaluate levees and earthen dams. 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.
Completed project: Conducted by U of A, this project was completed in June 2017. Final project report was submitted on time and distributed as per grant guidelines.

1.2.3 Livability and Emergency Management of Coastal and River Valley Communities Projects

Development of a Large-Scale Traffic Simulation Model for Hurricane Evacuation of Mississippi Coastal Region
Feng Wang, Ph.D., P.E.
July 2014-July 2015
Accomplishments: This project studied improved traffic flow assignment within an evacuation network and indicates that 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 inside the network and improve evacuation performance.
Completed project: Conducted by JSU, this project was completed in July 2015. Final project report was submitted on time and distributed as per grant guidelines.

Evaluating Coastal and River Valley Communities Evacuation Network Performance Using Macroscopic Productivity
Scott Parr, Ph.D.
Brian Wolshon, Ph.D., P.E.
May 2015-May 2017
Accomplishments The simulation of mass evacuation traffic processes, while enormously valuable in emergency planning and management presents a number of challenges to transportation modelers and analysts. In conclusion, it is recognized this theoretical approach can present difficulties in actual practice. To meter demand under an actual emergency condition, evacuee entries into the system would have to be restricted, spatially and/or temporally, to prevent sudden surges in demand from overwhelming the network. As a practical matter, this could present operational and ethical dilemmas because some portion of a threatened population would have to be physically prohibited from fleeing.
Completed project: Conducted by LSU, this project was completed in May 2017. Final project report was submitted on time and distributed as per grant guidelines.

Measurement of Traffic Network Vulnerability for Mississippi Coastal Region
Feng Wang, Ph.D., P.E.
November 2015-July 2017
Accomplishments: Potential critical links related to the flooding surges of a hurricane were identified using a probability distribution approach to obtain the risk of an inundation over a road surface. The links that direct from the non-evacuation area to the evacuation area are less critical than links in the opposite directions, and the links with high redundancy are less critical than the links with low

redundancy. This finding confirms the effectiveness of the traffic control strategies are those that make use of the less utilized highway capacities.

Completed project: Conducted by JSU, this project was completed in July 2017. Final project report was submitted on time and distributed as per grant guidelines.

National Inventory and Analysis of Transit Oriented Development (TOD) in Proximity to Coasts and Port Facilities
John Renne, Ph.D.
October 2013-September 2017
Accomplishments: 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.
Completed project: Conducted by UNO, this project was completed in September 2017. Final project report is being submitted on time and distributed as per grant guidelines.

Quantification of Multimodal Transportation Network Vulnerability: A Pilot Study in Mississippi
Himangshu Das, Ph.D., P.E.
May 2016-April 2017
Accomplishments: There are pressing needs to develop a network based quantification framework to assess vulnerability of multimodal transportation and infrastructure network exposed to both natural and fabricated hazards. We have developed a conceptual quantitative framework and database identifying critical transportation infrastructure and their vulnerability to natural hazards using existing data, modeling while incorporating downscaled climate scenario specific to the Mississippi Gulf Coast.
Completed project: Conducted by JSU, this project was completed in April 2017. Final project report was submitted on time and distributed as per grant guidelines.

Road Sign Recognition during Computer Testing versus Driving Simulator Performance for Stroke and Stroke Aphasia Groups
Neila Donovan, Ph.D.
October 2013-June 2015
Accomplishments: Research results show that post stroke aphasia significantly impacted accuracy and response time of road sign interpretation, and as language and symbol complexity increased on road signs, the aphasia-affected drivers performed with less accuracy and required more time indicating that designers of road signs and healthcare professionals should consider this when making decisions related to when those impacted to safely return to driving.
Completed project: Conducted by LSU, this project was completed in June 2015. Final project report was submitted on time and distributed as per grant guidelines.

Statistical Analysis of Vehicle Crashes in Mississippi based on Crash Data
Feng Wang, Ph.D., P.E.
November 2015-July 2017
Accomplishments: Analysis of the MDOT crash data showed that more than 15% of fatalities occurred in the coastal counties in 2013. The high crash frequencies are generally associated with metropolitan areas. The crash distribution in MDOT districts shows that high crash severity is not correlated with high population density in a metropolitan area. The crashes in rural areas are more severe or fatal than the crashes in urban areas. Similarly compared with Jackson Metro area, crashes in the Mississippi Gulf coastal area are significantly more severe.
Completed project: Conducted by JSU, this project was completed in July 2017. Final project report

was submitted on time and distributed as per grant guidelines.

Vulnerability of Fuel Distribution Systems to Hazards in Coastal Communities
John Pardue, Ph.D., P.E.
May 2015-March 2017
Accomplishments: The combined fueling station and road network constructed for this project is the first spatial representation of this system for a Louisiana coastal parish. While the Louisiana Governor's Office of Homeland Preparedness (GOHSEP) has a GIS-based system with spatial fueling data that can be used in an emergency, it has not been used for any pre-event analysis function. Results presented to the state's Supply Chain / Transportation Council.
Completed Project: Conducted by LSU, this project was completed in March 2017. Final project report was submitted and is being distributed as per grant guidelines.

Predicting Soil Type from Non-destructive Geophysical Data using Bayesian Statistical Methods
Michelle Bernhardt, Ph.D., P.E.
January 2018-September 2018
Accomplishments: In this study, we investigated how well several popular statistical methods (e.g., LDA, Logistic Regression and Decision Trees using Random Forest) predicted soil type using ER, V_s, and other geotechnical parameters. A more variable laboratory data-set was used to determine the most accurate method and then the method was applied to a field (landside) data-set. A supervised learning framework was used in both cases. We applied the logistic regression on the field landside data with 2 soil categories, and 4 different predictors. Although the field data has fewer categories, which makes it an easier classification task, we conjecture that the logistic regression will be able to predict the soil types even with more categories. As stated above, a more variable field site is needed in order to test this conjecture.
Completed project: Conducted by U of A, this project was completed in September 2018. Final project report was submitted on time and distributed as per grant guidelines.

2. Products

2.1 Publications

Journal Articles
1. Asborno, M. and S. Hernandez, "Using Data from a State Travel Demand Model to Develop a Multi-Criteria Framework for Transload Facility Location Planning", Annual Meeting of the Transportation Research Board, Washington D.C., (Forthcoming 2018)
2. Bu, L. (student), F. Wang, X. Zhou, and C. Yin, "Managed Gating Control Strategy for Emergency Evacuation," Transportmetrica A - Transport Science, (under revision)
3. Bu, L., Feng Wang, H. Gong, "Spatial and Factor Analysis of Vehicle Crashes in Mississippi State, Natural Hazards. Vol. No. 94, September 2018, ISSN 0921-030X
   https://doi.org/10.1007/s11069-018-3475-9
4. 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)
5. Delgado-Hidalgo, Liliana, and Heather Nachtmann "A Heuristic Approach to Managing Inland Waterway Disruption Response," Engineering Management Journal (under review)
6. Delgado-Hidalgo, Liliana, Chase Rainwater, and Heather Nachtmann, "A Computational Comparison of Cargo Prioritization and Terminal Allocation Problem Models," Computers & Operations Research (under review)

7. 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)
8. 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)
9. 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)
10. 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)
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. Smith, S., A. Braham, S. Hernandez, and J. Kent, "Development of a Cost Estimation Framework for Potential Transload Facilities", Annual Meeting of the Transportation Research Board, Washington D.C., (Forthcoming 2018)
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. Weike Lu, Feng Wang, Lei Bu, and Lan Liu, "Game Approach to Vulnerability Analysis of Evacuation Highway Networks," ASCE Journal of Transportation Engineer (under revision)

Books/Other One-Time Publications

1. Nachtmann, Heather, "Contributions of Women to Multimodal Transportation Systems," Women in Industrial and Systems Engineering (1st Edition; Switzerland: Springer, TBD) (accepted)
2. Delgado-Hidalgo, Liliana, "Barge Prioritization, Assignment, and Scheduling During Inland Waterway Disruption Response," University of Arkansas Dissertation, August 2018
3. Bu, L., F. Wang, and M. Thomas. "Data Science Method in Analysis of Flood Risk in Mississippi Gulf Coast Area", Book chapter of "Data Science and Digital Business" by Springer. Editors: Fausto Pedro García Márquez and Benjamin Lev (Eds). ISBN 978-3-319-95650-3
4. Grace W McGee, Modeling Commodity Flow as a Statistical Function of Lock Unavailability and Usage, 2018, undergraduate Honors College thesis
5. Adrian Fernandez, Selecting Variables for Inclusion in a Regression Model with Interaction Effects, 2018, Master's project report

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", submitted to 2019 TRB meeting, August 2018 (under review)

2. Karim, M.Z., S. Tucker-Kulesza, C. Rutherford, and Michelle Bernhardt-Barry, "Geophysical Engineering to Identify Seepage Channels in the Hager Slough Levee", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA. Submitted June 2018. (under review)
3. Khan M. S., J. Ivoke, M. Nobahar, and G. Kibria, "Effect of Wet-dry Cycle on the Void Ratio of Expansive Yazoo Clay Soil", (accepted for Geo-Congress 2019)
4. Khan M. S., J. Ivoke, M. Nobahar, and G. Kibria, G, "Progressive Change in Shear Strength of Yazoo Clay Soil", (accepted for Geo-Congress 2019)
5. Koehn, W., S. Tucker-Kulesza, V. Lebow, Michelle Bernhardt-Barry, and Clint Wood, "Enhanced Analysis of Landslide Failure Mechanisms in the Ozark Plateau Region With Near Surface Geophysics", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA. Submitted June 2018. (under review)
6. Rahimi, S., Clint Wood, Michelle Bernhardt-Barry, and A. Kamal Himel, "Updated Reference Shear Wave Velocity Curves for Near-surface Site Characterization", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA. Submitted June 2018. (under review)

Conference Presentations

1. 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
2. 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 Strom Surge, Inundation, and Flood Risk throughout the Houston-Galveston Region", 10th Annual Texas Hurricane Conference, University of Houston, August 2018
3. Karim, M.Z., S. Tucker-Kulesza, C. Rutherford, and Michelle Bernhardt-Barry, "Geophysical Engineering to Identify Seepage Channels in the Hager Slough Levee", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA, June 2018
4. Koehn, W., S. Tucker-Kulesza, V. Lebow (student), Michelle Bernhardt-Barry, and Clint Wood, "Enhanced Analysis of Landslide Failure Mechanisms in the Ozark Plateau Region With Near Surface Geophysics", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA, June 2018
5. Nachtmann, Heather, "Women in Engineering Management Panel," Industrial and Systems Engineering Research Conference, May 2018 (invited talk)
6. Prinz, Gary, "Controlling Fatigue and Fracture in Steel and Composite Structures During Extreme and Repeated Loading," Zurich, Switzerland, August 2018 (invited talk)
7. Prinz, Gary, "Methods and Results from Lock Gate Fatigue Retrofit Strategies, US Army Corps of Engineers (ERDC), August 2018
8. Rahimi, S., Clint Wood, Michelle Bernhardt-Barry, and A. Kamal Himel, "Updated Reference Shear Wave Velocity Curves for Near-surface Site Characterization", Proceedings of 8th International Conference on Case Histories in Geotechnical Engineering, ASCE Geo-Congress 2019, Philadelphia, PA, June 2018
9. Tong, Jingjing, Heather Nachtmann, and Justin Chimka, "Inland Waterway Disruption Response under Uncertain Conditions," Industrial and Systems Engineering Research Conference, May 2018

10. Whalin, Robert W. "A Hurricane Protection System for Houston/Galveston Bay Complex, Southeast Symposium on Contemporary Engineering Topics", Huntsville, AL, 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/

2.3 Technologies or Techniques
Nothing to report

2.4 Inventions
Nothing to report

2.5 Other Products
- Statistical models developed during this MarTREC project to predict soil type.

3. Participants & Collaborating Organizations

3.1 Partnerships

Organization Name	Location	Collaboration
Arkansas State Highway and Transportation Dept.	Little Rock, AR	$40k fund (match project)
Dr. Dennis Phillip Robinson, University of Arkansas	Little Rock, AR	research collaborator
Mr. Gene Higginbotham, Executive Director, AR Waterways Commission	Little Rock, AR	research collaborator
Ms. Deidre Smith, Waterways Manager, ODOT	Muskogee, OK	research collaborator
Mr. Matthew Tyler Henry, Regional Economist at the U.S. Army Corps of Engineer	Muskogee, OK	research collaborator
Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University	Cape Girardeau, MO	research collaborator
Dr. Kenneth Ned Mitchell, US Army Corps Engineer	Vicksburg, MS	research collaborator
Guillermo Riveros, US Army Corps of Engineers,	Vicksburg MS,	guidance on lock gates
Brandi Christian, Donnell Jackson, Amelia Pellegrin	Port of New Orleans	outreach
Kristi App, International Freight Forwarders & Customs Brokers Association	New Orleans, LA	advisory board service
Billy App and Caitlin Cain World Trade Center Transportation Committee	New Orleans, LA	advisory board service
Mr. Chad Johnston, Dept. of Homeland Security	Arkansas District	research collaborator
Mr. Glenn Moore, Dept. of Homeland Security	Oklahoma District	research collaborator
Gary LaGrange, Ports Association of Louisiana	New Orleans, LA	research collaborator
Christine Titus, GNO Port Safety Council	New Orleans, LA	research collaborator

RADM Joel Whitehead, Propeller Club of NO	New Orleans, LA	research collaborator
Dawn Lopez and David Fennelly, Turn Services	New Orleans, LA	Board Service, internships
Sharon Leader, Jefferson Parish Transit	New Orleans, LA	research collaborator
Walter Brooks, Regional Planning Commission	New Orleans, LA	research collaborator
Paul Aucoin, Port of South LA	New Orleans, LA	research collaborator
Randy Guillot, Triple G. Express, Inc.	New Orleans, LA	research collaborator
James Baldwin, Coastal Cargo	New Orleans, LA	research collaborator
Kristin G. Palmer, Super Region Rail Authority	New Orleans, LA	research collaborator
David Scoggin, Global Logistics Expert	New Orleans, LA	research collaborator
Douglas Grubbs, Crescent Port Pilots Assn. (ret.)	New Orleans, LA	research collaborator
Dr. Rick Leuttich and Dr. Gavin Smith, UNC	Chapel Hill, NC	research collaborator
Dr. Sam Brody, Texas A&M University	Galveston, TX	research collaborator

3.2 Other Collaborators

Organization Name	Location	Collaboration
Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University	Cape Girardeau, MO	case study development
Dr. Melissa Tooley, Director, TTI	College Station, TX	center collaborator
Professor Chi Li	Inner Mongolia Institute of Tech.	research collaborator
Associate Professor Changming Bu	Chongqing University of Science & Technology	research collaborator
Associate Professor Fan Liang	Chongqing Jiaotong University	research collaborator
Professor Dong Qian	Chongqing University of Science & Technology	research collaborator
Dr. Helen Chen	Johnson C. Smith University, Greensboro, NC	research collaborator
Dr. Barry Keim	Louisiana State University, Baton Rouge, LA	research collaborator
Dr. Sandra Knight	University of Maryland College Park	research collaborator
Dr. Gavin Smith	University of North Carolina, Chapel Hill, NC	research collaborator
Dr. Ismael Pagan and Dr. Ricardo Lopez	University of Puerto Rico, Mayaguez, P.R.	research collaborator
Dr. Meherun Laiju	Tougaloo College, Jackson, MS	research collaborator
Dr. Sam Brody, Dr. Wes Highfield, Dr. Jens Figlis and Dr. William Merrell	Texas A&M University	research collaborator
Dr. Bas Jonkman	Technical University Delft (TU Delft), The Netherlands	research collaborator
Dr. Shahadat Hossain	Department of Civil Engineering, UT Arlington	research collaborator
Florida Atlantic University	Boca Raton, FL	research collaborator
Dr. Lan Liu, Professor of School of Transportation and Logistics	Southwest Jiaotong University	research collaborator
Dr. Chuanzhong Yin	Shanghai Maritime University	research collaborator

Dr. P.C. Yuan and Dr. Jessica Murphy, Jackson State University	Jackson, MS	research collaborator
Dr. Jeffrey Melby, Engineer Research and Development Center	Novato, CA	Guest Lecturer
Mississippi DOT	Jackson, MS	external evaluator
Dr. Chris Massey and Dr. Norberto Nadal, Engineer Research and Development Center	Vicksburg, MS	Partner in NSF funded PIRE Coastal Flood Risk Reduction.
Dr. Jyotishka Datta,	Assistant Professor of Statistics, Department of Mathematical Sciences, University of Arkansas.	Expert in Bayesian methodology and machine learning.

4. Impacts

4.1 Impacts on Principal Disciplines

Leadership Positions
1. Chair, AISC Methods of Design Committee
2. Member, Advisory Council for Transportation Research, ARDOT
3. Member, AISC Fatigue and Fracture Committee
4. Panel Member, NCHRP Project Panel C01-59
5. Past President, American Society for Engineering Management
6. Sub-committee chair (ABG20- Transportation Training and Education)
7. Subcommittee on STEM Outreach, Institute of Transportation Engineers Diversity and Inclusion
8. Technical Member, TRB AFP 30 Soil and Rock Properties Committee
9. Transportation Research Board Committee Member (ABJ90 - Freight Transportation Data)
10. Treasurer, Ocean and Marine Division, American Society for Engineering Education
11. Vice Chair - Geo-Institute Soil Properties and Modeling Technical committee
12. Vice President, Geo-Institute Geophysics Committee

Leadership Awards
1. Mohammad Sadik Khan, 2018 Engineer of the Year, ASCE MS Section
2. Sarah Hernandez, MOVITE Rising Star Award, Presented at the ITE International Meeting, Minneapolis, MN, August, 2018
3. Magdalena Asborno, 2018 Jan Kibbe Student Scholarship Award from MOVITE, Presented a the MOVITE Fall 2018, Lexana, KS
4. Nachtmann, Heather, 2018 Wellington Award, Engineering Economy Division, Institute of Industrial and Systems Engineers, May 2018

4.2 Impacts on Other Disciplines

Related External Grants
1. Coastal Resilience Center of Excellence, University of North Carolina; Prime for Department of Homeland Security, May 2018

2. Southeastern Transportation Research, Innovation, Development, and Education (STRIDE), University of Florida, prime for Regional University Transportation Center, U.S. Department of Transportation, May 2018
3. Coastal Flood Risk Reduction, Partnership for International Research and Education (PIRE), Texas A&M University at Galveston, Prime for National Science Foundation PIRE project, June 2018
4. PIRE-Coastal Flood Risk Reduction Program: Integrated, Multi-scale Approaches for Understanding How to Reduce Vulnerability to Damaging Events, June 2018

4.3 Impacts on Human Resources and Workforce Development

K-12 Programs
- The University of Arkansas Office of Recruitment and Outreach participated in 42 events and engaged 2272 students in the area.
- The University of Arkansas also hosted 21 camps with 324 participants. GirlTREC hosted by MarTREC is one of the camps.
- The Mississippi Summer Transportaion Insitute, a three-week residential program hosted by Jackson State University, was co-funded by Federal Highway Administration, Mississippi Department of Transportation, and MarTREC. The cohort consists of 28 high school students, 50% female and 96% African American.

Pre-College and Recruitment
- The University of Arkansas Engineering Career Awareness program (ECAP) is designed to recruit students who are underrepresented in the field of engineering, and to give these students the support they need to feel comfortable, confident and ready to succeed.

Diversity
1. ITE Diversity and Inclusion Committee Member involved in developing K-12 learning modules for transport topics.
2. The 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.
3. MarTREC hosted 15 fifth and sixth grade girls 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.

4.4 Impacts on Physical, Institutional, and Informational Resources

Editorial Journal Positions
1. Area Editor, The Engineering Economist
2. Editorial Board, Stochastics and Quality Control
3. Editor-in-Chief, Engineering Management Journal

4.5 Impacts on Technology Transfer

Transfer of Results
- Education Modules - GirlTREC learning modules available at sites.uark.edu/sarahvh

4.6 Impacts on Society beyond Science and Technology

Distinguished Lectures
- Dan Flowers Distinguished Lecture Series, Melissa Tooley, PhD, PE, Director of External Initiatives, TTI, *Preparing for Automated and Connected Vehicles*, April 20, 2018 150 participants.

Conference Planning Positions
1. Co-chair, technical session, 8th International Conference on Case Histories in Geotechnical Eng.
2. Member, 2018 Marine Transportation System Research and Technology Conference
3. Member, Institute of Transportation Engineers, MOVITE Section Local Arrangements Committee
4. Member, Organizing Committee, Southeast Symposium on Contemporary Engineering Topics
5. Moderator, Ocean and Marine Division Technical Session, American Society for Engineering Ed.
6. Section Chair, World Transport Convention (WTC 2018) Beijing, China
7. Sub-committee chair (ABG20- Transportation Training and Education)
8. Track Organizer and Session Moderator, Southeast Symposium on Contemporary Engineering
9. Workshop Organizer, Transportation Research Board Committee, Freight Transportation
10. Vice President, Geo-Institute Geophysics Committee

5. Changes/Problems

Nothing to report

6. Special Reporting Requirements
Nothing to report