



**CFIRE**

# **Program Progress Performance Report (PPPR): July 1, 2015 to December 31, 2015**

**February 2016**

National Center for Freight & Infrastructure Research & Education  
Department of Civil and Environmental Engineering  
College of Engineering  
University of Wisconsin–Madison

**Principal Investigator:**

Teresa M. Adams, Ph.D., F.ASCE  
Director, CFIRE  
Professor, Dept. of Civil & Environmental Engineering  
University of Wisconsin–Madison

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Program Director:	Teresa M. Adams, Ph.D. Executive Director, CFIRE Professor, CEE University of Wisconsin-Madison adams@engr.wisc.edu; 608-263-3175
Submitting official:	Steven Wagner CFIRE Communications Manager steven.wagner@wisc.edu; 608-890-2311
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Signature of submitting official:	Steven V. Wagner
	

This report covers CFIRE's efforts to collaboratively address research, education, workforce development, and technology transfer under DTRT12- G-UTC19 during the reporting period of July 1, 2015 to December 31, 2015.

## ACCOMPLISHMENTS

### CFIRE's Goals

1. **Research:** Through the strategic planning process, CFIRE is continuing its efforts with eight research initiatives that support the USDOT Strategic Goals and advance the state of practice in freight and freight infrastructure systems.
2. **Education and Workforce Development:** The partner institutions of CFIRE are actively engaged in education and workforce development at the local, state, and national levels. CFIRE has built upon established successful programs to establish and leverage funding with the Midwest Transportation Workforce Center and continues support new collaborative initiatives. Our proposed education and workforce activities for university students and practicing professionals will develop skills and knowledge in multimodal freight transportation systems that reinforce our Center's theme. CFIRE is assessing workforce development needs to support implementation of the Marine Highways in the Great Lakes and tributary river system.
3. **Technology Transfer:** Technology transfer is the process of transferring discoveries or innovations derived from university research into products and services that benefit the profession. CFIRE continues to engage and facilitate the freight planning community in the 10 state region comprising the Mid-America Freight Coalition in a cross-section of technology transfer initiatives. These will include both traditional and innovative approaches to disseminating information.
4. **Collaboration:** The CFIRE team has taken advantage of regional expertise by establishing both northern and southern hubs to help coordinate proposed education, training, and technology transfer efforts. The CFIRE team brings a wealth of experience and a history of collaborative work. We are developing international relationships through our participation in the World Road Association (PIARC) and in various bi-national US-Canada initiatives that include both state and national-level collaborations.

### Research Initiatives

#### RI-1: A Multi-Modal Freight Safety, Security, and Environmental Routing Tool

USDOT Priorities: Safety/Sustainability

Performing Institutions: University of Wisconsin – Milwaukee, University of Wisconsin - Superior, University of Alabama - Huntsville, and University of Southern Mississippi.

Start Date: July 1, 2012 End Date: June 30, 2015

#### Major Activities

- Nothing to report.

#### Specific Objectives

- Make web version of the routing tool available for transportation stakeholder use.

#### Significant Results

- Once available, multiple freight transportation stakeholders will have access to a tool that allows for making more informed routing decisions taking into consideration impacts associated with efficiency, safety, security and environmental protection.

#### Key Outcomes

- Increasing confidence that a comprehensive and practical decision-support tool can be implemented.

## Changes

- Decision made to include representation of the entire continental United States rather than limiting application to just CFIRE corridor states.
- Project schedule has been set back by issues related to serving a web-based version that can be made publicly available.

## RI-2: Making Freight-Centric Communities More Livable: Measuring the Impact of Advanced Technologies

USDOT Priorities: Livability/Economic Competitiveness

Performing Institutions: University of Memphis, University of Wisconsin-Madison, University of Toledo.

Start Date: July 1, 2012 End Date: June 30, 2015

### Major Activities

- Online story map created.

### Specific Objectives

- We are developing a visual display via the story map to showcase the case study corridor, and factors impacting livability.

### Significant Results

The research team wanted to explore the use of an interactive visualization to tell the story about freight-centric communities. A website was designed called Living with Freight Project: Memphis which consists of an ESRI Story Map Journal with embedded interactive maps. Users can explore objective indicators—indicators of the current conditions of Memphis and the neighborhoods bordering Lamar Avenue, as well as understand the freight landscape. The narrative talks about the interaction of Freight (Goods Movement), Livability, and Environmental Justice in Memphis.

Perceptions of the barriers to livability from the residential survey responses serve as the voice from the community. While data is available at the census block for some type of data, neighborhood-level data to show disparity within a city is still unavailable. Crime data, a major barrier to livability, also is not readily available for Memphis.

The visualization as well as findings from this report helps the user wonder many questions from a freight, environmental justice, and livability perspective.

- Why is there only one EPA monitor near Lamar Avenue?
- What difference would it make to establish strategies – like low emissions zones—investigated in this report, unless crime is abated?
- Should schools be re-sited in light of freight?
- Should the city incentivize fleet renewal or adoption of natural gas in certain corridors?
- Why do we allow people to live near areas of high freight activity?

### Key Outcomes

- University of Memphis and University of Wisconsin team members collaborated to submit a publication to the 2016 TRB. The submission was selected for presentation at the annual meeting. The four-volume final report draft was edited and condensed during this reporting period. The final version will be completed in early spring 2016 for posting on the CFIRE website.
- A copy of the story map report can be found on this website <http://uw-mad.maps.arcgis.com/apps/MapJournal/?appid=090c0247e1384fcf8092e664670cb0f5>

## Changes

- IRB approval process and access to neighborhood meetings took much longer than expected. This resulted in an extended timeline for the project. Additionally, the scope of the project expanded significantly and included thesis work from 3 graduate students at the University of Memphis.

### **RI-3: Non-Destructive Technologies for Monitoring and Condition Assessment to Support Safety, Maintenance Programming, and Cost Allocation**

USDOT Priorities: State of Good Repair

Performing Institutions: University of Wisconsin-Madison; University of Wisconsin - Milwaukee

Start Date: July 1, 2012 End Date: June 30, 2015

#### **Major Activities**

- Continued work on the research project including adding more NDE methods.
- Fixed major issue with web based application with the help of the expert system provider Logic Nets.
- Continued working on draft report.
- Presented work at the Mid-Continent Transportation Research Symposium.

#### **Specific Objectives**

- This research project evaluates the potential uses of new and existing NDT technologies for infrastructure monitoring and damage assessment. The research will produce practical methods to install sensors, collect and reduce data, and summarize results for both short- and long-term monitoring of critical freight infrastructure. The results of this investigation will provide local, state, and federal agencies with information sources and tools for structural health monitoring, non-destructive testing, developing risk management systems, and upgrading design standards.
- Undergraduate and graduate students' involvement in research activities in NDE method for transportation infrastructure.
- Undergraduate and graduate students' involvement in conferences and meetings related to NDE method for transportation infrastructure.

#### **Significant Results**

- Nothing to report.

#### **Key Outcomes**

- NDE expert system will be deployed as web based application.

### **RI-5: Estimating the Effects of Extreme Weather on Transportation Infrastructure**

USDOT Priorities: Sustainability

Performing Institutions: Vanderbilt University and University of Wisconsin-Madison.

Start Date: July 1, 2012 End Date: June 30, 2015

#### **Major Activities**

- Began development of manuscript(s) to report project findings.
- Began work on final report.

#### **Specific Objectives**

- Develop and pilot test a methodology that can identify highway infrastructure that is most threatened by flooding events.
- Estimate the actual damage due to flooding to the highway infrastructure itself and related indirect effects (e.g., delays in shipments, increased travel times and fuel costs).
- Define a risk index based on extreme weather threat and consequential impact on transportation infrastructure and operations.

#### **Significant Results**

- Hazus estimates a significantly greater amount of economic damage due to flooding than has traditionally been reported, due to consideration of impacts to transportation and utility infrastructure as well as indirect damages such as sheltering requirements.
- Yet, not all negative impacts to transportation infrastructure and mobility are considered in Hazus, meaning that there is an even greater amount of economic loss associated with transportation impairment than has even been captured by Hazus itself.

- Road closures do not appear to be an effective proxy measure for representing damage to highway infrastructure due to major precipitation events.
- Hazus is best used as a screening-level tool to identify highly vulnerable areas and then a more refined hydrologic model is better suited to evaluate depth and extent of flooding in areas of specific transportation assets.
- NARCCAP model outputs are not easily integrated into GIS due to differing coordinate systems of the six main models used and coordinate system/projection anomalies. Additionally, NARCCAP data uses an unusual longitude convention (i.e., from 0 - 360 degrees East). NARR uses -180 West to 180 degrees East longitude.
- Using our criterion for “key precipitation events”, tropical areas had 24-hour daily precipitation averages of over 30”.
- There is little data available to utilize in development of a risk index. Additional research and data are necessary to complete this task. One possible option is to utilize damage functions from the Hazus earthquake model as an initial basis for estimating damage costs.

#### **Key Outcomes**

- Nothing to report.

#### **Changes**

- Greater emphasis being placed on developing a representative risk index.
- Hazus is useful for approximating depth and extent of inundation and not much else for predictive modeling related to transportation infrastructure.
- Delay in obtaining good Hazus results. The model kept crashing for some of the “hot spot” areas on the 500-yr and 1000-yr flood runs.
- Slight delay in completing final report in fall 2015 due to Janey Camp on maternity leave.

### **Research Projects**

#### **CFIRE 08-03 Wisconsin Study on the Impact of OSOW Vehicles on Complex Bridges**

Performing Institution: University of Wisconsin-Madison

Start Date: August 8, 2013      End Date: October 7, 2015

#### **Major Activities**

- Simplified methods for predicting the effects of OSOW vehicles on stringers and floor beams have been developed.

#### **Specific Objectives**

- The primary objective during this period was to finalize partial drafts for the project report and to validate simplified methods of force prediction by comparing with results from complex FEM analysis.

#### **Significant Results**

- Nothing to report.

#### **Key Outcomes**

- Most of the analytic work is completed and 70% of the final report is completed.
- A presentation/tutorial was provided for WisDOT on using complex FEM analysis with highway bridges.

#### **Changes**

- Nothing to report.

#### **CFIRE 08-04 Region V Transportation Workforce Assessment and Summit**

Performing Institution: University of Wisconsin-Madison

Start Date: October 1, 2014      End Date: January 31, 2015

### **Major Activities**

- During this period the researchers held a number of outreach presentations to engage researchers, state DOTs, economics development, and workforce development professionals to attend the Workforce Summit.
  - 2015 Mid-Continent Research Forum, Ames IA
  - Ohio Conference on Freight
  - Indiana Logistics Summit
  - Illinois Technology Education Conference
  - 2015 Wisconsin Tribal Transportation Conference
- Convened a two-day Midwest Transportation Workforce Summit. This event had 123 registrants representing all sectors and modes of transportation including industry, workforce development professionals and educators.
- Convened a State DOT Human Resources Directors Meeting. Personally engaged the DOTs. Seven of nine DOTs sent representatives to Madison to talk about workforce challenges. Wisconsin DOT Secretary facilitated the meeting. The DOTs agreed to meet again at MAASTO.
- Compiled a draft of the Phase I Job Needs and Priorities Report in cooperation with the MTWC.
- Finalized development of initiatives identified in the April Strategic Advisory Meeting.

### **Specific Objectives**

- The purpose of this project is to lay the groundwork for addressing the transportation workforce challenges in the region either by taking steps toward implementing the national recommendations regionally or by identifying the challenges and developing the solutions that may be unique to this region.

### **Significant Results**

- Published a report on the April Strategic Advisory Meeting.
- In cooperation with the MTWC built a robust stakeholder database to invite to the Summit. Worked in partnership with other transportation groups to disseminate information on the Summit.
- Brought together key participants from multiple agencies and industry and established opportunities for collaborative partnerships in transportation workforce development.

### **Key Outcomes**

- Established the presence of the Midwest Transportation Workforce Center within the transportation workforce development community.
- Created a Transportation Community of Practice using Google Community as a means to share resources and build community.

### **Changes**

- Nothing to report.

### **CFIRE 08-05 Use of Comparative Efficiency Analysis to Optimize Transportation Infrastructure Maintenance Strategy**

Performing Institution: University of Wisconsin-Madison, Purdue University

Start Date: July 1, 2014      End Date: June 30, 2015

### **Major Activities**

- Developed and completed case studies, which involved performing Data Envelopment Analysis (DEA) modeling of the historical data of bridge maintenance.
- Analyzed the results from the DEA modeling to identify the characteristics of maintenance parameters.
- Completed the final report.

### **Specific Objectives**

- Identify how maintenance parameters of bridges affect the efficiency of maintenance investment strategy, determine the type and extent of the effects these parameters have on maintenance efficiency, and how the effects may differ between different observation areas.

### **Significant Results**

- Tables and charts of data results from the DEA modeling process and analysis.
- Identification of the different effects that fluctuating maintenance parameters have on maintenance efficiencies in different jurisdictional areas.
- Identification of certain jurisdictional areas that are performing at their peak efficiency levels on maintenance of certain asset types.

### **Key Outcomes**

- Plan to implement the method as described in this study to: evaluate prior maintenance efficiencies in different observation areas of different asset types; prepare for subsequent maintenance period; and establish efficiency guideline to prepare for specific situation.

### **CFIRE 09-07 Understanding Time-of-Day Variation in Truck Transport and General Traffic Emissions: Guidance for Strategic Urban Air Quality Investments**

Performing Institution: UW-Madison and Texas A&M Transportation Institute

Start Date: August 1, 2014      End Date: October 31, 2015

### **Major Activities**

- The research tasks preceding the air quality modeling have been successfully completed, specifically: Task 1 - refine traffic information for air quality and trucking analysis; and Task 2 - calculate time-of-day air pollution emissions. Task 3 is in progress.

### **Specific Objectives**

- Detailed time-of-day data sets for speed and volume data developed by the Texas Transportation Institute (TTI) for 10 Eastern U.S. metropolitan areas.
- Incorporated data from 1 into the state-of-the-art vehicle emissions modeling platform (SMOKE-MOVES) to generate emissions inventories for experimental conditions reflecting: a) EPA's current default conditions reflected in the National Emissions Inventory, b) using TTI generated speed and volume timing data to evaluate whether this information provides improved air quality modeling outcomes, and c) leveled emissions, such that the importance (sensitivity) of considering emissions timing can be considered.
- The resulting emissions inventories for vehicles will be combined with emissions from other human and natural sources, meteorology data, and treatment of chemical processes in the EPA Community Multiscale Air Quality (CMAQ) model.
- The research team will analyze CMAQ results and compare these results with ground-based measurements of NO<sub>2</sub> and ozone.

### **Significant Results**

- The research team has successfully developed emissions inventories with improved data describing the location, timing, and composition of emissions from metro-area on-road transport. The SMOKE-MOVES model was successfully deployed to process these emission inventories for use in air quality modeling. These inventories are being recalculated to reflect changes in U.S. EPA's national emissions inventories, as mentioned in the Changes section below.

### **Key Outcomes**

- This work represents the first-ever initiative to apply time-of-day vehicle-miles of travel (VMT) and speed data to emissions across a multi-state region in a methodologically consistent manner. The research team has established unique capabilities to test the proposed questions related to the impact of traffic timing on air quality.

## Changes

- Based on the research team's discussion with Project Advisors, the recommendation to researchers was to reduce the project scope to fewer than 10 metro-areas, such that modeling and analysis can focus on higher impact/interest areas.
- Additional time has been requested to update the air quality modeling platform to reflect U.S. EPA's most current Annual Emissions Inventory. This is critical to ensuring that the results of this research are relevant to transportation and air quality research and policy. The associated SMOKE-MOVES modeling runs are currently underway. The subsequent air quality modeling runs are anticipated through April, and as such a NCE request is anticipated to extend the project through that date.

## CFIRE 09-08 Effects of Heavy Vehicles on Dynamic Traffic Features

Performing Institution: University of Wisconsin-Madison

Start Date: September 1, 2014 End Date: August 31, 2015

### Major Activities

- In this period, we finished the final report of this project and the final revision of the paper that has been accepted for publication at the *Journal of Transportation Research Board: Transportation Research Record*.

### Specific Objectives

- The main objective for the work in this period was to collect and address comments for the project report and the journal paper.

### Key Outcomes

- The final report is completed and the journal paper is accepted for publication.

## CFIRE 09-09 Enabling Online Logistics Services Auction Platform (OLSAP): Optimal Eco-routing Techniques

Performing Institution: University of Illinois-Chicago

Start Date: August 15, 2014 End Date: August 14, 2015

### Major Activities

- Two journal research papers have been submitted, one to Transportation Research Part E: Logistics and Transportation Review on the topic of cost-effectiveness of electric commercial vehicles as alternative in urban good delivery to diesel trucks, and the other to Transportation Research Part D: Transportation and Environment on the topic of Green Same Day Package Delivery Service with Real-time Demand. The first one is current being revised in response to the reviewers' comments. The second one is currently under review.
- The third paper is in preparation and an extended abstract has been submitted to the 22nd International Symposium on Transportation and Traffic Theories (ISTTT) to be held on July 24-26, 2017 in Evanston, IL. The title of the abstract is Peer-to-Peer Transshipment with Nonstationary Relay Points.
- Dr. Lin gave an invited talk on EV routing problem at an INFORMS session on November 1, 2015.
- Dr. Lin has been invited to give a talk in a session entitled "Green Vehicle Routing" at the 28th European Conference on Operational Research in Poznan, Poland, July 3-6, 2016.

### Specific Objectives

- Nothing to report

### Significant Results

- On research paper "Is Electric Commercial Vehicle a Cost-effective Alternative to Diesel Truck in Urban Delivery?": This study investigates the cost-effectiveness of electric vehicle (EV) as a green alternative to diesel truck (DT) in vehicle routing operations through a series of comparisons among

an all-DT fleet, an all-EV fleet, and mixed EV-DT fleets with various EV penetration ratios. At the core of the cost estimation is a green EVRP (G-EVRP) model. G-EVRP minimizes the total daily operating cost of EV that consists of travel time cost, energy cost and en-route battery recharging time cost. The energy cost is a nonlinear function of travel speed and vehicle load. The mathematical formulation of G-EVRP is detailed in the paper. A cluster-based heuristic algorithm is designed for solving large scale G-EVRP. The sensitivity analyses reveal the significant effect of the relative distributions of customers and charging stations on EV routing strategies. Using the real network of the Austin, Texas metropolitan region, the numerical analyses find that while EV is a greener alternative to DT, it incurs much greater total due to the long en-route recharging time, which could make up as much as 40% of the total daily operating cost. A partial recharging strategy is then evaluated to show that it has the potential to considerably reduce the total en-route recharging cost, in terms of both dollar value and percentage share, and the total daily operating cost of an EV.

- On research paper "Green Same Day Package Delivery Service with Real-time Demand ": In light of the rapid development in the e-commerce sector and the increasingly popular demand for same day delivery, this study evaluates a green same day delivery (green-SDDS) paradigm for its cost performance by comparing the total costs of three delivery paradigms - hub-and-spoke, green-SDDS with a commercial fleet, and green-SDDS by crowdsourcing. The cost performance of green-SDDS is quantified by a cost model that finds an optimal green-SDDS strategy with the minimal sum of travel time cost, fuel cost, and emission cost. The green-SDDS evaluated in this paper is an operational strategy with real time demand. In the paper an emission-based heuristic algorithm is also presented to efficiently solve a large scale green-SDDS problem, which is demonstrated through a large numerical study based on the Austin, TX network. Our emission-based algorithm is shown to be computationally efficient. Among the three service paradigms compared, hub-and-spoke proves to be cost-effective for the traditional distribution service provided by commercial carriers but ill suited for providing same day delivery service. Commercial carriers are facing tremendous pressure in the era when same-day delivery service is increasingly expected. Crowdsourcing seems like a promising solution to providing low cost same day delivery service. Lastly, regardless of the delivery paradigm, the cost goes down as the economy of scale increases; and green-SDDS by crowdsourcing would become even more competitive when the demand ratio is very high; however, its fuel consumption and emissions tend to go up due to the additional vehicle detours to accommodate real time demand.
- On research paper (ongoing) "Peer-to-Peer Transshipment with Nonstationary Relay Points": In this paper, a peer-to-peer package relay strategy is studied. A peer-to-peer package relay strategy relies on collaboration and coordination among couriers to extend beyond the normal range of a single courier, without a physical transshipment center. This can be realized via to better utilize the transportation resources (i.e., information and vehicle capacity) by encouraging the collaboration among couriers, which can improve the efficiency of the transportation system in the new context of mobility era. At the same time, couriers may also benefit from the collaboration if they form an organizational system to reduce overall system-wide costs and thus increase each partner's profit. The proposed peer-to-peer transshipment (P2PT) with nonstationary relay points model considers an environment that in which a set of couriers may collaborate in performing the service to the new orders arriving in real time through one or multiple relay points on the route. The objective is to minimize the overall logistics cost. In this study, an ad hoc coalition is considered and formulated. In addition, unlike traditional transshipment/relay problems, the couriers could transfer the shipments anywhere en-route instead of at the transfer stations.

### Key Outcomes

- Two journal papers have been submitted - one is in revision in response to comments and the other is currently under review.
- One extended abstract has been submitted to ISTTT 2017.
- One NSF grant (\$1,000,000) that builds on this CFIRE project has been kicked off.
- One INFORMS presentation was given in November, 2015.
- An invited talk at the 28th European Conference on Operational Research will take place in July 2016.

## **CFIRE 09-10 Evaluating Use of Operational Management Techniques for Capacity Improvements on Shared-use Rail Corridors**

Performing Institution: Michigan Technological University

Start Date: September 1, 2014 End Date: August 31, 2015

### **Major Activities**

- Completed technical tasks and held final Web Conference with the Professional Advisory Committee (PAC)

### **Significant Results**

- Operational modifications performed well in the analysis. Details can be read in the final report.

### **Key Outcomes**

- Successfully completed all project simulations and reported on results to PAC.

### **Changes**

- Due to the fact that the completed almost three months later than estimated initial project kick off (December 2014 instead of September 2014), the project work was extended until end of November 2015, instead of August, 2015. Final report has been prepared and will be submitted by February 4, 2016.

## **CFIRE 09-12 Integrated Strategy for Beneficial Use of Dredged Materials in Great Lakes Commercial Ports**

Performing Institution: Michigan Technological University

Start Date: August 1, 2014 End Date: July 31, 2015

### **Major Activities**

- Completed and submitted final report.

### **Specific Objectives**

- The overall objective is to link together the following components: 1) identify applications for use of DM in transportation-related projects, 2) summarize required geotechnical properties in specific transportation applications, 3) identify available geotechnical test methods to determine those properties, 4) identify specific values of required geotechnical material properties for specific uses, and 5) identify locations within the Great Lakes region where dredged materials meeting these specifications may be sourced.

### **Key Outcomes**

- The index and engineering properties of raw dredged material (RDM) and RDM stabilized with self-cementing Class C fly ash (FA) were evaluated systematically. RDM samples were obtained by near-surface grab sampling of material placed in a confined disposal facility located at the south end of Milwaukee (MKE) Harbor in Wisconsin. RDM was blended with 10%, 20%, and 30% FA and cured for 2 hours, 7 days, and 28 days. Results showed that blending RDM with FA reduced the plasticity and improved its engineering properties. Increasing FA content increased the maximum dry unit weight and reduced the optimum water content of the stabilized dredged material (SDM). For any curing time, the undrained shear strength of SDM increased linearly with increasing FA content. The improvement in strength increased significantly as the curing time increased. Freeze-thaw cycles only slightly reduced the strength of the SDM specimens (by 4% on average), indicating that SDMs are durable to freeze-thaw processes likely encountered in field beneficial use applications. California bearing ratio (CBR) values for SDM cured beyond seven days varied between 10-20, and were comparable to those of compacted silty sand or sand. Results from CBR testing indicate that the SDM rates as "fair" to "good" for subgrade construction applications. The resilient modulus values for all SDMs increased significantly with increasing FA content. Resilient modulus values for SDM specimens after seven days of curing varied between 35-83 MPa. These values are comparable to

those of gravel and crushed stone, and places the SDM in “good” to “excellent” rating categories for subgrade applications. Results of this study indicate that dredged materials stabilized with Class C fly ash show mechanical characteristics viable for beneficial use as subgrade or embankment fill

### **CFIRE 09-13 The Potential for Mode Conversion to Rail Service in Wisconsin**

Performing Institution: University of Wisconsin-Madison

Start Date: September 1, 2014 End Date: November 30, 2015

#### **Major Activities**

- Completion of Task 2 - the shipper surveys have been completed with researchers completing the survey report for the final project report), and close to completion on Task 4 - researchers completed formulating the needed inputs and parameters for the ITIC-IM model, and have run an initial iteration of the model running the base case analysis and policy case analysis for the following four industries: food and beverage, plastics, machinery, and paper products. Analysis of the results showed errors in the tracking of shippers with multiple locations in the state, so researchers are currently updating the inputs to run a second iteration of the model for the same industries.

#### **Specific Objectives**

- Nothing to report.

#### **Significant Results**

- Nothing to report.

#### **Key Outcomes**

- Nothing to Report

#### **Changes**

- The project was given a no-cost extension. Creating the Wisconsin shipper and rail access point databases took longer than originally scheduled, and researchers were unable to make up that time during work on the subsequent tasks. The new timeline, with the final report draft being finished and shared by March 1, has been communicated to the project advisory committee.

### **CFIRE 09-14 Field Validation of Polyurethane Technology in Remediating Rail Substructure and Enhancing Rail Freight Capacity**

Performing Institution: University of Wisconsin-Madison

Start Date: July 1, 2014 End Date: December 31, 2015

#### **Major Activities**

- In Q3 we completed the field investigation of Dayton Dip site in Illinois. We also made all the preparations and worked with the industrial partner to develop a polyurethane injection plan adjacent to a bridge where settlement occurred. Additionally, we continued the large-scale laboratory experiments to proof geophysical methods and determine rail response to loading under various combinations of subsurface conditions.
- In Q4 we were stalled regarding the field work. Our first site was not available and we found a second site in Minnesota and developed a field investigation and polyurethane injection plan all over again for this site to submit to the owner for their approval. Meanwhile winter set in eliminating any field work.
- We continued and completed the large-scale laboratory experiments to proof geophysical methods and determine rail response to loading under various combinations of subsurface conditions.

#### **Specific Objectives**

- Identify a suitable field site.
- Determine the track structure and substructure conditions and materials.
- Field injection of polyurethane into the substructure to remediate fouling effect.

- Instrument the location for dynamic and long term monitoring.
- Conduct and Life Cycle Assessment (LCA).

### **Significant Results**

- Three possible field sites were identified and investigated. The field site chosen for the investigation has a significant ballast and substructure deficiency causing frequent maintenance. A geotechnical and geophysical investigation was conducted. Soil profiles were developed as well as in situ strength.

### **Key Outcomes**

- A full geophysical and geotechnical report of the selected field site.
- Fully designed polyurethane injection location and pattern.
- Verification of selected instrumentation in a laboratory setting.

### **Changes**

- The schedule has been rearranged, but there should be no changes. Inability to get time from the rail company to do the field work is affecting the project progress.

## **CFIRE 09-15 The Impact of Fracking on Freight Distribution Patterns**

Performing Institution: Vanderbilt University

Start Date: August 1, 2014

End Date: December 31, 2105

### **Major Activities**

- Began constructing a review of regulations and policies that states and municipalities have implemented holding fracking companies accountable for damage inflicted on transportation infrastructure.

### **Specific Objectives**

- Help counties experiencing active or potentially active fracking operations improve their understanding of the impact of hydraulic fracturing in their jurisdiction on transportation risks, costs and benefits.

### **Significant Results**

- Oil and gas wells tend to be decentralized and in rural areas, so even if there are nearby multi-modal transport methods, everything comes to and from the well via truck, and local roads were often not built to withstand such weight on such a frequent basis. Accordingly, roads are most negatively impacted on the local level. We have learned that localities across the country approach this in different ways. For example, in Mississippi a county official just calls up an operator and asks for gravel for certain roads to be fixed, and the company pays for it. Whereas in Ohio and Pennsylvania, there are more formal contracts – Road Use Agreements – between companies and townships or counties.

### **Key Outcomes**

On the basis of what has been learned to date, project tasks will now focus on the following:

- Conduct a national study to determine how oil and gas producing counties/townships around the country approach road repair/maintenance agreements with trucking companies and/or operators. Gain an understanding of: the specifics of these agreements, the history of them, and the authority under which they are entered; whether oil and gas trucks are singled out or if the arrangements are required of all types of trucking (e.g., agricultural movements), and how (or whether) they are enforced. Compare and contrast approaches and best practices, identify what has worked well in certain locations and what has not worked well.

- Use the study results to perform a legal and policy analysis regarding the authority to require trucking companies/operators to pay for road damage/repair and the underlying authority of these agreements.
- Develop a “best approach” to addressing road damage from oil and gas development tailored for small counties and townships.
- Apply the results to generate useful information for local planners and decision makers in Mississippi.

### **Changes**

- Nothing to report.

### **CFIRE 09-16 Reshoring and its impact on Transportation Infrastructure & US Economy**

Performing Institution: University of Southern Mississippi

Start Date: August 15, 2014      End Date: December 31, 2015

### **Major Activities**

- The research team and advisory board members met and discussed research progress on a monthly basis – 1st Monday of each month.
- Advisory board member Harry Moser provided data regarding reshoring companies in the US.
- Worked on reshoring methodology and freight distribution system.
- Tasks 2-6 are in progress – Tasks 2 & 3 are 80% done, task 4 is 70% done, and tasks 6 & 7 are 35% done.

### **Significant Results**

- An abstract was submitted to the Industrial & Systems Engineering Annual Conference, 2016.
- PI of this project and Harry Moser (advisory board member of this project) conducted a webinar (organized by Federal Highway Administration (FHWA)) to share reshoring and its potential impacts on US transportation.
- Tasks 2-6 are ongoing and looks like the team is behind the schedule – the team asked for no-cost extension until September 30, 2016 to complete this project and request was accepted.

### **Key Outcomes**

- Nothing to report.

### **Changes**

- Original research plan called for using only ESRI’s Business Analyst Dataset for the analysis. The dataset is a collection of business locations throughout the United States and associated attributes including best guess/estimates for employment, revenue, square footage, and industrial classification. However, when location quotients were calculated and analyzed by subsector at the county level, there were anomalies in the results that caused concern. Counties with location quotients that were 2+ standard deviations from the mean and those with employment figures 2+ standard deviations from the mean were flagged, and then the employment sum by subsector at the county level were compared to 2013 County Business Patterns (CBP) employment levels reported by the US Census Bureau. The anomalies arose due to a couple of reasons: one, employment counts for business locations being reported as a ‘Headquarter’ resulted in significantly high employee counts; and two, the industry classification differed from the CBP data. Those counties flagged were then analyzed individually to determine if either the presence of a headquarter classification or industry misclassification required the county to still be flagged.
- Location quotients were also figured for the counties within the study area using the CBP data; however, this data source is not without its fault as well. Privacy concerns result in the withholding of industry, sector, and subsector employment data at the county level anytime that the publishing of data can lead to information regarding individual businesses. In this case, the counts of establishments within certain employment ranges are used, using the midpoint of the reported employment range, to aggregate a particular industry, sector, or subsector employment at the county level. The location quotients figured using estimated employment levels was then flagged.

## **CFIRE 09-17 Nationwide Best Practices to Implement Freight Transportation Careers**

Performing Institution: University of Alabama-Huntsville

Start Date: September 1, 2014 End Date: December 31, 2015

### **Major Activities**

- Worked with research team to define “Best Practices”.
- Held bi-weekly teleconferences to discuss program.
- Continued to identify educational units with transportation programs.

### **Specific Objectives**

- Collect data from education program
- Begin discussion of definition for “best” practices.

### **Key Outcomes**

- Developed and completed a preliminary list of transportation programs at all levels and begin to collect data about these programs.

## **CFIRE 09-18 Addressing MAP-21 Freight Objectives using GPS Data**

Performing Institution: University of Memphis

Start Date: July 1, 2014 End Date: December 31, 2015

### **Major Activities**

- Updated the ArcGIS toolbox “GPS-based FPMs Estimation”. The current version the toolbox includes six tools, which perform the following procedures: 1) Estimation of link-based freight performance measures (FPMs), 2) Estimation of OD-based FPMs; 3) Estimation of average link/OD-based FPMs over specified time period; 4) Analysis of truck parking locations; 5) Estimation of hours of delay; and 6) Estimation of congested lane miles.
- Developed a user guide for researchers who want to use the above-mentioned toolbox and the GPS Data Processing and Extracting Tool, developed in previous stage of this project;
- Estimated OD-based FPMs for the state of Tennessee;
- Developed a tool to calculate freight facilities’ performance indicators. The tool calculates hourly volumes, entry/exit volumes per time of day, and turn times;
- Estimated path-based reliability for Shelby county in Tennessee;
- Estimated hours of delay and congested lane miles for 10 counties in the state of Tennessee.

### **Specific Objectives**

- The developed GPS-based FPMs Estimation toolbox will allow estimating different FPMs, which can be further used by private and public agencies in freight transportation planning;
- The developed freight facilities tool estimates hourly volumes, turn times, and entry/exit volumes per time of day, allowing stakeholders analyze how the facilities perform for future planning;
- The proposed methodologies and results for estimation of OD-based FPMs, path-based reliability, calculation of hours of delay and congested lane miles for a given transportation network, may provide insightful outcomes for different stakeholders.

### **Significant Results**

- The developed tools (i.e., GPS-based FPMs Estimation toolbox and freight facilities tool) will be used for analysis of freight corridors and freight facilities within Tennessee, Mississippi, and Alabama using the available truck GPS data. Based on the analysis results recommendations and findings will be reported;
- The developed methodologies for estimation of OD-based FPMs, path-based reliability, and calculation of hours of delay and congested lane miles for a given transportation will be implemented using the available truck GPS data in all states and results will be provided in the final report.

## **Key Outcomes**

- Updated the GPS-based FPMs Estimation toolbox;
- Estimated OD-based FPMs for the state of Tennessee;
- Estimated path-based reliability for Shelby county in Tennessee;
- Estimated hours of delay and congested lane miles for 10 counties in the state of Tennessee.

## **Changes**

- Nothing to report.

## **CFIRE 09-19 Freight Economic Vulnerabilities Due to Flooding Events**

Performing Institution: Vanderbilt University

Start Date: July 1, 2014                      End Date: June 30, 2015

## **Major Activities**

- Task1: Began analyzing and synthesizing survey responses (109 responses)
- Task 2: Developed “scenarios” for future “worst case” conditions with respect to flooding at a county level using University of Georgia’s downscaled climate data for mid-century time period; Identified 4 key counties that are of concern for the future with regards to heavy precipitation, performed drill-down of two adjacent counties in middle-west Tennessee; We also used the FHWA’s CMIP Climate Data Processing Tool to better understand the mid-century projections for daily precipitation for the counties of concern.
- Task 3: From another project, we have identified critical transportation assets in Tennessee. We may test the methodology used for another state for this project. Identified key transportation assets in the counties identified to be most at risk due to future precipitation. Performed Hazus model simulations for 500-yr and 1000-yr precipitation events to identify bridges, highways, and other transportation at risk for the counties of concern. Utilized FHWA’s Vulnerability Assessment Scoring Tool (VAST) to develop vulnerability scores for transportation infrastructure assets at risk (only for demonstration purposes of how it could be utilized due to lack of detailed information about individual infrastructure assets’ condition, etc.) Focused on bridges, but need to look at other asset types also.

## **Specific Objectives**

- Estimate the direct and indirect economic impacts of various flooding scenarios on truck, rail and barge transportation by developing economic loss/damage functions based on the extent and level of flood inundation.
- Use models for a case study region to gain insights into the magnitude of economic impact that flooding has on truck, rail and barge operations.
- Identify those portions of the network that are considered most at economic risk due to their vulnerability to flooding and the strategic importance of the route segment relative to local, regional and national freight mobility.

## **Significant Results**

- We did find that much more information is required to use VAST for developing vulnerability scores.

## **Changes**

- We were unable to obtain a graduate student to work on the project full time and have thus utilized an undergraduate student worker.
- Janey Camp, PI, was out on maternity leave for 3 months of the fall semester which prevented much progress during this time.

## **CFIRE 09-20 Estimating the Future Agriculture Freight Transportation Network Needs due to Climate Change using Remote Sensing and Regional Climate Models**

Performing Institution: Vanderbilt University

Start Date: July 1, 2014                      End Date: September 30, 2015

## **Major Activities**

- Held initial project meetings.
- Reduced effort of MTSU due to limited availability of graduate students
- Added Craig Philip, new faculty at Vanderbilt and former CEO of Ingram Marine Group to project team.
- Re-shifted focus from Tennessee to upper Mid-west due to University of Wisconsin obtaining funding to participate. Originally, we were told that they were unable to participate due to lack of funding.
- Began evaluating crop data (acreage by crop type and year at the county level) from the National Agricultural Statistics Service.
- Began identifying “extreme” weather events that may impact crops from the National Weather Service data repository.
- University of Wisconsin team held interviews of key stakeholders in agriculture and freight transportation.
- MTSU has processed some remotely sensed crop data and created shapefiles from that – provided to VU recently.

## **Specific Objectives**

- Evaluate recent trends in crop yields and shifts using remote sensing technology.
- Develop any correlations between historic regional climate and crop yield/growing patterns for use in future projections.
- Approximate future locations of crops that will be grown in upper Midwest in 2050 using extrapolation of historic crop data from remote sensing, correlations that have been developed between climate and crop yield, and future climate predictions from the regional climate models.
- Use projected crop areas and climatic projections to estimate yield at appropriate harvesting times as input into freight routing and demand tools.
- Provide an estimate of the multi-modal demands and routes for freight to move agriculture from Midwest to lower Mississippi for export.

## **Significant Results**

- Shifted focus to upper Mid-west region due to Madison-Wisconsin partners receiving funding to participate long after the project start period
- Evaluating potential for agent-based modeling to look at freight network interactions, etc.

## **Key Outcomes**

- Nothing to report.

## **Changes**

- Shifted focus region back to upper Mid-west from Tennessee due to newly obtained funding for Wisconsin partners. MTSU's effort was reduced due to lack of graduate student availability to work on the project.
- Janey Camp, PI, was out on maternity leave for 3 months of the fall semester which prevented much progress during this time

## **CFIRE 09-22 Implementation and Field Evaluation of Pretensioned Concrete Girder End Crack Control Methods**

Performing Institution: University of Wisconsin-Madison

Start Date: July 1, 2014

End Date: December 31, 2015

## **Major Activities**

- Modeling has been completed on both 54W girders and 72W girders, with strand variations as shown in Standards 19.16 and 19.18, to identify the number and locations of strands that should be debonded to prevent predicted tension strains at the end of the girder from exceeding the cracking strain.

### **Specific Objectives**

- The project is monitoring strains and cracking in the precast highway bridge girders when built, preparing analytical models to simulate the cracking, and examining the effects of debonding strands on a range of Wisconsin girders to improve future designs.

### **Significant Results**

- Elastic modeling of the girders has been successful. This has led to the current work with inelastic modeling to develop new design guidelines.

### **Key Outcomes**

- Nothing to report.

## **Education and Workforce Development**

The following progress has been made on CFIRE's commitments to education and workforce initiatives.

### **University of Memphis**

- Sponsored the GEE and TREC week long programs- 64 students participated in the on-campus sessions and another 21 participated at a satellite location at a local high school. The last day of the week, both programs were on campus to have a friendly competition on the work they had completed over the week. This was the third year we had a satellite camp. The primary goal of the Girls Experiencing Engineering (GEE) and Transportation Engineering Careers (TREC) programs is to increase the number of students pursuing careers in transportation engineering by offering high school students an opportunity to increase their awareness and interest levels regarding existing and potential opportunities in the field. Secondly, the program seeks to create a broader impact by providing high school science and math teachers with new pedagogical methods and tools for use in their classrooms and by providing undergraduate students with leadership training and practice opportunities through peer mentoring. Websites for these programs are here: <http://www.memphis.edu/herff/trec/> and here: <http://www.memphis.edu/herff/gee/>.

### **University of Southern Mississippi**

- USM has awarded 5 Masters Degrees in logistics, trade and transportation in Fall 2015
- USM has delivered 4 logistics & supply chain courses on- line in the Fall 2015
- At least 10 MS-LTT students performed research projects on logistics transportation areas as part of their course requirement in the Fall 2015.
- Awarded 3 Economic development graduate certificates to Masters of Logistics, Trade, and transportation students
- Began incorporating transportation into the 2015 True South International Economic Development (IEDC) Accredited Basic Economic Development Course-50 attendees in 2015
- Brought 3 graduate students to the 9th Annual Intermodal Conference, Memphis, TN.
- A minor change in approach with the Center for Logistics, Trade, and Transportation (CLTT) being moved under the Trent Lott National Center (TLNC) for Excellence in Economic Development and Entrepreneurship. The TLNC is led by Dr. Shannon Campbell who has a strong background in workforce development. This will tie the CLTT closer to the Vice-President for Research and the President's office.

### **University of Wisconsin – Madison**

- UW Transportation Management and Policy Program. Conducted fall practicum and colloquium courses.
- Sponsored scholarships for Railroad Engineering Short Courses in Fall 2015.
- Provided funding and planning expertise for the 2015 Ohio Conference on Freight and Mid-America Freight Coalition Annual Meeting, to be held in October 2015.
- Conducting the MTWC Regional Transportation Workforce Summit in December 2015.
- Awarded the 2015 Student of the Year in Transportation.

- Provided support for the 2015 Mid-Continent Transportation Research Symposium to be held in August 2015 in Ames, Iowa.

#### **University of Wisconsin – Superior**

- Conducted the Rail and Intermodal Summer Youth program August 2015.
- Taught online modules for Certified in Transportation and Logistics (CTL) program at University of Wisconsin-Superior on transportation economics and general management.
- Taught courses on campus on transportation economics, international & intermodal logistics, port & terminal management and land transportation (pipelines, railroad and trucking).
- Richard Stewart was selected as member of the Freight Advisory Committee for the Wisconsin Department of Transportation. He participated in Committee meetings.

#### **University of Wisconsin-Milwaukee**

- One MS student research topic on OSOW truck single trip permit in Wisconsin, Iowa, and Illinois is within 85% of completion. One PhD student graduated on 12/14/2015.
- Undergraduate and graduate student participated in conferences and presentations including the Midcontinent transportation research symposium in IA, Transportation symposium in China, and Pavement Conference in Madison.

#### **Michigan Technological University**

- Provided updates to the online transportation education resource clearinghouse for K-12 teachers and students hosted by CFIRE: <http://www.wistrans.org/cfire/education/k-12/>.
- Created a new transportation web module “From Sea to Shining Sea” for K-12 students and teachers has been created as part of this project: <http://k12-transportation.mtu.edu/intermodal/>. The web module provides an interactive way to engage youth (future workforce) in learning about the four primary transportation modes and careers in transportation. The module will be share via the CFIRE website, Michigan Tech Alive website and will be emailed to all teachers attending past professional development workshops and summer institutes on transportation 2012 to present.
- Attended the MTWC Regional Transportation Workforce Summit in December 2015 with two students from MTU (Ronesha Strozier, an African American Environmental Policy M.S. student working for the Michigan Tech Tribal Transportation Program, and Rachel Chard, a 2<sup>nd</sup> year student in supply chain management).

### **Technology Transfer**

The following progress has been made on CFIRE's commitments to T2:

#### **The University of Southern Mississippi**

- The Logistics, Trade and Transportation (LTT) program at the University of Southern Mississippi (USM) has formed a Partner Industry Network comprising more than 100 local companies. The PIN seeks to use coordination with Gulf Coast businesses to further advance the logistics transportation career skills and opportunities of USM students while also benefitting the participating businesses through opportunities to acquire student interns, directly influence the knowledge and skill set of potential hires and to take advantage of relevant Logistics research and process improvements. This will be achieved by having businesses voluntarily enroll in the program and then, through communication with USM they can outline the needs of their business and what they can provide. In exchange, they provide to the University the opportunities for Facilities Tours for faculty and students, data access to be used for University research projects, as well as offering voluntary mentorships with company employees so that students can directly interface with someone working in their prospective field. This arrangement should benefit both parties, students at USM will receive valuable experience, knowledge, and exposure while businesses receive student interns, the ability to directly communicate their professional needs to potential hires, as well as share in the benefits of Logistics research and improvements in Logistics processes. On October 29th, 2015 there was an inauguration meeting held on the USM campus where USM PIN Program participants were invited to attend.

There were over 40 attendees signed-up for the event. A second meeting was held on December 10, 2015 where 30 people signed-up for the event.

- LTT students and professor attended the MPO planning meeting on November 18, 2015 at Edgewater Mall in Biloxi, MS. The meeting highlights the current status of and future plans of MS DOT.

### **Vanderbilt University**

- Participated in meeting of TDOT Freight Think Tank members
- Disseminated relevant CFIRE information to internal Vanderbilt community and externally to others
- Maintained transportation center website (<http://vanderbilt.edu/vector>)
- Sponsored travel to relevant transportation, GIS and risk assessment forums and training sessions

### **University of Memphis**

- IFTI hosted the 9th Annual Freight Intermodal Conference on December 10, 2015 at the FedEx Institute of Technology on the University of Memphis campus. The conference featured world-class presentations by industry experts, government officials, and transportation professors. Several IFTI students were recognized for excelling in transportation research and for their contributions to the transportation industry. Students also conducted a poster session during lunch of the event. The conference is the annual Tech Transfer activity for the Southern Hub. Over 150 practitioners from the public and private sector gather to hear from researchers, politicians and industry professionals on the state of the industry. Presentations from this conference are available here: <http://www.memphis.edu/ifti/outreach/2015presentations.php>.

### **University of Wisconsin-Milwaukee**

- Completed the Oversize Overweight (OSOW) Truck Single Permit Analyses Tool and verified the results reliability with WisDOT freight unit. Delivered the database to WisDOT and established access to the online portal. Completed the web based portal and implemented log in page for WisDOT access on UWM pavement server ([pavement.ceas.uwm.edu](http://pavement.ceas.uwm.edu)). The OSOW project is considered among the successful CFIRE projects at UWM since it currently used by WisDOT to support their analysis. Similar interest was heard in IA from IADOT during the Midcontinent transportation research symposium.

### **University of Wisconsin-Superior**

- Conducted outreach to local industry (visits to manufacturers and transporters and participation in monthly trade organization meetings).
- Researchers reviewed for Journal of Operations Management, Production and Operations Management Journal, and the Transportation Journal.
- Researchers attended the Intermodal Association of North America Annual EXPO, September, 2015, the Council of Supply Chain Management Professionals Annual meeting September 2015, the National Light Rail conference in Minneapolis, MN, the Great Lakes Governors' Maritime Task force meeting in November in Chicago, IL, and had a poster session about transportation education processes at MTWC Regional Workforce Summit in December 2015.
- The T&L Research Center hosted the Canadian Consulate General serving Wisconsin for a day long informational and outreach session in October 2015.

### **University of Toledo**

- Sponsored the 2015 Ohio Conference on Freight: Building a Future Together. There were 355 attendees, up from 269 in 2014. 54% of attendees were from the public sector with 46% from the private sector. 37% of attendees were repeat attendees with 63% new to the Conference. Attendees can from all over Ohio as well as 25 other states and Canada. Sessions on freight policy and planning, economic development, industry integration, energy, and sustainability were offered and all freight modes were addressed. The conference theme recognized the need for cooperation between people who move goods and those responsible for the condition of freight infrastructure. Increasingly, international, national, regional, and even local freight movements rely upon breaking down boundaries. Better coordination among producers and carriers, among modes, and among the public

and private sectors is needed to support competitiveness and prosperity. For the first time ever, three great conferences joined together: the Ohio Conference on Freight, the Mid-America Freight Conference, and the Kentucky Freight Conference in one event. In 2015 the Ohio Conference on Freight and the Mid-America Freight Coalition joined forces with the Ohio Department of Transportation, the Kentucky Transportation Cabinet, and the Indiana Department of Transportation along with the Federal Highway Administration to offer a comprehensive forum addressing the freight and logistics industry in Ohio, Kentucky, Indiana, and the 10-state mid-America freight region.

## Next Reporting Period

### Research Initiatives

CFIRE secured a no-cost extension with an end date of January 31, 2017. In the upcoming reporting period, research initiatives that are not already complete are scheduled to be completed.

## PRODUCTS

### Publications

- I. Abkowitz, M., A. Jones, L. Dundon, Janey Camp. Performing A Regional Transportation Asset Extreme Weather Vulnerability Assessment. Case Studies on Transport Policy. In Review.
- II. Abkowitz, M., J. Camp. 2015. Structuring an Enterprise Risk Assessment Protocol: Traditional Practice and New Methods. Risk Management and Insurance Review. In Press.
- III. Adams, T.M., E Wittwer, J. O'Doherty, M. Venner, and K. Schroeckenthaler. (2015). Approach to Level of Service (LOS) Target Setting for Highway Assets. Research Results Digest 396. National Cooperative Highway Research Program. Transportation Research Board, Washington, D. C., October.
- IV. Coley, N., Titi, H. H., and Latifi, V. (2016). "Mapping Overweight Vehicle Permits for Pavement Engineering Applications." Journal of Transportation Engineering, American Society of Civil Engineers. Accepted as of January 2016.
- V. Danjue Chen, Soyoung Ahn, Soohyuk Bang, and David Noyce, CAR-FOLLOWING AND LANE-CHANGING BEHAVIOR INVOLVING HEAVY VEHICLES, 95th Annual Meeting of the Transportation Research Board, Washington DC., 2016. The paper is also accepted by the Journal of Transportation Research Board: Transportation Research Record.
- VI. Dundon, L, M. Abkowitz, J. Camp. 2015. The Real Value of FracFocus as a Regulatory Tool: A National Survey of State Regulators. Energy Policy. 87, 496-504.
- VII. Dundon, L., J. Camp, M. Abkowitz, A. Jones, K. Nelson. 2015. Assessment of Spatial and Temporal Climate and Weather Patterns for Performing Regional Vulnerability Assessments. Climate Risk Management. In Review.
- VIII. Dundon, L.A., M. Abkowitz and J. Camp. "The real value of FracFocus as a regulatory tool: A national survey of state regulators". Energy Policy 87 (2015) 496–504.
- IX. Frost, E.A. (2015). Evaluating Air Emissions from Urban Transportation in Eight U.S. Cities. Masters Thesis. Environment and Resources. UW-Madison.
- X. Gong, Q., T.M. Adams, and X.B. Wang. (2015). "Estimating Link Travel Time Using Sparse GPS Data on Highway Corridors". TRR J. of the Transportation Research Board. 2477:7-17.
- XI. Jones, M. Abkowitz, L. Dundon, J. Camp. 2015. Identifying Critical Transportation Assets in Performing Extreme Weather Vulnerability Assessments: The Tennessee Experience. Journal of Transport Geography. In Review.
- XII. Khademul Haque; Sabyasachee Mishra; Rajesh Paleti; Mihalis M. Golias; Afrid A. Sarker; Karlis Pujats. Truck Parking Utilization Analysis Using Truck GPS data. 2016. Transportation Research Record: Journal of the Transportation Research Board. Status of publication: Pending.
- XIII. Nelson, K., M. Abkowitz, J. Camp. 2015. A Method for Creating High Resolution Maps of Social Vulnerability in the Context of Environmental Hazards. Applied Geography. 63, 89-100.
- XIV. Pouryousef, H, Lautala, P., Investigating the Trade-off between Level of Service and Capacity Parameters in Train Scheduling, INFORMS 2015 Annual Conference, Philadelphia, PA, Nov 1-4, 2015 (Abstract/presentation only)

- XV. Pouryousef, H., Lautala P., Hybrid Simulation Approach for Improving Railway Capacity and Train Schedules, *Journal of Rail Transport Planning & Management* (2015), <http://dx.doi.org/10.1016/j.jrtpm.2015.10.001>
- XVI. Pouryousef, H., Lautala P., Watkins, D., Development of Hybrid Optimization of Train Schedules Model for Railway Corridors, *Transportation Research Part C* (accepted pending minor revisions).
- XVII. Sarder, MD. (2015). Quality Sacrificed: A Look at Quality Issues Experienced in Global Outsourcing. *Supply Chain Management: Practices, Applications and Challenges*. Nova Science Publishers, Inc., Hauppauge, NY 11788-3619, USA
- XVIII. Sarder, MD. (2015). Reshoring – A Driving Force to US Manufacturing, *Proceeding of the Annual Industrial & Systems Engineering Research Conference (ISERC)*, Nashville, Tennessee.
- XIX. Yin, Kai, Wen Wang, X Bruce Wang, and T.M. Adams. (2015). “Line Travel Time Inference Using Entry/Exit Information of Trips on a Network.” *Transportation Research Part B*. 80:303-321.
- XX. Yu, H., Yin, J., Soleimanbeigi, A., and Likos, W.J., “Engineering Properties of Dredged Materials Stabilized with Fly Ash for Use as Highway Embankment Fill,” *J. Materials in Civil Engineering*, in review.
- XXI. Yu, H., Yin, J., Soleimanbeigi, A., Likos, W.J., Edil, T.B., 2016, “Engineering properties of dredged materials stabilized with fly ash,” *Proc. 4th International Conference on Sustainable Construction Materials and Technologies (SCMT4)*, Las Vegas, NV, in press.
- XXII. Zelezeck, S., L. Dundon, C. Miller, M. Abkowitz, J. Camp, C. Philip. 2015. Evaluating the Impact of Domestic Oil and Gas Development on the U.S. Transportation Sector: A Review of the Logistical, Safety, and Infrastructure Challenges. *Journal of Transport Policy*. In Review.
- XXIII. Zhou, W., J. Lin (submitted) Peer-to-Peer Transshipment with Nonstationary Relay Points, submitted to 22nd International Symposium on Transportation and Traffic Theory (ISTTT), Evanston, IL, July 24-26, 2017
- XXIV. Zhou, W., J. Lin (under revision) Is Electric Vehicle a Cost-effective Alternative to Diesel Commercial Vehicle in Urban Delivery? *Transportation Research Part E: Logistics and Transportation Review*.
- XXV. Zhou, W., J. Lin, L. Du (under review) A Green En-route Cargo Consolidation Problem, *Transportation Research Part D: Transportation and the Environment*.
- XXVI. Zietlow, B., Perry, E., Adams, T., Wagner, S., Oberhart, E. “Identification and Application of Non-traditional Marine Freight Data- Truck Permitting and Heavy Industry Movers.” *Italian Journal of Regional Science. Special Issue- Urban Policy, freight distribution planning, and behavior change: stakeholders’ engagement, perception and reaction S* (Submitted)
- XXVII. Zietlow, B., Perry, E., Adams, T., Wagner, S., Oberhart, E. “Identification and Application of Non-traditional Marine Freight Data- Truck Permitting and Heavy Industry Movers.” *TRB Annual Meeting 2015 S* (Submitted)

## Presentations

- I. Al Hajjeh, Ashraf; Rani Elhajjar, Hani Titi, and Alex Laflin (2015). “Oversize-Overweight Permit Mapping and Analysis Project in Wisconsin.” 2015 Mid-Continent Transportation Research Symposium, Ames, IA.
- II. Camp, J. Use of Hazus and Regional Climate Models to Identify Vulnerable Transportation Infrastructure due to Future Extreme Precipitation Events. Hazus National User Conference, 9-11 December 2015, Atlanta, GA.
- III. Camp, J. (Invited) “Use of Hazus for Adaptation Planning of Transportation Infrastructure Under Extreme Conditions,” Federal Emergency Management Association (FEMA) National Hazus User Group Call, April 2015.
- IV. Chadde, Joan. Michigan Technological University. Engaging K-12 Students & Teachers in Learning About Transportation. Presented at the Midwest Transportation Workforce Summit: Addressing the Future Now! December 7-8, 2015 in Madison, Wisconsin.
- V. Chen, Danjue, Soyoung Ahn, Soohyuk Bang, and David Noyce, CAR-FOLLOWING AND LANE-CHANGING BEHAVIOR INVOLVING HEAVY VEHICLES, 95th Annual Meeting of the Transportation Research Board, Washington DC., 2016. The paper is also accepted by the *Journal of Transportation Research Board: Transportation Research Record*.

- VI. Coley, N., Titi, H. H., and Latifi, V. (2015). "Development and Implementation of Axle Load Spectra for Overweight Truck Traffic for a Mechanistic-Empirical Pavement Performance Evaluation." International Symposium on Frontiers of Road and Airport Engineering, Tongji University, Shanghai, China.
- VII. Coley, N., Titi, H. H., and Latifi, V. (2015). "Oversize-Overweight Permit Mapping and Analysis Project in Wisconsin." 2015 Mid-Continent Transportation Research Symposium, Ames, IA.
- VIII. Coley, N., Titi, H. H., and Latifi, V. (2016). "Evaluation of Pavement Performance due to Overload Single Trip Permit Truck Traffic in Wisconsin," Poster Presentation, Session 312, Mechanistic-Empirical Pavement Design: Local Calibration Studies, Transportation Research Board 95th Annual Meeting, Washington, D.C.
- IX. Deligiannis, Nikolaos; Afrid Sarker; Karlis Pujats; Mihalis Golias; Sabyasachee Mishra. Road Network Reliability – A Critical Literature Review. 2016. Lectern session 855 and poster session 264 at the 95th TRB Annual Meeting, Washington, D.C. Acknowledgment of federal support: Yes
- X. Flaskou, Mania; Maxim Dulebenets; Karlis Pujats; Nikos Deligiannis; Afrid Sarker; Sabyasachee Mishra; Mihalis Golias. Freight Performance Measures Estimation Using Truck GPS Data. 2015. Poster presentation at the 9th Annual Intermodal Freight Conference, Memphis, TN. Acknowledgment of federal support: Yes
- XI. Gilligan, J., C. Brady, P. Sengupta, J. Nay, J. Camp. Emotional Engagement with Participatory Simulations as a Tool for Learning and Decision-Support for Coupled Human-Natural Systems: Flood Hazards and Urban Development. American Geophysical Union Conference, San Francisco, CA, 14-18 December 2015.
- XII. Haque, Khademul; Sabyasachee Mishra; Rajesh Paleti; Mihalis M. Golias; Afrid A. Sarker; Karlis Pujats. Truck Parking Utilization Analysis Using Truck GPS data. 2015. Poster presentation at the 9th Annual Intermodal Freight Conference, Memphis, TN. Acknowledgment of federal support: Yes
- XIII. Haque, Khademul; Sabyasachee Mishra; Rajesh Paleti; Mihalis M. Golias; Afrid A. Sarker; Karlis Pujats. Truck Parking Utilization Analysis Using Truck GPS data. 2016. Lectern session 472 at the 95th TRB Annual Meeting, Washington, D.C. Acknowledgment of federal support: Yes
- XIV. Hart, M., Greenstreet A. (2015) Freight Stories: Using ESRI Story Map Journal to Visualize Research 2015 Mid-Continent Transportation Research Symposium. Ames, IA.
- XV. Jones, A., M. Abkowitz and L. Dundon. 2015. Assessing the Vulnerability of Tennessee Transportation Assets to Extreme Weather, International Conference on Transportation System Resilience to Climate Change and Extreme Weather Events, Washington, DC.
- XVI. Naimi, Alireza; Maxim Dulebenets; Karlis Pujats; Mihalis Golias; Sabyasachee Mishra. Tools for Processing Truck GPS Data and Analysis of Freight Corridors. 2015. Poster presentation at the 9th Annual Intermodal Freight Conference, Memphis, TN.
- XVII. Nelson, K., C. Philip, and J. Camp. 2015. Navigable Inland Waterway Transportation Modeling: A Conceptual Framework and Modeling Approach for Consideration of Climate Change Induced Extreme Weather Events, SMART Rivers 2015, Buenos Aires, Argentina.
- XVIII. Perry, E. Aug 11, 2015. MAASTO Meeting in KC Mo. An Overview of Mid-America Freight Research and Collaboration
- XIX. Perry, E. Aug 27, 2015. Wisconsin Commercial Ports annual meeting. Milwaukee WI. Phase II of the WCPDI: Market Development for Wisconsin Ports.
- XX. Perry, E. Dec 21, 2015. Webinar with MAFC States and partners. Leveraging FAST Freight Initiatives.
- XXI. Perry, E. Nov 18, 2015. HWY H2O conference. Toronto Canada. Unleashing our Comparative Advantage: How the MAFC Region is becoming more Competitive.
- XXII. Perry, E. Oct 28, 2015. WEbinar with MAFC states and partners. Innovation in Freight Planning in the MAFC.
- XXIII. Perry, E. Sept 14, 2015. MAFC annual meeting in Conjunction with the Ohio Conference on Freight, Cincinnati, OH. The Importance of Collaboration: Mid-America Freight Coalition.
- XXIV. Perry, E. Sept 15, 2015. Cincinnati OH. MAFC Workshop: Developing State and Regional Freight Priorities
- XXV. Perry, E. Sept 24, 2015. AASHTO Meeting. Chicago IL. State Collaboration and Freight Innovation in the MAFC Region.

- XXVI. Philip, C. 2015. Climate Change and Inland Waterway Operations, International Conference on Transportation System Resilience to Climate Change and Extreme Weather Events, Washington, DC.
- XXVII. Philip, C. 2015. Freight System Fragility and Institutional Responses, CAIT Rutgers Resiliency of Transportation Infrastructure Workshop, New Brunswick, NJ.
- XXVIII. Pourabdollahi, Z., B. Karimi, A. Mohammadian, and K. Kawamura. "An Agent-based Supply Chain and Freight Transportation Model: Case Study for Chicago Metropolitan Area". The 95th Annual Transportation Research Board Meeting, Washington D.C. January 10-14, 2016.
- XXIX. Pourabdollahi, Z., B. Karimi, A. Mohammadian, and K. Kawamura. "Hybrid Agent-Based Computational Economics and Optimization Approach for Supplier Selection Problem". The 95th Annual Transportation Research Board Meeting, Washington D.C. January 10-14, 2016.
- XXX. Ross, T. and Sarder, MD. (2015). Transitioning to Post-War Supply Chain System in Afghanistan, Proceedings of the Annual Portland International Center for Management of Engineering and Technology Conference (PICMET), Portland, Oregon.
- XXXI. Sakai, T., K. Kawamura, and T. Hyodo. "Impact of Land Use Regulations on Logistics Facility Distribution". 2015 International Urban Freight Conference, Long Beach, CA. October 21-23, 2015.
- XXXII. Sakai, T., K. Kawamura, and T. Hyodo. "Location Choice Models of Urban Logistics Facilities and the Impact of Zoning on their Spatial Distribution and Efficiency". The 95th Annual Transportation Research Board Meeting, Washington D.C. January 10-14, 2016.
- XXXIII. Sarder, MD. "Helping the Marshall County Industrial Development Authority (MCIDA) Make Data Driven Decisions." (2015) 9th Annual Intermodal Conference, Memphis, TN. December 10.
- XXXIV. Sarder, MD. (2015). "Economic Development Strategies for Fracking: the Case of the Tuscaloosa Marine Shale Play." South Eastern Conference for Public Administration (SECoPA). October 1, Charleston, SC.
- XXXV. Sarder, MD. (2015). Identifying Best Practices of Logistics & Transportation Graduate Education, Proceeding of the American Society of Engineering Education Conference (ASEE), Seattle, Washington.
- XXXVI. Sarder, MD. Transitioning to Post-War Supply Chain System in Afghanistan at PICMET Conference, Portland, Oregon, August 2-6, 2015
- XXXVII. Titi, H. H. (2015). "Non-Destructive Testing and Evaluation of Base Layer in HMA Pavements," Presented at Tongji University, Shanghai, China.
- XXXVIII. Titi, H. H. (2015). "X-ray Micro-computed Tomography for the Durability Characterization of Limestone Aggregate," New Frontiers in Road and Airport Engineering Symposium, American Society of Civil Engineers, Shanghai, China.
- XXXIX. Titi, H. H. (2015). "X-ray Micro-computed Tomography for the Durability Characterization of Limestone Aggregate," Presented at Beijing University of Science and Technology, Beijing, China.
- XL. Zietlow, B. Ports, Cargoes and Corridors: Wisconsin Commercial Ports Strategic Development Initiative. Superior, WI. September 2, 2015. Harbor Technical Advisor Meeting

## Websites

1. Additional transportation lessons for K-12 teachers at <http://www.wistrans.org/cfire/education/k-12> and the Western UP Center for Science, Math, and Environmental Education (<http://wupcenter.mtu.edu>).
2. MTWC Regional Workforce Summit (CFIRE 08-04) proceedings at <http://mtwc.org/regional-workforce-summit/>.
3. Updated Great Lakes Commission website on beneficial use of dredged materials (CFIRE 09-12): <http://glc.org/projects/habitat/beneficial-use/>.
4. Website under construction to share reshoring tools (CFIRE 09-16) that can be used by any US Manufacturing company to evaluate their reshoring strategy: <http://www.usm.edu/logistics-trade-transportation/reshoring-index-backup>.
5. 9th Annual Freight Intermodal Conference proceedings at <http://www.memphis.edu/ifti/outreach/2015presentations.php>

6. GEE and TREC websites: <http://www.memphis.edu/herff/trec/> and <http://www.memphis.edu/herff/gee/>
7. Websites for CFIRE RI-02: Visualization: <http://www.wistrans.org/livability/MemphisLamarAve.htm> and Story Map: <http://uw-mad.maps.arcgis.com/apps/MapJournal/?appid=090c0247e1384fcf8092e664670cb0f5>
8. Ohio Conference on Freight proceedings at <http://ohiofreight.org>.
9. Oversize/Overweight Analysis portal (UW-Milwaukee) at <http://pavement.ceas.uwm.edu:8080>

## Newsletters

CFIRE has discontinued its formal newsletter in favor of news releases, tweets, and web articles.

## Collaboration

CFIRE has collaborated with the following organizations during the reporting period.

- I. Allied Coop
- II. ALS Environmental
- III. American Society of Transportation and Logistics
- IV. American Transportation Research Institute (ATRI)
- V. Amtrak
- VI. Appalachian Partnership for Economic Growth (APEG)
- VII. Applied Research Associates
- VIII. Ashley Furniture
- IX. Beijin Wuzi University, China
- X. Bella Sand
- XI. BNSF
- XII. Business Transportation Solutions
- XIII. CDM Smith
- XIV. Central Ohio River Business Association
- XV. CN
- XVI. Columbus 2020
- XVII. ContainerPort Group, Inc.
- XVIII. Council of Supply Chain Management Professionals
- XIX. CPCS
- XX. CSX Corporation
- XXI. DART
- XXII. Detroit Public Schools, Office of Science
- XXIII. Dickinson Wright PLLC
- XXIV. DLZ
- XXV. Duluth-Superior Transportation Association
- XXVI. Enbridge
- XXVII. Ericson Logging
- XXVIII. Federal Highway Administration (FHWA)
- XXIX. FedEx
- XXX. FracFocus
- XXXI. Franklin Furniture Institute
- XXXII. French Institute of Science and Technology for Transport, Development, and Networks
- XXXIII. Frito-Lay, Inc.
- XXXIV. Genesee & Wyoming, Inc.
- XXXV. Government of Canada
- XXXVI. Great Lakes Commission
- XXXVII. Great Lakes Fleet
- XXXVIII. Great Lakes Maritime Research Institute
- XXXIX. Halvor Lines
- XL. HDR
- XLI. IBI GROUP

- XLII. Illinois Department of Transportation
- XLIII. Indiana Department of Transportation (INDOT)
- XLIV. Institute for Trade and Transportation Studies
- XLV. Intermodal Association of North America
- XLVI. Iowa Department of Transportation
- XLVII. JobsOhio
- XLVIII. Kennrich Foods
- XLIX. Kentucky Transportation Cabinet
  - L. Kimley Horn
  - LI. KK Warehouse
  - LII. Kraft
  - LIII. Lake Michigan Air Directors Consortium (LADCO)
  - LIV. Lake Superior Railroad Museum
  - LV. Landscape Stone
  - LVI. Latino Memphis
  - LVII. Livable Memphis
  - LVIII. Marten Transport
  - LIX. Mayors of the Mississippi River
  - LX. Meijer
  - LXI. Memphis-Shelby County Airport Authority
  - LXII. Mercury Gate
  - LXIII. Metro Nashville Government
  - LXIV. Metropolitan Interstate Committee
  - LXV. Michigan Department of Transportation
  - LXVI. Mid-America Freight Coalition
  - LXVII. Middle Tennessee State University
  - LXVIII. Midwest Energy Resources
  - LXIX. Midwest Transportation Workforce Center
  - LXX. Mississippi Oil and Gas Board
  - LXXI. Mississippi State Port Authority
  - LXXII. National Association of Purchasing Managers
  - LXXIII. National Oceanic and Atmospheric Administration (NOAA)
  - LXXIV. Nature's Way
  - LXXV. Norfolk Southern Corporation
  - LXXVI. North American Regional Climate Change Assessment Program (NARCCAP)
  - LXXVII. Northwestern University
  - LXXVIII. Ohio Association of Regional Councils (OARC)
  - LXXIX. Ohio Conference on Freight
  - LXXX. Ohio Department of Transportation (ODOT)
  - LXXXI. Ohio Logistics
  - LXXXII. Ohio-Kentucky-Indiana Regional Council of Governments (OKI)
  - LXXXIII. Polyfab Corp
  - LXXXIV. Port of Greater Cincinnati Development Authority
  - LXXXV. REDI Cincinnati
  - LXXXVI. Regional Growth Partnership
  - LXXXVII. Reshoring Initiative
  - LXXXVIII. RGL Logistics
  - LXXXIX. Rickenbacker Inland Port
    - XC. RoadOne Intermodal Logistics
    - XCI. Sanimax
    - XCII. SCA Tissue
    - XCIII. Seneca Foods
    - XCIV. Southeast Michigan Council of Governments
    - XCV. Southeast Transportation Workforce Center
    - XCVI. St. Lawrence Seaway Development Corporation
    - XCVII. Taft Stettinius & Hollister LLP

- XCVIII. Technical University of Braunschweig-Germany
- XCIX. Tennessee Department of Transportation
  - C. Tokyo University of Marine Science and Technology
  - CI. Toledo Metropolitan Area Council of Governments (TMACOG)
  - CII. Toledo-Lucas County Port Authority
  - CIII. Tri-State Transportation and Logistics Council
  - CIV. Twin Cities Transportation Club
  - CV. University of Findlay
  - CVI. University of Le Havre, France
  - CVII. University of Minnesota - Center for Transportation Studies
  - CVIII. University of Minnesota Duluth
  - CIX. US Army Corps of Engineers (USACE)
  - CX. US Department of Agriculture
  - CXI. US Department of Transportation
  - CXII. US Energy Information Association
  - CXIII. UW Sea Grant Institute
  - CXIV. Verson
  - CXV. Wayne State University
  - CXVI. Wisconsin Department of Transportation
  - CXVII. Wisconsin Economic Development Corporation
  - CXVIII. Wisconsin Manufacturers and Commerce
  - CXIX. Women in Trucking
  - CXX. Women's Foundation for a Greater Memphis
  - CXXI. Wooddale High School, Memphis, Tennessee