USDOT Tier 1 University Transportation Center

Program Progress Performance Report #8

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: October 30, 2017

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: April 1, 2017
Reporting Period End Date: September 30, 2017

Report Term or Frequency: six months

Signature: [Signature]

1
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</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ongoing projects in all MarTREC research area</td>
<td>17</td>
<td>R1</td>
</tr>
<tr>
<td># of peer-reviewed journal articles (published, accepted, submitted)</td>
<td>11</td>
<td>R3</td>
</tr>
<tr>
<td># of conference presentations</td>
<td>7</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>21</td>
<td>R2</td>
</tr>
<tr>
<td># of UG/G students participating in transportation research projects funded by UTC</td>
<td>35</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>24</td>
<td>R2</td>
</tr>
<tr>
<td># of MS/PhD students supported by MarTREC who received degrees</td>
<td>3</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#8</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of national and regional leadership positions held</td>
<td>15</td>
<td>L1</td>
</tr>
<tr>
<td># of conference planning positions held</td>
<td>10</td>
<td>L1</td>
</tr>
<tr>
<td># of invited talks given</td>
<td>0</td>
<td>L1</td>
</tr>
<tr>
<td># of invited talks given</td>
<td>0</td>
<td>L1</td>
</tr>
<tr>
<td># of leadership and research awards received</td>
<td>1</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</td>
<td>35</td>
<td>L1</td>
</tr>
<tr>
<td>funded by UTC</td>
<td></td>
<td></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>4</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#8</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>9</td>
<td>EWD3</td>
</tr>
<tr>
<td>participant count of distinguished lectures &amp; seminars offered</td>
<td>450</td>
<td>EWD3</td>
</tr>
<tr>
<td># of short courses and workshops offered</td>
<td>0</td>
<td>EWD3</td>
</tr>
<tr>
<td>participant count of short courses and workshops offered</td>
<td>0</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>406</td>
<td>EWD3</td>
</tr>
<tr>
<td># of educational modules and case studies developed</td>
<td>0</td>
<td>EWD2</td>
</tr>
<tr>
<td># of student-authored publications</td>
<td>10</td>
<td>EWD2</td>
</tr>
<tr>
<td># of student-presented presentations</td>
<td>2</td>
<td>EWD2</td>
</tr>
<tr>
<td># of K-12 programs offered</td>
<td>4</td>
<td>EWD4</td>
</tr>
<tr>
<td>participant count of K-12 programs (events) offered</td>
<td>90</td>
<td>EWD4</td>
</tr>
<tr>
<td>% of female participants in K-12 programs</td>
<td>48%</td>
<td>EWD4</td>
</tr>
<tr>
<td>% of minority participants in K-12 programs</td>
<td>82%</td>
<td>EWD4</td>
</tr>
<tr>
<td># of pre-college programs offered</td>
<td>21</td>
<td>EWD4</td>
</tr>
<tr>
<td>participant count of pre-college programs offered</td>
<td>1323</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#</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of peer-reviewed journal articles (published, accepted, under review)</td>
<td>11</td>
<td>TT2</td>
</tr>
<tr>
<td># of conference presentations</td>
<td>7</td>
<td>TT2</td>
</tr>
<tr>
<td># of technical briefs</td>
<td>0</td>
<td>TT2</td>
</tr>
<tr>
<td># of guidebooks</td>
<td>0</td>
<td>TT2</td>
</tr>
<tr>
<td># of short courses and workshops offered</td>
<td>6</td>
<td>TT1</td>
</tr>
<tr>
<td>participant count of short courses and workshops offered</td>
<td>225</td>
<td>TT1</td>
</tr>
<tr>
<td># of conference planning positions held</td>
<td>10</td>
<td>TT1</td>
</tr>
<tr>
<td># of editorial journal positions held</td>
<td>8</td>
<td>TT1</td>
</tr>
<tr>
<td># of technician certification programs offered</td>
<td>8</td>
<td>TT1</td>
</tr>
<tr>
<td>participant count of technician certification programs offered</td>
<td>406</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#</th>
<th>Objective Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td># of collaborative partnerships formed</td>
<td>22</td>
<td>C1</td>
</tr>
<tr>
<td># of collaborative activities conducted</td>
<td>5</td>
<td>C2</td>
</tr>
<tr>
<td># of collaborative deliverables completed</td>
<td>5</td>
<td>C2</td>
</tr>
<tr>
<td># of collaborative team events</td>
<td>5</td>
<td>C1</td>
</tr>
<tr>
<td># of collaborative outreach events held</td>
<td>4</td>
<td>C2</td>
</tr>
<tr>
<td># of faculty involved in collaborative activities</td>
<td>12</td>
<td>C3</td>
</tr>
<tr>
<td># of students involved in collaborative activities</td>
<td>24</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 10, 2017.

1.2 Project-Level Accomplishments

MarTREC had 17 active research projects during this reporting period. Eight projects were completed during this reporting period. Two projects were 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 can 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 that can created as a result 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-October 2017**  
**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:** We are currently extending our earlier work through CPTAP model enhancement in order to provide timely knowledge and awareness of what cargoes should be prioritized for offloading during disruption response and what infrastructure exhibits low resiliency in terms of modal capacity to potential attacks or natural disasters against inland waterway transportation systems.

**Supporting Secure and Resilient Inland Waterways Phase Two**  
Heather Nachtmann, Ph.D.  
Justin Chimka, Ph.D.  
**July 2017-June 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 Phase One project by expanding our current model to consider uncertainty into the decision. Future commodities transported, barge traffic, and water and land capacities are all unknown parameters that will be considered.
1.2.2 Building Resilient and Sustainable Multimodal Infrastructure Projects

**Climate Impacts on Lock Use and Performance**  
**Justin Chimka, Ph.D.**  
**July 2016-June 2018**

**Accomplishments:** Statistical models of Climate Impacts on Lock Use and Performance will help DOT and USACE integrate Climate Change Adaptation with Lock Operations and Marine Services by quantifying fixed route infrastructure vulnerability. Currently consolidating locks by district / division and / or waterway data for calendar years 1993 – 2015.  
**Project plans:** Create new datasets by collecting relevant online climate data and matching them to existing lock unavailability data and newly created spatial lag variables (lock unavailability in nearby places). These new datasets allow us to begin exploring statistical models of lock unavailability as a function of climate data and spatial lags, for different measures of unavailability (scheduled unavailabilities, scheduled unavailable time, unscheduled unavailabilities, unscheduled unavailable time) and different waterways (Arkansas, Illinois, Mississippi, Ohio).

**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-June 2018**

**Accomplishments:** Fatigue analysis using Miner’s Rule determined that section F13 (Figure 21), 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:** Related to the fatigue retrofit development, a prototype retrofit has been created and is being tested for pre-stress loss, surface preparation requirements, and pre-stress application. In addition to the physical fatigue testing, high-fidelity finite element simulations of the installed retrofit were conducted to evaluate pre-stressing formulas developed during earlier project reporting periods. Preliminary analyses indicate an extension in fatigue life of approximately 10 years using the retrofit strategies.

**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.  
**Project plans:** The design can be executed with the following steps: The factor of safety of the unreinforced slope should be determined by using the soil parameters and depth of surficial failure, according to the Equation. The spacing of RPP should be considered. Finally, the factor of safety of the reinforced slope can be determined. If the factor of safety of a reinforced slope is inadequate, the spacing of the RPP should be reduced to increase the factor of safety of the reinforced slope.
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: Intermodal connectors - critical “last mile” roadways connecting intermodal freight facilities such as maritime ports to the National Highway System. Gathered existing traffic, facility (port), and other relevant data to identify major data gaps for ICs in AR.
Project plans: During the past reporting period we have made progress on sensor development. Currently our Lidar based sensor accurately measures vehicle speed and length (i.e. effective vehicle length), and traffic volume. The sensor is bundled with a low-cost video camera. We developed an algorithm to match the Lidar data and video images for each passing vehicle so that we can identify the vehicle type associated with each Lidar data array. We are now in the process of gathering a diverse data set to demonstrate the capability of the Lidar sensor to capture truck body type. During the testing phase we will evaluate different hardware configurations, noting those that provide the most robust classification potential.

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: The work presented in this research uses archival data from the United States Coast Guard’s Nationwide Automatic Identification System (NAIS) to quantify the state of resiliency of coastal navigation systems.
Project Plans: Application of this model to quantify the resiliency of port operations on case study areas will be conducted.

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 man-made 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.
2. Products

2.1 Publications

Journal Articles
3. Lu, WeiKe, Feng Wang, Lei Bu (student), and Lan Liu , "Game Theory Approach to Analysis of Vulnerability of Highway Networks in Evacuation”, Transportation Research Part C (under review).
4. Lynn, Ayanna (student), Lei Bu (student), Haitao Gong (student), and Feng Wang, "Characteristics and Factor Analysis of Vehicle Crashes in Mississippi", Journal of TRB (under review).

Books/Other One Time Publications
Conference Papers
1. Li, L., K. Wen (student), C. Li, and F. Amini, “FIB/SEM Imaging of Microbial Induced Calcite Precipitation in Sandy Soil, Microscopy & Microanalysis Proceedings” 23 (Supplement 1), 310-311, doi: 10.1017/S1431927617002239. 2017

Conference Presentations
5. Nachtmann, Heather, “Engineering Research at the University of Arkansas,” Beihang University, Beijing, China, June 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
Nothing to report

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 at Little Rock</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 Branch 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, Corey Winton, and Mark Cowan Research Civil Engineer, US Army Engineer Research and Development Center Coastal and Hydraulics Laboratory</td>
<td>Vicksburg, MS</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Guillermo Riveros, US Army Corps of Engineers, Vicksburg MS</td>
<td></td>
<td>guidance on lock gates, review of interim reports, and access to lock gate construction documents</td>
</tr>
<tr>
<td>Brandi Christian, Donnell Jackson, Amelia Pellegrin, Port of New Orleans</td>
<td></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>Name</td>
<td>Organization/Location</td>
<td>Collaboration</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Mr. Chad Johnston, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor</td>
<td>Arkansas District</td>
<td>research collaborator</td>
</tr>
<tr>
<td>Mr. Glenn Moore, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor</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 New Orleans.</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, research, 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, New Orleans 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, Southeast Missouri State University</td>
<td>Cape Girardeau, MO</td>
<td>case study development</td>
</tr>
<tr>
<td>Dr. Melissa Tooley, Director, Texas Transportation Institute</td>
<td>College Station, TX</td>
<td>center collaborator</td>
</tr>
<tr>
<td>Professor Chi Li</td>
<td>Inner Mongolia Institute of Technology</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, MD</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>
</tbody>
</table>
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 Hessain  | 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  | School of Traffic and Transportation, Shanghai Maritime University | research collaborator 
Dr. P.C. Yuan and Dr. Jessica Murphy, Jackson State University  | Jackson, MS | collaborated on DHS Scientific Leadership Award to host students in the CRC for Spring/Summer 2017 
Dr. Jeffrey Melby, Engineer Research and Development Center  | Novato, CA | Guest Lecturer in graduate courses, Spring 2017 
Mississippi Department of Transportation  | Jackson, MS | serve as external proposal evaluator, March 2017. 
Dr. Chris Massey and Dr. Norberto Nadal, Engineer Research and Development Center  | Vicksburg, MS | partner in NSF funded PIRE Coastal Flood Risk Reduction. 

4. Impacts

4.1 Impacts on Principal Disciplines

**Leadership Positions**
1. Co-Chair, Roadway Safety and Emergency Management, World Transport Convention
2. Member, ASCE GI Unsaturated soil technical committee
3. Member, ASCE GI Shallow Foundation technical committee
4. Vice chair, AFP-40 committee, TRB
5. Member, Transportation Research Board Committee (ABJ90 - Freight Transportation Data)
6. Sub-committee chair (ABG20- Transportation Training and Education)
7. Chair, AISC/SEI Methods of Design Committee
8. Member, AISC/SEI Fatigue and Fracture Committee
9. Member, TRB Intermodal Freight Committee
10. Member, TRB Logistics of Disaster Committee
11. Chair, Standing Committee on Emergency Evacuation, Transportation Research Board
12. Member, Standing Committee on Emergency Evacuation, Transportation Research Board
13. Member, Standing Committee on Traffic Law Enforcement, Transportation Research Board
14. President, American Society for Engineering Management
15. Member, Advisory Council for Transportation Research, Arkansas DOT

Leadership Awards
- High Grant Award, Jackson State University, April 2017

4.2 Impacts on Other Disciplines

Related External Grants
1. "Coastal Resilience Center of Excellence", Department of Homeland Security
2. "Coastal Flood Risk Reduction Program", National Science Foundation Partnership for International Research and Education
3. "Coastal Resilience Center of Excellence", Texas A&M University
4. “EAGER: SSDIM: Data Simulation to Support Interdependence Modeling in Emergency Response and Multimodal Transportation Network”, National Science Foundation

4.3 Impacts on Human Resources and Workforce Development

Diversity
1. MarTREC hosted 35 fifth and sixth grade girls in July 2017 at our new GirlTREC summer camp. 65% of the participants were from underserved populations.
2. UNO National Summer Transportation Institute in July 2017 sponsored fourteen young men ages 13-17 spent the day visiting transportation hubs of New Orleans.
3. LSU Math Circle hosted nine 9th-12th grade underserved students in a four-week program
4. JSU hosted its annual Mississippi Summer Transportation Institute program in June 2017. 32 high school students participated, and of those 100% were African American and 60% female.
5. UNO hosted Women’s Transportation Seminar Greater New Orleans Chapter.

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.

4.4 Impacts on Physical, Institutional, and Informational Resources

Physical (also Collaborative Activities)
2. In July, UNO National Summer Transportation Institute partnered with Son of A Saint Program, New Orleans Union Passenger Terminal, Public Belt Railroad, and New Orleans Lakefront Airport to “Spotlight Transportation Careers”. Fourteen young men ages 13-17 spent the day visiting transportation hubs of New Orleans.

3. In July, MarTREC hosted 35 fifth and sixth grade girls at our new 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. 65% of the participants were from underserved populations. This was a collaborative effort of MarTREC, U of A Recruitment Office, U of A faculty, and Springdale Public Schools.

Institutional
- UNO hosted Regional Transit Authority, Strategic Mobility Plan Community Workshops, August 2017.

Informational
- Regional Economic Impact Study of the McClellan-Kerr Arkansas River Navigation System project has been noted as a key input to an ongoing RRAP study by DHS Infrastructure team.

Editorial Journal Positions
1. Editor Board Member, Journal of Geotechnical and Geological Engineering
2. Associate Editor, Economic Quality Control
3. Editor, International Journal of Six Sigma and Competitive Advantage
4. Editorial Board, International Journal of Quality Engineering and Technology
6. Guest Co-Editor, Special Issues, International Journal of Disaster Risk Reduction and Journal of Advanced Transportation
7. Associate Editor, Engineering Management Journal
8. Area Editor, The Engineering Economist

4.5 Impacts on Technology Transfer

Transfer of Results


4.6 Impacts on Society beyond Science and Technology

Distinguished Lectures
1. Dr. Gavin P. Smith, DHS Coastal Resilience Center of Excellence and Research Professor, Department of City and Regional Planning, UNC, "Hurricane Matthew Disaster Recovery and Resilience Initiative" Disaster Coastal Studies Research Symposium, Tougaloo College April 2017.
4. Stephen Champagne, Terminal Manager, "Crude Oil Transport", August 2017

Conference Planning Positions
1. Paper Review Coordinator Committee, World Transport Convention, Beijing, China
2. Moderator, Civil, Environmental and Coastal Engineering Session, New Orleans, LA
3. Organizing Committee Member, Southeast Symposium for Contemporary Engineering Topics, Civil, Environmental and Coastal Engineering Session
4. Reviewer of Technical Papers, 2017 American Society for Engineering Education Conference, Columbus, OH
5. Conference Chair, Institute of Industrial and Systems Engineering
6. Member, Transportation Research Board Committee, (ABJ90 - Freight Transportation Data)
7. Sub-committee Chair (ABG20- Transportation Training and Education)
8. Member, Institute of Transportation Engineers, MOVITE Section Local Arrangements Committee
9. Session Moderator, 2017 Southern Plains Transportation Center Summer Symposium
10. Member, 2018 Marine Transportation System Research and Technology Conference Committee

5. Changes/Problems
Nothing to report

6. Special Reporting Requirements
Nothing to report