USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #7

Federal Agency: Office of the Assistant Secretary for Research and Technology

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

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Reporting Period Start Date: October 1, 2021
Reporting Period End Date: March 31, 2022

Report Term or Frequency: six months

Signature:

Maritime Transportation Research & Education Center (MarTREC) is a USDOT Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under the FAST Act, MarTREC is *working to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure*. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education. Made up of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development, the MarTREC consortium are University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; University of New Orleans (UNO), New Orleans, LA; Texas A&M University/Texas Transportation Institute (TAMU/TTI), College Station, TX; and Vanderbilt University (VU), Nashville, TN. Maritime and related multimodal transportation research is critical to the future of our transportation system and should be a national priority. Given the link between gross domestic product and international trade, which is expected to double over the next 30 years, efficient and resilient ports are critical to the nation's overall economy and the ability of intermodal carriers to move freight between ports of entry and inland locations. Proximity to navigable waterways makes this consortium uniquely situated to address our theme.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research

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

Accomplishments:

Research Effectiveness Metrics	Progress
# of peer-reviewed journal articles (published, accepted, submitted)	13
# of conference presentations given	25
# of students participating in transportation research projects funded by UTC	37

1.1.2 Leadership

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

Accomplishments:

Leadership Effectiveness Metrics	Progress
# of national and regional leadership positions held	46
# of invited talks given	6
# of leadership and research awards received	3

1.1.3 Education and Workforce Development

Goal: MarTREC will develop educational resources for maritime and multimodal transportation systems.

Accomplishments:

Education and Workforce Development Effectiveness Metrics	Progress
# of transportation-related courses offered	36
# of technician certification programs offered	7
# K-12 outreach programs offered	5

1.1.4 Technology Transfer

Goal: MarTREC institutions will participate in national, regional, and local education and workforce development outreach to provide knowledge to private and public transportation organizations.

Accomplishments:

Technology Transfer Effectiveness Metrics	Progress
# of project deliverables submitted	4
# of technical briefs	1
# of editorial journal positions held	17

1.1.5 Collaboration

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

Accomplishments:

Collaboration Effectiveness Metrics	Progress
# of existing collaborative partnerships	67
# of new collaborative partnerships formed	18

1.1.6 Opportunities for Training and Professional Development

- Two students presented at professional conferences
- 10 conference planning positions were held by MarTREC faculty researchers
- 46 leadership positions held by MarTREC faculty researchers
- 608 individuals completed transportation certified courses

1.1.7 Dissemination of Results (In this reporting period)

- Four final reports successfully submitted
- 13 peer-reviewed journal articles and two books were published

1.1.8 Plans to Accomplish Goals and Objectives during Next Reporting Period

The faculty researchers will continue to engage with industry experts to ensure that these projects are making transformational contributions. We will continue to emphasize educational and technology transfer activities.

1.2 Project-Level Accomplishments and Plans for Next Reporting Period

- 57 total projects (life to date)
- 29 completed projects (life to date)

1.2.1   Maritime and Multimodal Logistics Management Projects

Analysis of Blockchain's Impacts on and Applicability to Maritime Industry
Jim Kruse, MBA
Texas A&M Transportation Institute
May 2019-October 2020
Accomplishments: Currently, the most prominent blockchain projects in the maritime sector are initiatives by the shipping segment. However, the results presented in this research point toward the fact that ports and marine terminals have a pivotal role in the blockchain functionalities.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Changing Trade and Transportation Patterns: NAFTA, Cuba, and the US Gulf Coast
Bethany Stich, PhD
University of New Orleans
March 2018-September 2022
Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation and public participation demands have revealed innumerous problems of outdated techniques.
Project Plans: Final review of final report for submission

Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports
Sarah Hernandez, PhD and Chase Rainwater, PhD
University of Arkansas
January 2019-October 2020
Accomplishments: This project developed a method to fuse truck and marine vessel tracking data to better estimate performance of multi-modal supply chains that use inland waterway ports**.**
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development and Application of a Methodology for Maritime-Truck Shipments Generation Analysis
Mario Monsreal, PhD and Jim Kruse, MS, MBA
Texas A&M Transportation Institute
December 2017-March 2019
Accomplishments: Truck activity is logically connected to and generated by vessel activity at a port. In turn, vessel activity is generated by truck shipments. Although one might expect a 1 to 1 relationship between the two types of shipments, that is unlikely the case. This study shed light on the relationship between multimodal flows (trucks and vessels), which will enable agencies and organizations to increase efficiency – and thus competitiveness – for industry, while minimizing negative impacts on a region.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of AIS Model of Texas Gulf Intracoastal Waterway Travel Times
Jim Kruse, MBA
Texas A&M Transportation Institute
October 2019-April 2021
Accomplishments: The focus of this research project is to perform analysis on the Texas portion of the Gulf Intracoastal Waterway (GIWW). The Texas GIWW presents a level of complexity significantly greater than rivers because of the intersections with ship channels and the fact that some barges go into and exit port areas while others pass through. Established origins and destinations. Segmented the

waterway into links. Analyzed AIS data to identify vessel transits and associated transit times on the links. Developed a methodology for predicting travel times. Evaluated the effect of special conditions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Driving Simulators as Educational Outreach for Freight Transportation
Sarah Hernandez, PhD, PE
University of Arkansas
August 2021-June 2023
Accomplishments: The goal of this project is to enhance outreach efforts for middle and high school student groups for freight career awareness by using truck driving simulators. There is a shortage of truck drivers across the US which contributes to inefficiency in the freight system.
Project Plans: Undergraduate research assistants will present the lesson plans at the Fayetteville Public Library to six undergraduate students

Evaluating the resilience of port operations to local and regional transportation infrastructure
Jim Kruse, MBA
Texas A&M Transportation Institute
December 2021-February 2023
New Project: This project will develop a quantitative model of the local and regional road and rail network that serve a port, and the flow of goods to and from the port. The goal is to develop a reusable quantitative framework to assess questions relating to the port road transportation system.

Inland Waterway Travel Time Prediction
Jim Kruse, MBA
Texas A&M Transportation Institute
November 2020-April 2022
Accomplishments: This project will build an inland waterways travel time prediction model that builds on and improves existing work at the Corps of Engineers Engineer Research and Development Center.
Project Plans: Forecast and analyze travel times in one of the simplest river segments. The resulting forecast model will be applied to a more complex river segment involving locks and possibly bridges.

Interdisciplinary Educational Outreach with Traffic Sensor Build Kits
Sarah Hernandez, PhD, PE
University of Arkansas
May 2019-August 2020
Accomplishments: This project designed and implemented freight oriented educational outreach activities centered on traffic sensing technologies for middle, high, and first-year college students.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Learning from USACE Open Data for Locks
Justin Chimka, PhD
University of Arkansas
August 2018-May 2021
Accomplishments: In August 2017, the USACE began to enable unprecedented data access by publishing its Open Data for Navigation online. This project sought to explore the new USACE Open Data for Locks, describe its relevant datasets, and inventory their contents, identify responses or variables across relevant datasets, and diagnose efficient statistical models.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modal Comparison Update: 2001-2019
Jim Kruse, MBA
Texas A&M Transportation Institute
March 2021-October 2021
Accomplishments: In December 2007, the Texas A&M Transportation Institute submitted a report to the U.S. Maritime Administration and the National Waterways Foundation titled "A Modal Comparison of Domestic Freight Transportation Effects on the General Public". Since that time, several updates to the study have been performed, with the last update covering the period 2001 to 2014. Effects will cover congestion, emissions, energy efficiency, safety, and infrastructure impacts from 2001 to 2019.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modeling Dynamic Behavior of Navigable Inland Waterways
Heather Nachtmann, PhD and Justin Chimka, PhD
University of Arkansas
August 2018-June 2023
Accomplishments: This project is expanding prior MarTREC research. We collected current data and replicated our past scenario analyses of the McClellan-Kerr Arkansas River Navigation System (MKARNS). A literature search and review of prior research on and implementation of container-on-barge was published in the Maritime Economics and Logistics journal (August 2021). We completed the development of a value-focused framework to assess the feasibility of container-on-barge in the United States. Results of this project were presented at the Institute of Industrial and Systems Engineers annual conferences (May 2019, November 2020, and May 2-22 (forthcoming) and the annual American Society for Engineering Management conference (October 2019).
Project Plans: We are completing a journal manuscript on the value-focused framework to assess the feasibility of container-on-barge in the United States. We have begun to develop a machine learning study to perform container volume forecasting for COB transportation within the United States.

Measures of Freight Network Resiliency: An expanded data capture of Truck Drivers and Support Services under Pandemic Distress
Sarah Hernandez, PhD, PE
University of Arkansas
May 2020-September 2020
Accomplishments: The purpose of this research was to collect timely data on the impacts of the Covid-19 pandemic on truckdriver and trucking operations with a specific focus on issues that affect driver health and safety. An online opt-in panel survey was developed using the Qualtrics survey platform. The survey questionnaire contained 65 questions with skip logic dependent on responses.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Policy and Infrastructure Evaluation Model of Commodity Flows through Inland Waterway Ports
Sarah Hernandez, PhD, PE and Sandra Eksioglu, PhD
University of Arkansas
August 2020-June 2022
Accomplishments: The purpose of this project is to guide strategic investment into port capacity through the development of a policy and infrastructure evaluation model of inland waterway commodity flows.
Project Plans: We are exploring use and operation of the driving simulator; contacting national truck education program for curriculum sharing

Shipping Container Chassis in the US: The Legacy of Ocean Carriers
Bethany Stich, PhD
University of New Orleans
March 2018-December 2019
Accomplishments: Almost half of the chassis date from before 1997 and it is common at marine terminals to find chassis well over 20 years old. Newer chassis are safer, as they are outfitted with radial tires, antilock brakes, and LED lights. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and trucking companies.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

The Changing Legal Landscape of Intermodalism – Part 1
Bethany Stich, PhD
University of New Orleans
July 2021-June 2022
Accomplishments: This project investigates the ongoing legal challenges surrounding chassis. In 2020, Intermodal Motor Carriers Conference (IMCC) of American Trucking Associations and the Ocean Carriers Equipment Management Association (OCEMA) were involved in negotiations to resolve what IMCC charged were high-priced and inferior quality chassis at many of the nation's ports.
Project Plans: Determine the status of the United States International Trade Commission and the US Chamber of Commerce investigations about Chassis and Subassemblies from China, determine the current domestic situation for chassis production as well as other international providers, determine if and to what extent China is dumping chassis in the US to put domestic production out of business, examine the evolution in chassis ownership, operation, maintenance, and cost, what effects, if any, are the steel and aluminum tariffs having on production.

The Changing Legal Landscape of Intermodalism – Part 2
Janey Camp, PhD, PE
Vanderbilt University
August 2021-July 2022
Accomplishments: This project investigates the ongoing legal challenges surrounding chassis. In 2020, Intermodal Motor Carriers Conference (IMCC) of American Trucking Associations and the Ocean Carriers Equipment Management Association (OCEMA) were involved in negotiations to resolve what IMCC charged were high-priced and inferior quality chassis at many of the nation's ports.
Project Plans: Determine the status of the United States International Trade Commission and the US Chamber of Commerce investigations about Chassis and Subassemblies from China, determine the current domestic situation for chassis production as well as other international providers, determine if and to what extent China is dumping chassis in the US to put domestic production out of business, examine the evolution in chassis ownership, operation, maintenance, and cost, what effects, if any, are the steel and aluminum tariffs having on production.

Novel Big Data and Artificial Intelligence Analytics Methods for Tracking and Monitoring Maritime Traffics
Tor A. Kwembe, PhD
Jackson State University
November 2021-October 2022
New Project: This project will utilize Automatic Identification System (AIS) datasets to design scalable Maritime Traffic Monitoring and Analysis (MTMA) applications and tools. Critical applications such as the detection of anomalies, offshore and onshore attacks and data intrusions, require fast mechanisms for

Artificial Intelligence (AI) analysis of thousands of events per second, as well as efficient techniques for the analysis of massive historical AIS data.

Network Science-based Analysis of the US Marine Highway Network and a Random Graph Model for the Intermodal Port Network
Natarajan Meghanathan, PhD
Jackson State University
November 2021-October 2022
New Project: Marine highways in the US correspond to navigable waterways that run closer to major interstate roads in the country. Unlike the US Interstate road network and the airport network, the US marine highway network (MHN) and the US marine intermodal port network (MIPN) have not been analyzed and no results have been so far reported in the literature. We model the MHN as a graph whose vertices correspond to the marine highways and there exists an edge between two vertices if the corresponding marine highways intersect each other. We propose to analyze the MHN using algorithms for community detection, cluster analysis and centrality assessment to identify the critical marine highways and their intersection points (intermodal ports) that could potentially be a bottleneck.

Mississippi Multimodal Freight Analysis Model
Tzusheng Pei, PhD
Jackson State University
November 2021-October 2022
New Project: Enable policy makers, transportation planners and logistic analysts in various federal, state, and local agencies for assessing the demand for transportation facilities and services, energy use, and safety risk and environmental concerns.

Assessing Maritime Infrastructure along the Mississippi: Chokepoints and Implications for Food Security
Berneece S. Herbert, PhD
Jackson State University
November 2021-December 2022
New Project: Supply chains are inherently complex due to their interdependency with critical infrastructure systems including maritime and multimodal transportation with the largest risk to agricultural trade resulting from age and inadequate or inappropriate infrastructure. It is imperative to close the infrastructure gap, which is not just a function of more construction; new developments must be smart and able to withstand increasingly hostile weather and elements of climate change as they age.

1.2.2   Maritime and Multimodal Infrastructure Preservation Projects

A Digital Twin for Visualizing, Evaluating and Maintaining Multimodal Transportation
Haito Liao, PhD
Shengfan Zhang, PhD
Heather Nacthmann, PhD
University of Arkansas
August 2021-June 2023
Accomplishments: This research project will develop a digital twin that enables visualizing, evaluating and maintaining multimodal transportation infrastructure. The ultimate goal is to provide an opensource software tool and machine learning-based decision-making approaches that assist the relevant stakeholders in improving their information collection and tracking capabilities, as well as enhancing the resilience of multimodal transportation infrastructure and beyond. On the Agent Based Simulation

software, some functions were added: adding new boats based on owner need with regarding source and destination node, tracking special boat's route using its positions in a real map, calculating cost: fixed, variable and delay, assigning different color to boats based on used capacity, calculating actual travelled time and distance and predicted ones for specific boats, calculating statistics of KPI.

Project Plans: Function/features that will be added: showing required values on the real map by clicking on them and Implementing lock queue system in our simulation.

Bio-Inspired Stabilization of Levee Slope on Expansive Yazoo Clay at the Maritime and Multimodal Transportation Infrastructure in Mississippi
Sadik Kahn, PhD, PE
Jackson State University
April 2020 – June 2022
Accomplishments: The existence of Yazoo clay in Mississippi frequently causes distress in levee and highway embankment slopes, which are an integral component of maritime and multimodal transportation infrastructure. This project will investigate the effect of the vetiver grassroots to stabilize levee slopes at the maritime and multimodal transportation infrastructures at Mississippi. Study were presented in TRB AKG 90 Standing Committee on Stabilization of Geomaterials and Recycled Materials.
Project Plans: The findings thus far have been presented to the senior officials of MDOT. More dissemination is planned in 2021 MS ASCE Section meeting, 101st TRB, and GeoCongress 2022.

Continued Study of Rapidly Deployable Soil-Cement Mixtures
Cameron Murray, PhD, PE
Michelle Barry, PhD, PE
University of Arkansas
September 2021-June 2023
Accomplishments: The maintenance and repair of maritime infrastructure is critical to maintaining important shipping channels and preventing unnecessary loss of life or economic impact from severe weather events. The fastest repair, reconstruction, and maintenance techniques may become more desirable as labor costs increase and delays become costlier. The objective of this research is to identify the properties and proportioning of Belitic Calcium Sulfoaluminate (BCSA) soil-cement mixtures most effective for use in waterway structures. BCSA cement is a rapid setting, low-shrinkage cement which can be used in a similar fashion to portland cement.
Project Plans: Narrow down the design and appropriate use of this materials, develop mixture proportioning guidelines and investigate its durability with an emphasis on its use in waterway applications (e.g., levee construction and repair, slope protection, erosion protection, seepage reduction).

K8 MEMES: K-8 Maritime Education Modules to Engage Students
Gary Prinz, PhD, PE
University of Arkansas
September 2021-June 2023
Accomplishments: This education development project will create entertaining, informative, and STEM promoting "plug-and-play" curriculum learning modules for K-8 educators, using maritime transportation and infrastructure related topics to teach STEM concepts. Coupling music memory, fun STEM theories, and innovative experiential demonstrations into entertaining video learning modules. Three of the learning modules have been outlined, the educational songs have been written and recorded.
Project Plans: It is anticipated that the first three modules will be recorded this summer and ready to be implemented into the elementary class curriculum for study this fall.

Dredging Projects Selection when the Random Shoaling Effect is Considered
Bruce Wang, PhD
Texas A&M University
October 2019-December 2021
Accomplishments: Dredging is a constant operation to maintain the waterway shipping capacity. The goal is to achieve a maximum network capacity to support the regional and national economies within a given budget. Literature review complete. Problem formulation developed.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves
Brianne Glover, JD and Jim Kruse, MS, MBA
Texas A&M Transportation Institute
September 2017-August 2018
Accomplishments: This project reviewed existing literature on the economic value of the Gulf Intracoastal Waterway (GIWW), reviewed the importance of the GIWW to the energy industry, examined the overall economic impact of the GIWW to the states it serves, and estimated the increases in transportation costs resulting from an immediate closure in the GIWW.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Effect of Permeability Variation of Expansive Yazoo Clay, Maritime and Multimodal Trans Infra MS
Sadik Kahn, PhD, PE
Jackson State University
September 2018-December 2019
Accomplishments: The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. Each year, fixing the pavement requires significant maintenance budget of MS DOT.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Trans Infra HI
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
March 2018-December 2020
Accomplishments: The goal of this research was to assess the use of 3D virtual and augmented reality as a tool for improved coastal planning for better understanding of sea level rise impacts among the business and tourism industries in Waikiki. The study found that participants were better able to understand the data about flood impacts in the future due to SLR after watching a 3D video.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design
Yadong Li, PhD
Jackson State University
August 2019-December 2021
Accomplishments: Expansive soil causes a variety of maritime transportation infrastructure problems, such as cracks, damage of pipeline, and the differential settlement of foundation. Results showed that cracks appeared on the surface of the hydrogel-treated Yazoo clay samples when subjected to moisture.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi Modal Fracture
Gary Prinz, PhD, PE
University of Arkansas
August 2018-February 2021
Accomplishments: This research project will address multi-mode fatigue cracking within critical lock gate pintle locations. The lock gate pintle is a ball-and-socket joint that is crucial for proper gate operation but is subject to frequent fatigue cracking. Fatigue crack repair within pintle locations is particularly challenging due to the complex multi-axial loading conditions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures
Danuta Leszczynska, PhD
Jackson State University
March 2018-December 2019
Accomplishments: This study produced and investigated a carbon-based substance, namely biochar, as a new material for the in-situ adsorption of pollutants carried by the storm water runoff from the roads.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Identifying Critical Waterway Infrastructure and Managing Risk Associated with Natural Disasters
Michelle Barry, PhD, PE and Shengfan Zhang, PhD
University of Arkansas
July 2020-June 2022
Accomplishments: The transportation system in the U.S. is extremely vulnerable to disruptions and delays from natural disasters. The overall goal of this research is to develop a risk assessment framework that can be used to aid decision making and mitigation strategies for maritime infrastructure deemed critical to the U.S. transportation system and economy.
Project Plans: Currently reviewing and developing models using several different methods for the risk framework and analysis.

Large Scale Evaluation of Erosion Resistance of Biocementation against Bridge Scour and Roadway Shoulder Erosion
Lin Li, PhD., P.E.
Jackson State University
March 2018-April 2019
Accomplishments: This project examined the feasibility of using biocementation through MICP as an erosion countermeasure. The results of this study bring an important conclusion that MICP-treated soil was weak to resist long-term erosion of exposing to outdoor environment.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas Phase II: The Future of LNG for the US and Gulf Coast Economies
Bethany Stich, PhD
University of New Orleans
November 2017-December 2019
Accomplishments: The continued growth of Liquefied Natural Gas (LNG) production and long-distance trade has traditionally been taken as a given by global energy analysts, who have premised their positive estimates on gas being both relatively scarce and demand for it virtually unquenchable. Despite Louisiana experiencing a new cargo export potential with LNG and the subsequent construction and pending permitting of LNG Export Terminals in diverse locations along Louisiana's shorelines, the

primary finding of this report, based on the state of the current energy market, precludes the utility of a focus on LNG as an export commodity.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas III: Export Competition in a Well Supplied, Flow-Shifting Global Economy
Bethany Stich, PhD
University of New Orleans
March 2018-December 2019

Accomplishments: With trillions of cubic feet of shale reserves, the United States' (US) abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. UNOTI continues to urge that U.S. natural gas energy policy best practice is not to focus on export and export alone, but rather adopt a diversified and climate responsible energy policy that focuses on the Ports of South Louisiana, the Gulf Coast, and the U.S. remaining globally competitive by investing in necessary LNG fueling infrastructure, as well as continued investment in the existing petrochemical sector of Coastal Louisiana and the Gulf Coast.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Multimodal Network Approach to the Inland and Coastal Waterway System
Bruce Wang, PhD
Texas A&M University
July 2017-January 2019

Accomplishments: This project has developed a multimodal freight network model that includes both waterway landside components in order to analyze the impact of waterway operations. Tests show that the solutions are not sensitive to these parameters. The model illustrates changing the total amount of available budget into five different scenarios, each having an amount allocated to the locks and dams.

Completed Project: Final project report was submitted and distributed as per grant guidelines.

Port Infrastructure Resilience through Combined Wind-Surge Demand Characterization
Gary Prinz, PhD, PE
University of Arkansas
July 2020-June 2022

Accomplishments: This project aims to understand the interactive effects of severe wind and storm surge demands on port infrastructure and to develop hazard demand models to aid improvements to infrastructure design.

Project Plans: An integrated analytical and experimental research approach, combining information from detailed fluid-structure-interaction simulations and scaled wind-wave experiments.

Rapid Assessment of Internal Erosion Damage and Erodibility in Levees
Michelle Barry, PhD, PE and Clint Wood, PhD, PE
University of Arkansas
July 2020-June 2022

Accomplishments: Recent flooding events have tested our nation's levee systems and highlighted the vulnerability of our transportation system to disruptions and delays caused by natural disasters. Traditional drilling and sampling techniques only provide discrete data points. This project seeks to make a correlation between geophysical properties and vital engineering properties such as erodibility. Development of the Hole Erosion Test (HET) apparatus has been completed. The team has identified a number of benchmark samples that will provide a wide range of soil property and erosion behavior data.

Project Plans: Collect field samples.

Trade-Off Analytics for Infrastructure Preservation
Greg Parnell, PhD and Ed Pohl, PhD
University of Arkansas
August 2018-December 2019
Accomplishments: The objective of this project was to develop a course that can be taught to civil engineers, industrial engineers, and the maritime and multimodal infrastructure community on the use of trade-off analytics as a tool to assist them in their infrastructure preservation efforts. This course was packaged into a webinar that can be delivered on-line for practicing professionals.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Using CSA Cement for Novel Waterway Repair Materials
Cameron Murray, PhD and Michelle Bernhardt-Barry, PhD, PE
University of Arkansas
August 2018-August 2021
Accomplishments: The goal of this study was to proportion a mortar mixture using BCSA cement suitable for underwater use. The mixture developed is expected to be suitable as a repair material. The mixture was intended to achieve a compressive strength of 4000 psi (27.6 MPa) within 3 hours when placed underwater while being self-consolidating. Mortar flow was measured as well as compressive strength for "dry-cast" and "wet-cast" specimens. A follow up project has been approved.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

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

Assessment of Evacuation Network Performance under Different Evacuation Scenarios
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2019-April 2022
Accomplishments: Several major disasters have occurred in the United States and impacted coastal and river valley communities. The economic and societal impact of such disasters have demonstrated a need for better emergency planning, response, recovery, and adaptation.
Project Plans: Focusing on the evacuation process of the coastal communities in the Florida Keys and preparing final report.

Development and Implementation of Sustainable Transportation Resilience Indicators
Mark Abkowitz, PhD
Vanderbilt University
June 2017-March 2019
Accomplishments: This project established a protocol and method for evaluating a community's level of sustainable transportation resilience. If deficiencies exist, attention can be focused on mitigating those concerns. The project was applied to a river valley community to demonstrate proof-of-concept.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of Freeway Corridor Capacity Measure to Improve Transportation Resilience
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2019-April 2022
Accomplishments: Natural disasters like hurricanes and floods occur throughout the world. However, coastal areas tend to be the most vulnerable to these disasters. Capacity is one of the most important

characteristics of a freeway facility which quantifies its traffic carrying capability and is a critical component to the resilience of transportation systems. A case study has been conducted in this research to estimate the capacity of a freeway corridor consisting of multiple bottleneck sections using traffic data from a coastal area. The results have been analyzed. A journal article has been published.
Project Plans: Preparing final report

Evacuation Behavior and its Mobility Impacts in Coastal Communities from Across the Nation
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2020-April 2022
Accomplishments: Coastal communities are at risk from a multitude of potentially disruptive events. Severe weather, climate change, and sea-level rise all pose serious and long-term societal challenges. This research seeks to develop a better understanding of the travel flow principles that govern the evacuation process and its impact on the mobility of a community, for different hazard types.
Project Plans: Collecting and analyzing hurricane and wildfire evacuation data.

Exposure to STEM: Diversity in Maritime Transportation
Rick Coffman, PhD, PE
University of Arkansas
August 2018-September 2019
Accomplishments: The goal of this education and workforce development project was to develop an educational/mentoring/advising model to open doors to all students, regardless of socio-economic background, who want to pursue careers in fields related to maritime and multimodal transportation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Impacts of COVID Restrictions on Freight Transportation in Coastal and Intermodal Port Regions
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
February 2022-December 2022
The global COVID pandemic of 2020, effected travel patterns across the world. This research is to identify and quantitatively assess the impact of COVID-related restrictions on travel activities, with a particular focus on freight and economic activity. The study will examine vehicle classification volume in both the United States and China to compare volume trends of specific types of traffic in both countries. Specific attention will be focused in areas where freight movement is related to intermodal port exchange.

Informing Post Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks
Sarah Nurre, PhD, Kelly Sullivan, PhD, and Ben Runkle, PhD
University of Arkansas
August 2018-December 2021
Accomplishments: Agriculture supply chains are important for the function of society. Agriculture supply chains are inherently complex due to their interdependency with critical infrastructure systems including energy, water, and maritime and multimodal transportation. We aim is to develop the necessary methodology to describe ag-sector and transportation-sector interdependence. We successfully created a mathematical model to characterize multi-modal transportation flow while incorporating interdependencies between agriculture and transportation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks - Phase II VU
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
October 2018-June 2022
Accomplishments: While disruptions due to weather, etc. can affect any sector, agriculture is unique in its time sensitivity for planting, harvesting, etc. Agriculture is interdependent on other sectors, particularly transportation to get seed and fertilizers to fields at appropriate times and in getting products that may spoil to market efficiently. This project will develop models that determine how to use transportation and coordinate restoration efforts to make ag supply chains more resilient.
Project Plans: Resolving issues with coordinate systems and the transportation networks across the three modes, as well as identifying potential disruption scenarios.

Interdependency of Port Clusters during Regional Disasters
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
January 2018-August 2019
Accomplishments: The research built upon the prior knowledge and expand the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The results showed that regionally, ports are more resilient to disruptive events than the individual ports that make up the region.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modifying Ramp Management Strategies to Enhance Resiliency of Freeway Facilities
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2020-April 2022
Accomplishments: Increased traffic demand of coastal areas during emergency evacuations have been shown to affect transportation systems negatively. Application of the ramp management algorithms modified by this method becomes increasingly important during emergency evacuation.
Project Plans: Data collection complete. Currently developing the simulation model.

Planning for Managed Retreat: Decision Making in the Face of Climate Uncertainty
Leah A. Dundon, JD, PhD and Mark Abkowitz, PhD
Vanderbilt University
December 2019-May 2022
Accomplishments: Sea level rise, increased frequency and intensity of flooding, and other extreme weather events have sparked a growing recognition that managed retreat must be among the solutions considered. This project will examine the need for managed retreat, case studies, and the significant challenges to implementing managed retreat as an adaptation strategy with a particular focus on transportation and its interdependencies with other critical infrastructure systems.
Project Plans: Looking at shifting away from specific crops in certain areas, changes to the types of vessels or scheduling used in inland waterway freight shipping, changes to the flood insurance program to stop rewarding building in high-risk areas or shifts in regulations governing water management.

The Unintended Consequences of Flood Mitigation along Inland Waterways – A Look at Resilience and Social Vulnerabilities
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
July 2020 – June 2022
Accomplishments: The objective of this project is to evaluate different flood mitigation efforts in terms of the community costs such as residential buyouts or elevation of structures. We will utilize agent-based models and empirical data from select communities where significant buyouts have taken place to simulate and estimate the extent to which buyouts may negatively affect community resilience. We will also examine the extent to which community size and ruralness contribute to phenomenon.
Project Plans: Near complete data collection on the project to inform development of the social fabric scores for communities. The remaining tasks are to finish developing the "model", which may not be an agent-based model now that we better understand the data and issues at play and then writing the report. The graduate student on the project is working on developing a journal manuscript about the social fabric score at present.

Towards Integrating Resilience into Everyday Transportation Practices of Coastal and River Valley Communities
Brian Wolshon, PhD, PE, PTOE and Nelida Herrera
Louisiana State University
August 2018-March 2021
Accomplishments: Coastal and river valley communities have become increasingly vulnerable to sea level rise, hurricanes, and other natural disasters. In many cases, these events force the communities to evacuate in a relatively unpredictable way. The results showed that the resilience metrics and methods implemented in this study seemed to have captured the resilience of the freeway using simulation. The results of the analysis also showed that active ramp metering improved the resilience of the freeway based on all of the methods and metrics considered in this study.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Utilizing Graceful Failure as an Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
May 2018-March 2020
Accomplishments: In 2011, we observed how "graceful failure" through planned damages to the Birds Point Levee by the US Army Corps of Engineers was enacted to alleviate extreme flooding on the Mississippi River. This action, while flooding croplands as planned in the past, actually reduced flooding and damage to waterway infrastructure and communities downstream.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Visualizing Sea Level Rise Impacts in Transportation Planning
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
January 2018-December 2019
Accomplishments: The goal of this research was to test and compare new technologies in community-meetings in South Florida to assess the effectiveness of 3D visualization technology, improving residents' understanding of the impacts of sea level rise on their communities and infrastructure.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

2. Participants & Collaborating Organizations

Amir, Gharehgozli, California State University Northridge; Okan Duru, Nanyang Technological University, Singapore; Jean-Paul Rodrigue, Hofstra University; Chris Clott, Maritime College State University of New York; Leo Tadeu Robles, Federal University of Maranhao State, Brazil; Ana Casaca, World of Shipping Portugal; Port of New Orleans, International Freight Forwarders & Customs Brokers Association; World Trade Center Transportation Committee; Ports Association of Louisiana; Greater New Orleans Port Safety Council; New Orleans Regional Planning Commission; MS Valley Trade & Transport; Port of South LA; Port of Plaquemines; Coastal Cargo; Jefferson Transit; Regional Innovation Alliance; TN Dept. of Transportation; TN Dept. of Economic and Community Development; American Bureau of Shipping; Don Loftis, Olin Corporation; Brian Rafferty, Ingram Barge Company; Chris Barkin, University of Illinois; Diane Husic, Morovian College; Gillian Bowser, Colorado State; Deidre Smith, Deputy Director, Inland Rivers, Ports and Terminals, Inc.; Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University, Cape Girardeau, MO; Dr. Kenneth Ned Mitchell, Research Civil Engineer, US Army Engineer Research and Development Center Coastal and Hydraulics Laboratory, Vicksburg, MS; Chad Johnston, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Arkansas District; Glenn Moore, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Oklahoma District; Dr. Furkan Oztanriseven, Assistant Professor of Data Science, LeMoyne College; Travis Black, Office of Ports & Waterways Planning, Port Infrastructure Development Program Team Lead, US Dept. of Transportation Maritime Administration; Matthew Chambers, Bureau of Transportation Statistics, USDOT; Raquel Wright, Federal Railway Administration, USDOT; Kirk Claussen, Loan Specialist, Maritime Administration, USDOT; Wade Morefield, Office of Ports & Waterways Planning, US Dept. of Transportation, Maritime Administration; Bruce Lambert, MARAD, USDOT; Bill Eisele, Head of the Mobility Division, Texas A&M University Texas Transportation Institute; Marin Kress, Research Scientist, CHL, ERDC, USACE; Chase Long, Staff Lead, Maritime Data Integrated Action Team (IAT); Action Coordinator, Infrastructure Investment IAT, Committee on the Marine Transportation System, USDOT; Forrest Vanderbilt, Headquarters, USACE; Ed Strocko, Director, Office of Spatial Analysis and Visualization, BTS, USDOT; Brian Tetreault, Navigation Systems Specialist, CHL, ERDC, USACE; Reese M. Brewer, Transportation Director, Frontier Metropolitan Planning Organization; Cody Schindler, MPO Transportation Planner Western Arkansas Planning and Development District; Mat Pitsch, Western Arkansas intermodal Authority and AR State Senator; Katie Lientz, Economist, MARAD, USDOT; Doug McDonald, Director, Office of Policy and Plans, MARAD, USDOT; Jack Cothren, Center for Advanced Spatial Technology, University of Arkansas; Chris Angel, Center for Advanced Spatial Technology, University of Arkansas; Dr. Donald T. Resio, University of North Florida; Dr. John van de Lindt, Colorado State University; Dr. Dan Cox, Oregon State University; Dr. Phil Berke, University of North Carolina; Dr. Phil Bedient and Dr. Jamie Padgett, Rice University; Dr. Casey Dietrich, Dr. Billy Edge, and Dr. Gavin Smith, North Carolina State University; Dr. Issac Ginis and Dr. Jim Prochaska, University of Rhode Island; Dr. Scott Hagen, Dr. Carola Kaiser, Dr. Robert Twilley, Louisiana State University. Dr. Mizunur Rahman, University of Alabama, Dr. Karl Kim, University of Hawaii, Dr. Jasim Imran, University of South Carolina, Chris Price, Chief Geotechnical Engineering and Geosciences Branch, US Army Corps of Engineers ERDC, Jamie Lopez Soto, US Army Corps of Engineers ERDC, Elmo Webb, Seth Martin, and Jonathan Palmer US Army Corps of Engineers, Leslie Montgomery Crawford County Levee

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Aghamohammad, Maryam, Jose Azucena, Haitao Liao, Shengfang Zhang, Heather Nachtmann, "Two-phase stochastic programming for improving the resilience of an inland waterway system," International Journal of Production Economics, 2022, under review.
2. Asborno, M., Hernandez, S., Mitchell, K., and Manzi, Y., Inland Waterway Network Mapping of AIS Data for Freight Transportation Planning, Journal of Navigation, January 2022, under review.
3. Dundon, L., M. Abkowitz and J. Camp, "Transformational Adaptation for Managed Retreat: Case Studies and Considerations for a Revised Policy Approach to Climate Change Adaptation," Journal of Environmental Studies and Sciences, under review.
4. Dundon, L.A. and M. Abkowitz, "Climate-Induced Managed Retreat in the U.S.: A Review of Current Research," Climate Risk Management, 2021, DOI 10.1016/j.crm.2021.100337
5. Folkman, D., Gharehgozli, A., Mileski, J., Galvao, C.B., "Port Resiliency and the Effects of Hurricanes on Port Operations," International Journal of Advanced Operations Management, Vol. 13, No. 4, P.409-430, https://www.inderscienceonline.com/doi/pdf/10.1504/IJAOM.2021.120779
6. Galvao, Cassia, Kruse, C. James, Villa, Juan Carlos, Mileski, Joan P. "Blockchain's Impacts on and Applicability: the case of Houston maritime cluster," Maritime Transport Research Journal, under review.
7. Johnson, P.M., H. Baroud, C. Philip and M. Abkowitz, "An Integrated Approach to Evaluate Inland Waterway Disruptions Using Economic Interdependence, Agent-Based, and Bayesian Models," International Journal of Production Economics, under review.
8. Johnson, P.M., H. Baroud, C. Philip and M. Abkowitz. An Integrated Approach to Evaluate Inland Waterway Disruptions Using Economic Interdependence, Agent-Based, and Bayesian Models. International Journal of Production Economics, under review.
9. Khan, M.S., Nobahar, M., Ivoke, J. and Amini, F., "Numerical Investigation of Hydraulic Conductivity Variation on Highway Slopes Made of Expansive Yazoo Clay," Journal of Transportation Research Record, accepted.
10. Kristiansson, F., Russel, H., S. Parr, E. Kaiser, and B. Wolshon, "Truck Traffic During COVID-19 Restrictions," ASCE Journal of Transportation Research Record, December 2021, under review
11. Wolshon, B., "Emergency Evacuation: 20-Year Evolution of Research and Practice," TR News, Transportation Research Board of the National Academies, Sep-Oct 2021, No. 335, pp 8-13.
12. Zhang, Z., D. Fu, F. Liu, and B. Wolshon, "COVID-19, Travel Demand, and Activity Restrictions in China: A National Assessment," Travel Behavior and Society, January 2022, under review.
13. Zhang, Z., Liu, F., B. Wolshon, and Sheng, Y., "Virtual Traffic Signals: Safe, Rapid, and Efficient Driving Without Traffic Controls," IEEE Transactions on Intelligent Transportation Systems, Vol. 22, No. 11, November, 2021, pp. 6954-6966.

Books/Other One-Time Publications

- Wolshon, B., "Transport Modes and Disasters," Encyclopedia of Transportation, Frist Edition, Volume 5, pp. 127-133. ISBN: 978-0-081-02671-7, Elsevier Inc., Philadelphia, PA, 2021
- Galvao, Cassia B., "Brazilian Port Development Policy: A Multidimensional Analysis," Editora Dialetica, DOI10.48021/978-65-252-1056-8(ISBN: 978-6525-21057-5-E-book 978-65-252-1056-8)

Editorial Journal Positions – Tech transfer
- 17 Editorial positions

3.2   **Website: martrec.uark.edu**

3.3   **New Methodologies, technologies, or techniques -** Nothing to report

3.4   **Inventions, patents, and/or licenses -** Nothing to report

3.5   **Other products -** Nothing to report

4.   **Outcomes**

4.1   **Increased understanding and awareness of transportation issues**

Leadership and Research Awards
- UA Soil Properties and Modeling Committee, committee of the year, Geo-Institute
- UA Applied Best Paper award by INFORMS Data Mining and Decision Analytics
- Cameron Murray, ACI Walter P Moore Junior Faculty Achievement Award

4.2   **Passage of new policies, regulation, rulemaking, or legislation -** Nothing to report

4.3   **Increases in body of knowledge**
Conference Presentations (Invited)
1. Briuglio, Sam, "Asset Management Technology for Federal Infrastructure," SAME JETC, February 2022
2. Briuglio, Sam, "Master Planning for Federal Facilities and Infrastructure," Fort Worth District USACE, March 2022
3. Cassia, Galvao, "Inland Rivers, Ports and Terminals Association," Biloxi, Mississippi Annual Conference, October 2021
4. Guang, Tian, "Transportation planning and system in American cities," Urban Management Seminar, University of Miami, March 2022
5. Sunchu, Vivek, Canhao Wang, Mercy Chebet and Terrence Conley, "Mississippi Multimodal Freight Analysis Model," Jackson State University Engineering Week, February 2022
6. Wolshon, B., "Roadway Design, Professional Standard of Care, and Expert Assessment for Law Suit Litigation," Clemson University, October 2021

4.4   **Improved processes, technologies, techniques, and skills -** Nothing to report

4.5   **Enlargement of the pool of trained transportation professions**
Certification Courses (Center for Training Transportation Professionals)
- 608 students through 5 webinars and 22 in person sessions
- 7 programs: Aggregates, Asphalt, Concrete, Pavement, Safety, Soils and Stormwater

4.6   **Adoption of new technologies, techniques or practices –** Nothing to report

5. Impacts *(through project deliverables and diversity)*

5.1 Effectiveness of the Transportation System – Nothing to report

5.2 Technology Transfer (Project Deliverables)
Final Reports during this period
- Modal Comparison Update: 2001-2019
- Dredging projects selection when the random shoaling effect is considered
- Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design
- Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks

Research Impacts
- Publications have begun to receive citations in peer reviewed journals: Guojing Hu, Feng Wang, Weike Lu, Tor A. Kwembe, and Robert W. Whalin, "A Cooperative Bypassing Algorithm for Connected and Autonomous Vehicles in Mixed Traffic." "Analytical Approximation for Macroscopic Fundamental Diagram of Urban Corridor with Mixed Human and Connected & Autonomous Traffic."
- 12 geospatial databases and applications developed for federal transportation planning and project management projects.
- Agent Based Simulation code developed in Netlogo

5.3 Increase in the Body of Scientific Knowledge
- Four final reports successfully submitted
- 13 peer-reviewed journal articles and two books were published

5.4 Transfer of Results to Government/Industry Entities
- A former student Guojing Hu is gainfully employed as a Transportation Engineer in academics

5.5 Commercialization of Technology/Process or Adoption of New Practices
- NSF I-Corp grant successfully awarded based on project "Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports"

5.6 Improved Performance, Skills, or Aptitudes of Underrepresented Groups
- 36% of our research projects are led by female researchers
- 40% of our student research participation are from underrepresented populations

5.7 Development and Dissemination of New Educational Materials – Nothing to report

6. Changes/Problems
- Problem: Our MarTREC institutions continue to be impacted by COVID-19.
- Change: We received an additional year of funding and a one year extension.

7. Special Reporting Requirements – Nothing to report