USDOT Tier 1 University Transportation Center

Program Progress Performance Report #9

Agency: Office of the Assistant Secretary for Research and Technology

Federal Grant #: DTRT13-G-UTC50

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

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

Submission Date: April 30, 2018

DUNS: 1914297450000

EIN: 71-6003252

Recipient Organization: University of Arkansas

Project/Grant Period: Start Date: September 30, 2013
End Date: September 30, 2018

Reporting Period Start Date: October 1, 2017
Reporting Period End Date: March 31, 2018

Report Term or Frequency: six months

Signature: [Signature]

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Maritime Transportation Research & Education Center (MarTREC)

MarTREC is a USDOT Tier 1 University Transportation Center funded in September 30, 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:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Achieved PPPR#9</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ongoing projects in all MarTREC research area</td>
<td>13</td>
<td>R1</td>
</tr>
<tr>
<td># of peer-reviewed journal articles (published, accepted, submitted)</td>
<td>6</td>
<td>R3</td>
</tr>
<tr>
<td># of conference presentations</td>
<td>21</td>
<td>R3</td>
</tr>
<tr>
<td># of tenure track faculty who conduct MarTREC research activities</td>
<td>13</td>
<td>R2</td>
</tr>
<tr>
<td># of external partners involved in center research activities</td>
<td>27</td>
<td>R3</td>
</tr>
<tr>
<td># of research activities that impact diversity through participants and/or outcomes</td>
<td>15</td>
<td>R2</td>
</tr>
<tr>
<td># of UG/G students participating in transportation research projects funded by UTC</td>
<td>20</td>
<td>R2</td>
</tr>
<tr>
<td># of MS/PhD transportation-related advanced degree programs</td>
<td>14</td>
<td>R2</td>
</tr>
<tr>
<td># of MS/PhD graduate students supported by MarTREC</td>
<td>15</td>
<td>R2</td>
</tr>
<tr>
<td># of MS/PhD students supported by MarTREC who received degrees</td>
<td>4</td>
<td>R3</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Achieved PPPR#9</th>
<th>Objective Addressed</th>
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</thead>
<tbody>
<tr>
<td># of national and regional leadership positions held</td>
<td>17</td>
<td>L1</td>
</tr>
<tr>
<td># of conference planning positions held</td>
<td>7</td>
<td>L1</td>
</tr>
<tr>
<td># of invited talks given</td>
<td>3</td>
<td>L1</td>
</tr>
<tr>
<td># of invited talks given</td>
<td>3</td>
<td>L1</td>
</tr>
<tr>
<td># of leadership and research awards received</td>
<td>9</td>
<td>L1</td>
</tr>
<tr>
<td># of impactful research citations by stakeholders</td>
<td>1</td>
<td>L2</td>
</tr>
<tr>
<td># of UG/G students participating in transportation research projects funded by UTC</td>
<td>20</td>
<td>L2</td>
</tr>
<tr>
<td># of junior faculty mentored</td>
<td>2</td>
<td>L1</td>
</tr>
<tr>
<td># of leadership workshops held</td>
<td>0</td>
<td>L2</td>
</tr>
<tr>
<td># of external grant proposals submitted</td>
<td>1</td>
<td>L2</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Achieved PPPR#9</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of projects in MarTREC educational and workforce development areas</td>
<td>0</td>
<td>EWD1</td>
</tr>
<tr>
<td># of UG/G transportation-related courses associated with UTC</td>
<td>33</td>
<td>EWD2</td>
</tr>
<tr>
<td># of distinguished lectures &amp; seminars offered</td>
<td>6</td>
<td>EWD3</td>
</tr>
<tr>
<td>participant count of distinguished lectures &amp; seminars offered</td>
<td>285</td>
<td>EWD3</td>
</tr>
<tr>
<td># of short courses and workshops offered</td>
<td>10</td>
<td>EWD3</td>
</tr>
<tr>
<td>participant count of short courses and workshops offered</td>
<td>183</td>
<td>EWD3</td>
</tr>
<tr>
<td># of times technician certification programs are offered</td>
<td>23</td>
<td>EWD3</td>
</tr>
<tr>
<td>participant count of technician certification programs offered</td>
<td>377</td>
<td>EWD3</td>
</tr>
<tr>
<td># of educational modules and case studies developed</td>
<td>1</td>
<td>EWD2</td>
</tr>
<tr>
<td># of student-authored publications</td>
<td>6</td>
<td>EWD2</td>
</tr>
<tr>
<td># of student-presented presentations</td>
<td>5</td>
<td>EWD2</td>
</tr>
<tr>
<td># of K-12 programs offered</td>
<td>61</td>
<td>EWD4</td>
</tr>
<tr>
<td>participant count of K-12 programs (events) offered</td>
<td>3000</td>
<td>EWD4</td>
</tr>
<tr>
<td>% of female participants in K-12 programs</td>
<td>40</td>
<td>EWD4</td>
</tr>
<tr>
<td>% of minority participants in K-12 programs</td>
<td>25</td>
<td>EWD4</td>
</tr>
<tr>
<td># of pre-college programs offered</td>
<td>17</td>
<td>EWD4</td>
</tr>
<tr>
<td>participant count of pre-college programs offered</td>
<td>1300</td>
<td>EWD4</td>
</tr>
<tr>
<td># of online K-12 educational resources posted</td>
<td>8</td>
<td>EWD4</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Achieved PPPR#9</th>
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</thead>
<tbody>
<tr>
<td># of peer-reviewed journal articles (published, accepted, under review)</td>
<td>6</td>
<td>TT2</td>
</tr>
<tr>
<td># of conference presentations</td>
<td>21</td>
<td>TT2</td>
</tr>
<tr>
<td># of technical briefs</td>
<td>0</td>
<td>TT2</td>
</tr>
<tr>
<td># of guidebooks</td>
<td>2</td>
<td>TT2</td>
</tr>
<tr>
<td># of short courses and workshops offered</td>
<td>10</td>
<td>TT2</td>
</tr>
<tr>
<td>participant count of short courses and workshops offered</td>
<td>183</td>
<td>TT1</td>
</tr>
<tr>
<td># of conference planning positions held</td>
<td>7</td>
<td>TT1</td>
</tr>
<tr>
<td># of editorial journal positions held</td>
<td>6</td>
<td>TT1</td>
</tr>
<tr>
<td># of technician certification programs offered</td>
<td>7</td>
<td>TT1</td>
</tr>
<tr>
<td>participant count of technician certification programs offered</td>
<td>377</td>
<td>TT1</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Achieved PPPR#9</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of collaborative partnerships formed</td>
<td>27</td>
<td>C1</td>
</tr>
<tr>
<td># of collaborative activities conducted</td>
<td>2</td>
<td>C2</td>
</tr>
<tr>
<td># of collaborative deliverables completed</td>
<td>10</td>
<td>C2</td>
</tr>
<tr>
<td># of collaborative team events</td>
<td>10</td>
<td>C1</td>
</tr>
<tr>
<td># of collaborative outreach events held</td>
<td>23</td>
<td>C2</td>
</tr>
<tr>
<td># of faculty involved in collaborative activities</td>
<td>13</td>
<td>C3</td>
</tr>
<tr>
<td># of students involved in collaborative activities</td>
<td>20</td>
<td>C3</td>
</tr>
</tbody>
</table>
1.1.6 Plans for Next Reporting Cycle

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. Our next annual Advisory Board meeting is planned for November 16, 2018.

1.2 Project-Level Accomplishments

MarTREC had 13 active research projects during this reporting period. Three completed and one project added during this reporting period.

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. We developed a mathematical model 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 demonstrated how our model and algorithms could be used at a variety of resource levels to allocate maintenance budget to districts. Using these results, we demonstrated the tradeoff between available maintenance budget and system-wide performance. Furthermore, we demonstrated insights, created because of solving our model.
**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-June 2018  
**Accomplishments:** We have developed and tested a linear approach to extend our Cargo Prioritization Terminal Allocation Problem (CPTAP) modeling capability. This new approach allows us to solve realistic response scenarios more quickly  
**Project plans:** Our CPTAP model enhancement is complete, and we are developing the final report. We are preparing to present the work at the upcoming Industrial and Systems Engineering Conference in May 2018.

**Supporting Secure and Resilient Inland Waterways Phase Two**  
Heather Nachtmann, Ph.D.  
Justin Chimka, Ph.D.  
July 2017-August 2018  
**Accomplishments:** Unexpected disruptions to the inland waterway system due to natural disasters, vessel accidents, or terrorist attacks can cause non-navigable water levels or destroy major navigation infrastructures, resulting in closures of the inland waterway.  
**Project Plans:** We are extending our current CPTAP model to consider uncertainty into the decision. Data and distributions are being defined for four unknown parameters; water transport time, offload time, land transport time, and terminal capacity. The simulation model design is underway. We are preparing to present the work at the upcoming Industrial and Systems Engineering Conference in May 2018.
1.2.2 Building Resilient and Sustainable Multimodal Infrastructure Projects

Climate Impacts on Lock Use and Performance
Justin Chimka, Ph.D.
July 2016-August 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 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 is to integrate resilience planning and climate change preparedness for water-resource infrastructure.

Project plans: New datasets have been created by collecting relevant online climate and water level data and matching them to existing lock unavailability data and newly created spatial and temporal lag variables. We are exploring statistical models of lock unavailability as a function of climate and lagged versions of the response, for different measures of unavailability and different waterways (AR, IL, MS, and OH).

Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrosfits for Improved Waterway Lock Reliability
Gary Prinz, Ph.D., P.E.
Clint Wood, Ph.D., P.E.
July 2016-August 2018

Accomplishments: Fatigue analysis using Miner’s Rule determined that section F13 has the highest fatigue damage following one lock drain-fill cycle. In this study, the Greenup Lock and Dam was the lock gate analyzed under a moving hydrostatic pressure using the finite element software package ABAQUS. The experimental setup for the full-scale component testing was completed, the first fatigue test was started, a prototype fatigue retrofit was built, and multiple finite element analyses investigating retrofit effectiveness were conducted.

Project plans: Due to the nature of fatigue testing and the large number of fatigue cycles being required to fracture our laboratory gate specimens. We are working on instrumentation and monitoring of Lock #16 (enhancing the project data gathered), improve the data acquisition for our experimental lab testing with a new amplifier card for connecting our LVDT displacement measuring devices, and allow machined fabrication of additional retrofit design iterations.

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 at 2H: 1V, 3H: 1V and 4H: 1V slopes and developed a design protocol to stabilize Mississippi slopes using RPP. Based on the study, it was observed that there is a high suction at the initial moment before rainfall. With short
duration of rainfall, a decrease in the suction takes place. This decrease in suction is immediate at the shallow surface faster compared to the deeper surface. It was also noticed that with an increase of rainfall intensity does not affect much infiltration, due to the low permeability of the highly plastic clay soil. The total volume of the rainfall plays a major role in the infiltration behavior for highly plastic clay soil. In addition, the successive rainfall can have a significant influence on slope failure in shallow depth in Mississippi due to several rainfall events.

**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.

**Project Plans:** Develop model that connects the repeated shrink-swell behavior and progressive saturation of Yazoo clay due to rainfall, which will help transportation officials and Levee owners to predict the slope failure before it actually happens and repair it to maximize the system capacity.

**Evaluating the Performance of Intermodal Connectors**

Sarah Hernandez, Ph.D.

**August 2016-June 2018**

**Accomplishments:** This project focuses 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). ICs account for less than 1% of NHS mileage, but are critical for timely and efficient multimodal freight movements. ICs are currently not well monitored or understood and are frequently missing from statewide planning, programming, and forecasting models. ICs are in relatively poor condition compared to the NHS as a whole. This has cascading effects on the reliability of multimodal freight operations - a 1- or 2-hour delay in a drayage movement can result in a 24-hour holdup in a domestic multimodal shipment. We have made progress on non-obtrusive sensor development based on low cost LiDAR sensors. We carried out an extensive data collection at the Van Buren, AR port area and are in the midst of processing the video data that will become input for our truck body classification model using LiDAR data.

**Project plans:** We are examining truck GPS data records for each of the ICs in AR. From the GPS records, we will prepare “truck sheds” to show the spatial impact of each port facility.

**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-June 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. Observed losses in system functionality following a major disruption will be used to quantify the resiliency of the waterway using time dependent performance analysis. This type of analysis is critical when investigating the efficacy of the recovery process protocols and management strategies employed in the days and weeks that follow a major disruptive event. The primary contribution of this research is creating a systematic, objective means of measuring commercial port resiliency. The methods developed can be used for future studies of post-disaster operations and protocols, such as evaluations of channel operations after a disruption to better understand characteristics that increase resiliency.

**Project Plans:** During this reporting period, the research team worked on the preparation of the final report, which are still in progress. The final report submission and project completion is anticipated to be completed on or before the end of the period of performance.
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-August 2018**

**Accomplishments:** Electrical resistivity measurements and surface wave methods were determined to be the most advantageous in terms of capturing features of interest; rapid non-destructive geophysical testing that can be used to proactively evaluate levees.

**Project Plans:** A more accurate and interpretable predictor of soil type is critically needed in order to assess the many miles of undocumented levees scattered across the United States. The proposed method would allow this information to be gathered non-destructively which would save both time and money.

2. Products

2.1 Publications

**Journal Articles**

**Books/Other One-Time Publications**


**Conference Papers**


**Conference Presentations**

1. Langston, Maggie (student) "Corrosion-Tolerant Pre-Stressed CFRP Fatigue Retrofits for Improved Waterway Lock Reliability", U of A graduate seminar, February 2018.

2. Lozano, Christine (student) "Pre-stressed retrofit strategies for mitigating fatigue cracking in steel waterway lock gate components", MS thesis committee, December 2017.


4. Gary Prinz "Recent steel research at the University of Arkansas", BYU graduate seminar, November 2017.


2.2 Websites

<table>
<thead>
<tr>
<th>Website Title</th>
<th>Web Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>MarTREC</td>
<td><a href="http://martrec.uark.edu/">http://martrec.uark.edu/</a></td>
</tr>
<tr>
<td>Institute for Multimodal Transportation</td>
<td><a href="http://www.jsums.edu/imtrans/">http://www.jsums.edu/imtrans/</a></td>
</tr>
<tr>
<td>Gulf Coast Center for Evacuation and Transportation Resiliency</td>
<td><a href="http://www.evaccenter.lsu.edu/">http://www.evaccenter.lsu.edu/</a></td>
</tr>
<tr>
<td>Merritt C. Becker Jr. UNO Transportation Institute</td>
<td><a href="http://transportation.uno.edu/">http://transportation.uno.edu/</a></td>
</tr>
</tbody>
</table>

2.3 Technologies or Techniques
Nothing to report
2.4 Inventions
Nothing to report

2.5 Other Products
- ARDOT WIM Database and truck GPS database hosted on PI server for project development

3. Participants & Collaborating Organizations

3.1 Partnerships

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Location</th>
<th>Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas State Highway and Transportation Dept.</td>
<td>Little Rock, AR</td>
<td>$40k fund (match project)</td>
</tr>
<tr>
<td>Dr. Dennis Phillip Robinson, University of Arkansas</td>
<td>Little Rock, AR</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Mr. Gene Higginbotham, Executive Director, AR Waterways Commission</td>
<td>Little Rock, AR</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Ms. Deidre Smith, Waterways Manager, ODOT</td>
<td>Muskogee, OK</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Mr. Matthew Tyler Henry, Regional Economist at the U.S. Army Corps of Engineer</td>
<td>Muskogee, OK</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University</td>
<td>Cape Girardeau, MO</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Kenneth Ned Mitchell, US Army Corps Engineer</td>
<td>Vicksburg, MS</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Guillermo Riveros, US Army Corps of Engineers,</td>
<td>Vicksburg MS,</td>
<td>guidance on lock gates</td>
</tr>
<tr>
<td>Brandi Christian, Donnell Jackson, Amelia Pellegrin</td>
<td>Port of New Orleans</td>
<td>outreach</td>
</tr>
<tr>
<td>Kristi App, International Freight Forwarders &amp; Customs Brokers Association</td>
<td>New Orleans, LA</td>
<td>advisory board service</td>
</tr>
<tr>
<td>Billy App and Caitlin Cain World Trade Center Transportation Committee</td>
<td>New Orleans, LA</td>
<td>advisory board service</td>
</tr>
<tr>
<td>Mr. Chad Johnston, Dept. of Homeland Security</td>
<td>Arkansas District</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Mr. Glenn Moore, Dept. of Homeland Security</td>
<td>Oklahoma District</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Gary LaGrange, Ports Association of Louisiana</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Christine Titus, GNO Port Safety Council</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>RADM Joel Whitehead, Propeller Club of NO</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dawn Lopez and David Fennelly, Turn Services</td>
<td>New Orleans, LA</td>
<td>Board Service, internships</td>
</tr>
<tr>
<td>Sharon Leader, Jefferson Parish Transit</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Walter Brooks, Regional Planning Commission</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Paul Aucoin, Port of South LA</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Randy Guillot, Triple G. Express, Inc.</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>James Baldwin, Coastal Cargo</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Kristin G. Palmer, Super Region Rail Authority</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>David Scoggin, Global Logistics Expert</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Douglas Grubbs, Crescent Port Pilots Assn. (ret).</td>
<td>New Orleans, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Rick Leuttich and Dr. Gavin Smith, UNC</td>
<td>Chapel Hill, NC</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Sam Brody, Texas A&amp;M University</td>
<td>Galveston, TX</td>
<td>research collaborator</td>
</tr>
</tbody>
</table>
### 3.2 Other Collaborators

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Location</th>
<th>Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Jingjing Tong, Assistant Professor, South East Missouri State University</td>
<td>Cape Girardeau, MO</td>
<td>case study development</td>
</tr>
<tr>
<td>Dr. Melissa Tooley, Director, TTI</td>
<td>College Station, TX</td>
<td>center collaborator</td>
</tr>
<tr>
<td>Professor Chi Li</td>
<td>Inner Mongolia Institute of Tech.</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Associate Professor Changming Bu</td>
<td>Chongqing University of Science &amp; Technology</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Associate Professor Fan Liang</td>
<td>Chongqing Jiaotong University</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Professor Dong Qian</td>
<td>Chongqing University of Science &amp; Technology</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Helen Chen</td>
<td>Johnson C. Smith University, Greensboro, NC</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Barry Keim</td>
<td>Louisiana State University, Baton Rouge, LA</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Sandra Knight</td>
<td>University of Maryland College Park</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Gavin Smith</td>
<td>University of North Carolina, Chapel Hill, NC</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Ismael Pagan and Dr. Ricardo Lopez</td>
<td>University of Puerto Rico, Mayaguez, P.R.</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Meherun Laiju</td>
<td>Tougaloo College, Jackson, MS</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Sam Brody, Dr. Wes Highfield, Dr. Jens Figlis and Dr. William Merrell</td>
<td>Texas A&amp;M University</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Bas Jonkman</td>
<td>Technical University Delft (TU Delft), The Netherlands</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Shahadat Hossain</td>
<td>Department of Civil Engineering, UT Arlington</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Florida Atlantic University</td>
<td>Boca Raton, FL</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Lan Liu, Professor of School of Transportation and Logistics</td>
<td>Southwest Jiaotong University</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Chuanzhong Yin</td>
<td>Shanghai Maritime University</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. P.C. Yuan and Dr. Jessica Murphy, Jackson State University</td>
<td>Jackson, MS</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Dr. Jeffrey Melby, Engineer Research and Development Center</td>
<td>Novato, CA</td>
<td>Guest Lecturer</td>
</tr>
<tr>
<td>Mississippi DOT</td>
<td>Jackson, MS</td>
<td>external evaluator</td>
</tr>
<tr>
<td>Dr. Chris Massey and Dr. Norberto Nadal, Engineer Research and Development Center</td>
<td>Vicksburg, MS</td>
<td>Partner in NSF funded PIRE Coastal Flood Risk Reduction.</td>
</tr>
<tr>
<td>Dr. Jyotishka Datta,</td>
<td>Assistant Professor of Statistics, Department of Mathematical Sciences, University of Arkansas.</td>
<td>Expert in Bayesian methodology and machine learning.</td>
</tr>
</tbody>
</table>
4. Impacts

Stakeholder Citations
- MKARNS project noted as a key input to an ongoing RRAP study by DHS Infrastructure team

4.1 Impacts on Principal Disciplines

Leadership Positions
1. Chair, ASCE methods of design committee
2. Member, ASCE fatigue and fracture committee
3. Conference Chair, Institute of Industrial and Systems Engineering
4. Research Member, Advisory Council for Transportation, ARDOT
5. Chair, Standing Committee on Emergency Evacuation, Transportation Research Board
6. Member, Standing Committee on Emergency Evacuation, Transportation Research Board
7. Member, Standing Committee on Traffic Law Enforcement, Transportation Research Board
8. Technical Member, TRB AFP 30 Soil and Rock Properties Committee
9. Panel Member, NCHRP Project Panel C01-59
10. Member, TRB Intermodal Freight Committee
11. Member, TRB Logistics of Disaster Committee
12. Member, STPA of ASPA
13. Member, Transportation Research Board Committee (ABJ90 - Freight Transportation Data)
14. Sub-committee chair (ABG20- Transportation Training and Education), Institute of Transportation Engineers Diversity and Inclusion Committee Subcommittee on STEM
15. Chair, Highway Division for World Transport Convention (WTC)
16. Member, TRB Intermodal Freight Committee
17. Member, TRB Logistics of Disaster Committee

Leadership Awards
2. Christine Lozano Jack Buffington Poster Award, MBTC annual meeting November 2018.
8. Sarah Hernandez, University of Arkansas, awarded the Private Sector Applicability Award by the TRB Standing Committee on Intermodal Freight Transportation.
9. 1st place of Mississippi in Traffic Bowl competition, Deep South Institute of Transportation Engineers (DSITE), New Orleans, LA, March 2018.
4.2 Impacts on Other Disciplines

Related External Grants

4.3 Impacts on Human Resources and Workforce Development

K-12 Programs
- The University of Arkansas Office of Recruitment and Outreach participated in 61 events and engaged 3000 students in the area.

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. The ECAP program provides financial assistance to qualifying students, three-week summer bridge program and continued engagement to graduation and beyond.

Internships
2. Spring 2018, Emily Matlock, Industrial Engineering, University of Arkansas, Logistics, Toyota.

Diversity
1. Women's Transportation Seminar New Orleans Chapter (WTSGNO)
2. Ayanna A. Lynn (African American female) TRB minority research fellow
3. Ayanna A. Lynn (African American female) recipient of Eisenhower Fellowship

4.4 Impacts on Physical, Institutional, and Informational Resources

Physical (also Collaborative Activities)
1. With Dr. Lan Liu, Professor of School of Transportation and Logistics, Southwest Jiaotong University, in collaboration of research paper "The Spatial Partitioning of Traffic Networks for Boundary Flow Control," accepted to China Journal of Highway and Transport.
2. Dr. Chuanzhong Yin, Associate Professor of School of Traffic and Transportation, Shanghai Maritime University, research paper “Just-in-time Railway Transport of Power Plant Coal with Safety Inventory,” accepted to the 97th Annual TRB Meeting, Washington, DC, January 2018.

Institutional
- UNOTI hosted "Logistics Career Fair and Summer Learning Program" in coordination with Traffic and Transportation Club of Greater N.O.

Editorial Journal Positions
1. Associate Editor, Stochastics and Quality Control
2. Editor, International Journal of Six Sigma and Competitive Advantage
3. Editor-in-Chief, Engineering Management Journal
4. Area Editor, The Engineering Economist
5. Area Editor, Journal of Transportation Safety System Security

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
1. Sam Briuglio, VP, Planning & Geospatial, POND Company; October 2017; UNO library; 35 participants.
2. Randy Guillot, President, Triple G. Express, October 2017, UNO, 25 participants.
5. Gary P. LaGrange, Principal, Gary P. LaGrange and Associates, UNO, October 2017, 25 participants.

Conference Planning Positions
1. Workshop Organizer, Transportation Research Board Committee Member
2. Sub-committee chair (ABG20- Transportation Training and Education)
3. Institute of Transportation Engineers (ITE) MOVITE Section Local
4. Member, 2018 Marine Transportation System Research and Technology Conference
5. Session Co-Chair, Pipeline and Transportation Structures in Unsaturated Soils of PAN-AM UNSAT
6. Conference Chair, Institute of Industrial and Systems Engineering
7. Paper review coordinator of "Waterway transport safety" committee of Waterway Division for World Transport Convention (WTC)

5. Changes/Problems
Nothing to report

6. Special Reporting Requirements
Nothing to report