



USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #4

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

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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.

Objectives:

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

Accomplishments:

Research Effectiveness Metrics	Progress
# of peer-reviewed journal articles (published, accepted, submitted)	30
# of conference presentations given	11
# 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.

Objectives:

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

Accomplishments:

Leadership Effectiveness Metrics	Progress
# of national and regional leadership positions held	45
# of invited talks given	1
# of leadership and research awards received	6

1.1.3 Education and Workforce Development

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

Objectives:

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

Accomplishments:

Education and Workforce Development Effectiveness Metrics	Progress
# of transportation-related courses offered	38
# of technician certification programs offered	15
# K-12 outreach programs offered	10 (virtual)

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.

Objectives:

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

Accomplishments:

Technology Transfer Effectiveness Metrics	Progress
# of project deliverables submitted	5
# of technical briefs	1
# of editorial journal positions held	16

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.

Objectives:

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

Accomplishments:

Collaboration Effectiveness Metrics	Progress
# of existing collaborative partnerships	29
# of new collaborative partnerships formed	29

1.1.6 Opportunities for Training and Professional Development

- 11 students presented at professional conferences
- 13 conference planning positions were held by MarTREC faculty researchers
- 45 leadership positions held by MarTREC faculty researchers
- 497 individuals certified in 5 transportation disciplines

1.1.7 Dissemination of Results (In this reporting period)

- Two final reports successfully submitted
- 12 peer-reviewed journal articles 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

- 42 total projects (life to date)
- 16 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-November 2020

Accomplishments: It is unclear how relevant or critical the use of blockchain is for maritime business. A recent survey by Deloitte interviewed U.S.-based executives in the shipping sector and found that 39% of them have little or no knowledge about blockchain. Still 55% of them believe that failure to implement blockchain will put their company at a disadvantage; and 25% of them said that their companies viewed blockchain as a critical top 5 priority. Since it is new to an industry that is international, fragmented, and complex in nature, we explore several research questions arising from the application of blockchain to maritime supply chains and logistics.

Project plans: Final review of final report for submission

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

Bethany Stich, PhD

University of New Orleans

March 2018-February 2021

Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation coupled with public participation demands have revealed innumerable problems associated with the use of outdated techniques. In order to satisfy the current regulations and public policies, the transportation planning process can no longer solely rely on the basics of engineering; it is now forced to find the way in a sea of data, values and actors towards a comprehensive and integrated solution.

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-December 2020

Accomplishments: The purpose of this project is to develop a method to fuse truck and marine vessel tracking data to better estimate performance of multi-modal supply chains that use inland waterway ports. We have reviewed literature and characterization of Marine AIS and Truck GPSData and developed fusion approaches and derivation/apply multi-modal freight fluidity measures.

Project Plans: Final report in process

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. Terminal capacity is a determinant and a coupling link for vessel and truck flows. This study found data availability as an important constraint for a more detailed analysis. The main recommendation is to explore new data sources and evaluate data generation techniques to produce a more complete data set for a more thorough analysis.

Completed Project: Conducted by TTI, this project was completed in March 2019. 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 mentioned above 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.

Project Plans: Evaluate the effect of “special conditions” on travel time.

Interdisciplinary Educational Outreach with Traffic Sensor Build Kits

Sarah Hernandez, PhD, PE

University of Arkansas

May 2019-August 2020

Accomplishments: This project seeks to design and implement freight oriented educational outreach activities centered on traffic sensing technologies for middle, high school, and first-year college students. We’ve designed a low-cost, easily implementable LiDAR and Bluetooth sensor bundle that was capable of detecting, characterizing, and tracking freight trucks as they traveled to and from inland waterway port areas. We have completed assessment of technologies and design of the build kit.

Completed Project: Conducted by UA, this project was completed in August 2020. 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-February 2021

Accomplishments: This project plans to describe stoppages that cause downtime. This information would be a valuable addition to what has previously been available in the Lock Performance Management System data. We have assembled a dataset for the Key Locks, from the Public Lock Commodity, Usage and Unavailability Reports.

Project Plans: Our focus now is on creating and understanding methods for mitigating interdependence among Public Lock Report variables while preserving the most important among them, to understand variation in usage and unavailability. We have generated some results related to effectiveness of our

methods based on Cluster Variables, and we have generated some other results based on competing methods. We must devise a reasonable, systematic way to compare model recommendations. Then we must assess those recommendations according to model assumptions. Also we want to interpret our selected model(s) of Public Lock Report data and communicate what it is we have learned from them. Finally it will be important to present summary statistics and visualizations for the relevant data.

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, PhD and Justin Chimka, PhD

University of Arkansas

August 2018-June 2022

Accomplishments: This project is expanding prior MarTREC research and is utilizing our previously developed Maritime Transportation Simulator (MarTranS). We collected current data and replicated our past scenario analyses of the McClellan-Kerr Arkansas River Navigation System (MKARNS). MarTranS was modified in order to collect and study more operational data related to lock and dam behavior. In addition, a literature search and review of prior research on and implementation of container-on-barge was completed, and we have developed gap research areas and questions to explore. We provided economic impact data to the Arkansas Waterways Commission in support of their response to the MKARNS flooding event that occurred fall 2019. Results were presented in May 2019 at the Institute of Industrial and Systems Engineers annual conference and in October 2019 at the annual American Society for Engineering Management conference.

Project Plans: We have completed a global academic and public literature search and review, which will be submitted for publication this fall. Our current results will be presented this month at the 2020 Institute of Industrial and Systems Engineers annual conference. We continue to work on a multi-attribute framework for evaluating the decision whether or not to implement Container-on-Barge within an inland waterway.

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

New Project: COVID-19 responses by public agencies and private citizens have affected drivers and driver support systems. In this project, we consider an expanded definition of the freight network, beyond roads and warehouses, to include truck drivers and driver support systems. Driver support systems include physical infrastructure like public and private rest stops as well as operational protections like Hours of Service (HOS).

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-December 2021

New Project: 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. A multi-stage stochastic optimization model will be developed to evaluate tradeoffs in strategic, long-term port infrastructure investment with mid-term capacity expansion decisions and provision of complementary highway infrastructure made by public and private stakeholders, and shorter-term operational practices made by shippers and carriers.

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, rather than the ocean carriers. Cultivating a few large regional pools, a national chassis pool, or possible federal public-private investment in the chassis fleet are some workable answers. One proposed solution is more competitive pricing among more international chassis lessors.

Completed Project: Conducted by UNO, this project was completed in December 2019. Final project report was submitted and distributed as per grant guidelines.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

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

New Project: 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.

Dredging Projects Selection when the Random Shoaling Effect is Considered

Bruce Wang, PhD

Texas A&M University

October 2019-March 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.

Project Plan: Algorithms and numerical tests are in the works.

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. Overall, this report estimates that the GIWW has an economic impact of \$61.5 billion annually, supports 143,000 jobs, and saves up to \$4.3 billion in transportation cost savings annually.

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

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

Sadik Kahn, PhD, PE

Jackson State University

September 2018-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: Conducted by JSU, this project was completed in December 2019. Final project report was submitted and distributed as per grant guidelines.

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

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

March 2018-December 2020

Accomplishments: The goal of this research is to assess if the use of 3D virtual and augmented reality as a policy deliberation tool for improved coastal planning, engineering and design by deepening the understanding of sea level rise impacts among the business and tourism industries in Waikiki, Hawaii. During this reporting period, the post-surveys for the community meetings were developed.

Project Plans: Analyze post surveys.

Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design

Yadong Li, PhD

Jackson State University

August 2019-February 2021

Accomplishments: Expansive soil causes a variety maritime transportation infrastructure problems, such as cracks, damage of pipeline, and the differential settlement of foundation. Test results showed that many cracks appeared on the surface of the hydrogel-treated Yazoo clay samples when subjected to moisture, which could be caused by the swelling property of clay in water. Unconfined compressive stress test on the samples showed that the hydrogel improved the strain of the clay significantly but had little improvement on its stress.

Project Plans: We are now optimizing hydrogel treatment recipe based on the stress-strain curve of the hydrogel-treated samples. The focus is on the improvement of the swelling behavior of expansive soil.

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. Detailed Sub-Modeling of the Pintle Ball and Socket during Gate Operation has been completed.

Project Plans: Parametric FEA Investigation to Develop Effective Multi-Mode Retrofit Strategies, task is currently under way and we are investigating several CFRP orientations and geometries for mitigating the crack-tip stresses. Experimental Verification task is also under way and we have been running

several fatigue tests on un-retrofitted cracked plates to develop our base-line fatigue performance for later retrofit improvement comparisons.

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: Conducted by JSU, this project was completed in December 2019. 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

New Project: The transportation system in the U.S. is extremely vulnerable to disruptions and delays from natural disasters. There is a need for an assessment strategy capable of capturing the probability of failure and associated economic impacts for maritime and inland waterway infrastructure subjected to flooding and other 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.

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. In addition, fiber reinforcement of MICP-treated samples improved the resistance to accelerated erosion.

Completed Project: Conducted by JSU, this project was completed in April 2019. 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. Regarding the acceleration of LNG as an industrial feedstock, as supported by the American Chemistry Council's growth projection data for the use of LNG in the

petrochemical industry, our fieldwork revealed a petrochemical manufacturing boom in the parishes between New Orleans and Baton Rouge.

Completed Project: Conducted by UNO, this project was completed in December 2019. 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: Conducted by UNO, this project was completed in December 2019. 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: Conducted by TAMU, this project was completed in January 2019. 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

New Project: 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. An integrated analytical and experimental research approach is proposed herein, 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

New Project: 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 which can lead to ineffective repairs and wasted funds. The ability of geophysical methods to enable quick measurements

of material properties over large areas was demonstrated in a previous project. This project seeks to make a correlation between geophysical properties and many vital engineering properties such as erodibility.

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: Conducted by UA, this project was completed in December 2019. 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-February 2021

Accomplishments: Calcium Sulfoaluminate-Belite (CSA) cement is a rapid setting hydraulic cement. Due to its rapid hardening characteristics and lower shrinkage and creep compared to typical portland cement, it is an ideal candidate as a repair material. The goal of this work is to develop new mixtures utilizing CSA cement that can be applied to waterway repairs.

Project Plans: A grout mixture capable of setting up rapidly underwater and a soil-cement mixture that can rapidly stabilize slopes and waterway structures will be developed. We have found the ideal water/cement ratio for an underwater BCSA cement grout. Soil cement mixtures is being developed to test the soil cement under moving water and determine its resistance to erosion.

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-December 2020

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. This study will utilize data from Hurricane Irma (2017).

Project Plans: Focusing on the evacuation process of the coastal communities in the Florida Keys.

Development and Implementation of Sustainable Transportation Resilience Indicators

Mark Abkowitz, PhD

Vanderbilt University

June 2017-March 2019

Accomplishments: This project worked to establish a protocol and method for evaluating a community's level of sustainable transportation resilience, such that if deficiencies exist, attention can be focused on

mitigating those concerns. The protocol and method were applied to a river valley community to demonstrate proof-of-concept.

Completed Project: Conducted by Vanderbilt, this project was completed in March 2019. 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-December 2020

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.

Project Plans: 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.

Evacuation Behavior and its Mobility Impacts in Coastal Communities from Across the Nation

Brian Wolshon, PhD., P.E., PTOE

Louisiana State University

July 2020-June 2021

New Project: 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.

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: Conducted by UA, this project was completed in September 2019. Final project report was submitted and distributed as per grant guidelines.

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-February 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.

Project Plans: Objective 2: Build a geospatial dataset of interdependent agriculture and transportation infrastructure. Objective 3: Optimize post-disaster restoration plans for interdependent agriculture and

transportation infrastructures. Objective 4: Perform a case study to analyze the impact of potential disasters on multimodal transportation systems and the interdependent food and agriculture sector.

Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks - Phase II VU

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

October 2018-February 2021

Accomplishments: Agriculture is a critical part of the U.S. economy both domestically and in terms of exports. 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 effectively use transportation and coordinate restoration efforts to make ag supply chains more resilient.

Project Plans: Progress has been made on the GIS to feed into the model that our colleagues at U of Arkansas is building. Next steps are 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 seeks to build upon the prior knowledge and expand the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The contribution of this research is to empirically show how port clusters rely upon each other during disruptive events to increase the overall resiliency of water bourn commerce during disruptive events.

Completed Project: Conducted by LSU, this project was completed in August 2019. 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-June 2021

New Project: 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.

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 (e.g., resources, policy, law, role of insurance, cultural acceptance, and ability of relocated area to absorb increased population), with a particular focus on transportation and its interdependencies with other critical infrastructure systems.

Project Plans: Managed retreat is not static. 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 practices in areas of increasing drought.

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 2021

New Project: 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 may contribute to this phenomenon.

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-December 2020

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. We have completed identifying performance measurements and developed simulation scenarios.

Project Plans: Working on the impact of different strategies and analyze simulation outputs.

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: Conducted by VU, this project was completed in March 2020. 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: Conducted by LSU, this project was completed in December 2019. 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, Moravian 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.

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Ahmed, A., Khan, M.S., Hossain, M.S., Sadigov, T. and Bhandari, P., "Safety Prediction Model for Reinforced Highway Slope Using Machine Learning Method," Journal of Transportation Research Board: 0361198120924415.
2. Allen, M., L. Gillespie-Marthaler, M. Abkowitz, J. Camp, "Evaluating Flood Resilience in Rural Communities: A Case-Based Assessment of Dyer County, Tennessee," Natural Hazards, (accepted).
3. Asborn, M., Taslima Akter, (students) and Sarah Hernandez, "Multicommodity Port Throughput from Truck GPS and Lock Performance Data Fusion," Maritime Economics and Logistics, <https://doi.org/10.1057/s41278-020-00154-7>
4. Carroll, S. (student), Le Moreno-García, and Benjamin Runkle, "Simulating Soybean-rice rotation and irrigation strategies in Arkansas, USA Using APEX, Sustainability, 12, 6822, doi:10.3390/su12176822, <https://www.mdpi.com/2071-1050/12/17/6822/htm>.
5. Castellví, F., K. Suvočarev, M. Reba, and B. Runkle, "Friction-Velocity Estimates Using the Trace of a Scalar and the Mean Wind Speed, Boundary-Layer Meteorology," 10.1007/s10546-020-00520-1.
6. Castellví F, K. Suvočarev, M. Reba, and B. Runkle, "A New Free-Convection Form to Estimate Sensible Heat and Latent Heat Fluxes for Unstable Cases," Journal of Hydrology, 124917, 10.1016/j.jhydrol.2020.124917.
7. Dash, I. (student), M. Abkowitz and C. Philip, "Design and Implementation of an Integrated Technology System for Rail Shipper Safety & Security," (in review).
8. Delgado-Hidalgo, Liliana, and Heather Nachtmann, "A Heuristic Approach to Managing Inland Waterway Disruption," Engineering Management Journal, (published).
9. Delgado-Hidalgo, Liliana, Chase Rainwater, and Heather Nachtmann, "A Computational Comparison of Cargo Prioritization and Terminal Allocation Problem Models," Computers & Industrial Engineering, Vol. 144 (published).
10. Dundon, L. and J. Camp., "Climate Justice and Home-Buyout Programs: Renters as a Forgotten Population in Managed Retreat Actions," Journal of Environmental Studies and Sciences, (in review).
11. Dundon, L. and M. Abkowitz, "Climate-Induced Managed Retreat in the U.S.: A Review of the Transportation Sector," Climate Risk Management, (in review).
12. Duru, O., Galvao, C. B., Gharehgozli, A. H., Mileski, J.P. and Robles, L.T., "Developing a Comprehensive Approach to Port Performance Assessment," The Asian Journal of Shipping and Logistics, (in press).
13. Galvao, C. B. and Robles, L.T., "The Political Dimension of Brazilian Port Development: a content analysis of the 2013 New Port Law," Journal of Maritime Affairs, (in review).
14. Galvao, C. B. and Robles, L.T., "The Strategic Dimension of Brazilian Port Development Policy," Case Studies on Transport Policy Journal, (under review).
15. Garay, S.(student) and S. Pinkley," Interdependent Integrated Network Design and Scheduling Problems with Movement of Machines," European Journal of Operational Research, (accepted).
16. Gedik, Ridvan, Gokhan Egilmez, Chase Rainwater, Kenneth Ned Mitchell, and Heather Nachtmann, "A Constraint Programming Approach for Scheduling Maintenance Dredging

- Activities of the U.S. Marine Transportation System Expert Systems with Applications," *Expert Systems with Applications*, (under revision).
17. Gharehgozli, A. H., Galvao, C. B., Mileski, J.P., Swaney (student), "The role of Sea Ports in the International Supply Chain of Wind Energy," *International Journal of Shipping and Transport Logistics*, (under review).
 18. Guojing Hu, Feng Wang, Weike Lu, Tor A. Kwembe and Robert W. Whalin, "Cooperative Bypassing Algorithm for Connected and Autonomous Vehicles in Mixed Traffic," *Institution of Engineering and Technology Journal of Intelligent Transport Systems*, April 2020, (doi:10.1049/iet-its.2019.0707).
 19. Guojing Hu, Weike Lu, Robert W. Whalin, Feng Wang, and Tor A. Kwembe, "Analytical Approximation for Macroscopic Fundamental Diagram of Urban Corridor with Mixed Human and Connected Autonomous Traffic," *IET Intelligent Transport Systems*, September 2020, (under review).
 20. Ivoke, J., Nobahar, M., and Khan, M. S., "Unsaturated Hydraulic Conductivity Variation of Expansive Yazoo Clay with Wet Cycles," *Transportation Research Board*, (under review).
 21. Janssen, C. (student), W. Barbour, E. Hafkenschiel, M. Abkowitz and J. Camp, "Evaluating Flood Resilience in Rural Communities: A Case-Based Assessment of Dyer County, Tennessee," *Natural Hazards*, (published).
 22. Johnson, P. (student), C. Brady, C. Philip, H. Baroud, J. Camp, M. Abkowitz, "A Factor Analysis Approach to Unify Community Vulnerability and Resilience Indices for Natural Hazards," *Risk Analysis*, (under review).
 23. Khan, M.S., Hossain, M.S., and Nobahar, M., "Stabilization of Highway Slope", *Transportation Research Board*, (under review).
 24. Khan, M.S., Thornton, D., Ivoke, J. and Nobahar, M., "Numerical Investigation of Slope Stabilization using Recycled Plastic Pin on Yazoo Clay," *ASCE Journal of Materials in Civil Engineering*, (under review).
 25. Mahmoudzadeh A., Chaolun Ma (students), Mohammadadel Khodakarami, Kenneth Mitchell, Bruce Wang and Yunlong Zhang, "Waterway Maintenance Budget Allocation in A Multimodal Network," *Transportation Research Part E*, (under review).
 26. Mileski, J.P., Clott, C, La Verne, T. (student), and Galvao, C. B., "The Psychology of the Market of Dry Bulk Freight Rate," *Journal of Shipping and Trade*, (under review).
 27. Nelson, K.S. and J. Camp, "Quantifying the Benefits of Home Buyouts, Demonstration of an Approach and Local Application to an Urban Area," *Anthropocene (special issue) - Urban Hydroclimatic Risks in the 21st Century: Integrating Engineering, Natural, Physical and Social Sciences to Build Resilience*, (under review).
 28. T.C. Sharkey, S.G. Nurre Pinkley, D.A. Eisenberg, D.A. Alderson, "In Search of Network Resilience: An Optimization-Based View," *Networks*, (accepted).
 29. Tong, Jingjing, and Heather Nachtmann, "A Tabu Search Approach to the Cargo Prioritization and Terminal Allocation Problem," *International Journal of Shipping and Transport Logistics*, (Vol. 12 No. 3).
 30. Wen, K., Li, Y., Huang, W., Armwood, C., Amini, F., and Li, L., "Mechanical Behaviors of Hydrogel-Impregnated Sand," *Construction and Building Materials*, (207, 174-180).

Conference Papers

1. Asborno, M. and Hernandez, S., "Commodity-based Vessel Trip Characterization on an Inland Waterway Network," *Annual Meeting of the Transportation Research Board*, 2021, (under review).

2. Camp, J., K. Nelson, C. Philip, M. Moravec, D. Scheffler, P. Johnson, "Utilizing Agent-based Modeling to Evaluate Operational Impacts of an Incident and Possible Alternatives on U.S. Waterways," Transportation Research Record, (accepted)
3. Cassia B. Galvao, Joan P. Mileski, Jim Kruse, Juan Carlos Villa, "Analysis of Blockchain's Impacts on and Applicability to Maritime Industry," Transportation Research Board Annual Meeting, January 2021, (under review).
4. Wang, C., Chen, N., & Tian, G., "Does Accessibility or Clustering Affect Your Walking and Cycling Behavior? Spatial Modeling of Multi-Use Path Usage for Salt Lake City," Transportation Research Board (TRB) 100th Annual Meeting, Washington D.C., 2021.
5. Zeringue, K., Stich, B., & Tian, G., "Suitability of Fusing Vehicle Probe Data and Vessel Data to Contextualize the Multimodal Interaction Impacts on Corridor Mobility – a New Orleans Case Study," Transportation Research Board (TRB) 100th Annual Meeting, Washington D.C., 2021.

Books/Other One-Time Publications

1. Abkowitz, M. "Can Your Community Handle a Natural Disaster and Coronavirus at the Same Time?," The Conversation, (published).
2. Fujii, A., "Multiaxial Fatigue of Notched Steel Plates and Investigation of CFRP Retrofits for Crack Initiation Prevention," Honors Thesis, (published).
3. Mayori Rivero, Mariel, "Preliminary Investigation of Required BCSA Amount for Soil Cement Mixtures," Honors Thesis, (accepted).
4. Verkamp, L., "Development of Multi-axial Fatigue Retrofits for Waterway Lock Gate Components." MS Thesis, (published).

Editorial Journal Positions – Tech transfer

1. Acting Managing Editor, Engineering Management Journal
2. Area Editor, The Engineering Economist
3. Associate Editor, ASCE Journal of Structural Engineering
4. Associate Editor, INFORMS Journal on Computing
5. Associate Editor, Journal of Infrastructure Systems
6. Associate Editor, Operations Research Letters
7. Guest Associate Editor, Climate Risk Management
8. Guest Editor, Geomaterials for Transportation Infrastructures
9. Guest Editor, Natural Hazards Review
10. Member, Editorial Board, ASCE Journal of Infrastructure Systems
11. Member, Editorial Board, Environment Systems and Decisions
12. Member, Editorial Board, Journal of Infrastructure Preservation and Resilience
13. Member, Editorial Board, Quality Engineering
14. Member, Editorial Board, Stochastics and Quality Control
15. Member, Editorial Board, Transportation Research Part D: Transport and Environment
16. Member, Editorial Board, Transportation Research Part E

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

3. Outcomes

4.1 Increased understanding and awareness of transportation issues

Distinguished Lectures

- One lecture, Vanderbilt University

K-12 Programs and Pre-College Events

- 21 virtual presentations, 10 virtual tours, 6 virtual camps, 4 virtual outreach events

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

4.3 Increases in body of knowledge

Conference Presentations

1. Asborno, M. "GIS-Based Identification and Visualization of Multimodal Freight Transportation Impact Areas," AASHTO GIS-T symposium, Minneapolis, MN, April 2020, (accepted).
2. Asborno, M., and Hernandez, S., "Crowdsourcing Tools to Train and Evaluate Machine Learning Classifiers: Freight Data Management Application," 2020 National Travel Monitoring Exposition and Conference (NaTMEC) (accepted and postponed for 2021).
3. Asborno, M., and Hernandez, S., "Single Beam Lidar Detection for Truck-Body Type Classification", National Travel Monitoring Exposition and Conference , (accepted/postponed).
4. Asborno, M., and Hernandez, S., "Towards Multimodal Freight Network Modeling: Geospatial Map-Matching of AIS Data and Integration with Truck Movements," Sixth Biennial Marine Transportation System Innovative Science and Technology Conference, Washington, D.C., (accepted and postponed until March 2021).
5. Asborno, M., Moscardi, C., and Hernandez, S., "Ask the Crowd: Expedited Data Labeling for Supervised Machine Learning in Freight Data Applications," Commodity Flow Survey Workshop, Washington, D.C., (accepted and postponed).
6. Broho, Mazen, Mileski, J., and Galvao, C., "Maritime Finance: Financial Strategies and Risk hedging of IMO 2020," 28th Annual Conference of the International Association of Maritime Economists (IAME) Hong Kong, (via Zoom), June 2020.
7. Dundon, L., "An Interdisciplinary Approach to Climate Education: Making Infrastructure Exciting," ICNet Global Infrastructure and Climate Network, June 2020.
8. Galvao, C. B. and Mileski, J., "Cruise Port Governance: The Case of Major U.S. Ports," Annual Conference of the International Association of Maritime Economists, (via Zoom), June 2020.
9. Mileski, J. and Galvao, C. B. "Maritime Cyber Security: A Comparative Analysis of AIS Receptors in the Port of Houston," 28th Annual Conference of the International Association of Maritime Economists, Hong Kong, (via Zoom), June 2020.
10. Mileski, J., Galvao, C. B., Dewitte, P. and Swaney, B. "Internet Services Onboard of Cruise Ships: an Initial Study of Risks and Vulnerabilities," 28th Annual Conference of the International Association of Maritime Economists, Hong Kong, (via Zoom), June 2020.
11. Nachtmann, Heather, and Jackson Cothren, "Transportation and Maritime Analytics Partnerships Hub," Frontier Metropolitan Planning Organization Policy Board meeting, Virtual, August 2020.

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)

- 3 webinars, 5 online, and 7 in person

- 5 programs, 15 sessions, 497 students
- Programs: Aggregates, Concrete, Pavement, Soils, Stormwater.

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

4. Impacts (through project deliverables and diversity)

5.1 Effectiveness of the Transportation System – Nothing to report

4.2 Technology Transfer (Project Deliverables)

Final Reports during this period

1. Interdisciplinary Educational Outreach with Traffic Sensor Build Kits
2. Measures of Freight Network Resiliency: An expanded data capture of Truck Drivers and Support Services under Pandemic Distress

Research Impacts

1. Rapid setting flowable underwater mortars and concretes
2. Novel method of applying generalized assignment method to conflate truck and marine movements to estimate commodity flows
3. Build kits with traffic sensor components are a novel form of pedagogy

5.3 Increase in the Body of Scientific Knowledge

- Two final reports successfully submitted
- 12 peer-reviewed journal articles were published

5.4 Transfer of Results to Government/Industry Entities – Nothing to report

5.5 Commercialization of Technology/Process or Adoption of New Practices - Nothing to report

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 is from underrepresented populations
- 40% female and 30% underrepresented, K-12 and pre-college events

5.7 Development and Dissemination of New Educational Materials

- Interdisciplinary Educational Outreach with Traffic Sensor Build Kits

6. Changes/Problems – Our MarTREC institutions have been impacted by COVID-19. Our campuses made rapid shifts to virtual learning in the spring and have continued to educate transportation students in higher education through hybrid, remote, and safe face-to-face learning options this fall. Despite travel restrictions, our research programs have continued to progress through virtual team meetings and data collection. Many of our professional conferences were shifted to virtual events, and we have been advising our student research teams remotely. MarTREC’s outreach programs have been negatively impacted by the pandemic as we were unable to hold our spring and summer k-12 student events and had to cancel on-campus invited lectures. We all look forward to engaging on-site with our next generation transportation students and industry stakeholders as soon as it is safe to do so.

7. Special Reporting Requirements – Nothing to report