CFIRE

Program Progress Performance Report (PPPR): January 1, 2015 to June 30, 2015

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National Center for Freight & Infrastructure Research & Education
Department of Civil and Environmental Engineering
College of Engineering
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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 January 1, 2015 to June 30, 2015.

1. Accomplishments
   A. CFIRE's Goals
      i. **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.
      ii. **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.
      iii. **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.
      iv. **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.

   B. Accomplishments under CFIRE's goals
      i. 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 or other achievements
             - Increasing confidence that a comprehensive and practical decision-support tool can be implemented.
           - Changes
             - Decision made to include representation of the entire continental U.S. 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, and University of Toledo.
  Start Date: July 1, 2012 End Date: June 30, 2015
  - Major activities:
    - Draft of final report completed.
  - Specific objectives:
    - The final project report outlines the entire project findings including literature review, case studies, project methodology, results, and implications for future work.
  - Significant results:
    - While the results of this study provided valuable insight regarding factors important for and barriers to livability of communities as well as strategies with the potential to alleviate negative externalities of freight, the work was largely a pilot scale project and several limitations exist that reveal opportunities for future research. More research is necessary to determine if the findings related to the Lamar Avenue corridor in Memphis, TN can be applied to other FC communities. A major limitation exists in the limited number of responses received for the survey efforts for this study. The research related to livability quantification was conducted at the neighborhood level due to limited availability of survey data, however; exploration of a block-level approach may reveal heterogeneity that impacts metric scores. As the Memphis and Shelby County Health Department's Pollution Control Section, responsible for emissions monitoring and modeling for the Memphis Urban Area Metropolitan Planning Organization, has neither conducted emissions monitoring along the Lamar Corridor, nor conducted a MOVES analysis of the Lamar Corridor in order to compare the results for validation, no real-world emissions data for comparing the model outputs was available.
  - Key outcomes:
    - University of Memphis and University of Wisconsin team members collaborated to develop a submission to the 2016 TRB Annual Meeting. A four-volume final report draft was completed this reporting period.
    - A key outcome of this research is identification of numerous areas that should be considered for future research. Addressing these issues would lead to a much more robust assessment of community livability. Additionally, this would enable an approach to be developed that may be more broadly applicable and transferable across communities. The following are the primary recommendations resulting from this work:
    - It is essential to identify better methods for community engagement that work for diverse members of a community. The key obstacle faced in this research was in obtaining participants in the project. Only 75 freight-centric respondents were obtained over the course of an entire year. Planning organizations and other government agencies (particularly Departments of Transportation) are constantly challenged with obtaining input on plans and projects from a representative sample of community stakeholders.
    - It is important to obtain a larger dataset to determine if differences (or not) identified through this project are representative of the larger Memphis and Lamar Avenue community. With a larger dataset, additional methodologies can

be used to analyze the data and identify relationships between factors and perceptions of livability.

- If a large enough sample size is obtained, there is value in investigating differences in responses and perceptions of community residents based upon gender, age, race, and other demographic data. Any differences may lead to recommendations regarding strategies for engagement, education, and approaches for addressing livability in ways that consider needs of all stakeholders.
- Future research should also investigate freight-centric communities in other cities and states in order to determine if a common definition of and approach to measuring livability and community priorities is possible, or if these are community dependent. A national-level project should be conducted using both the residential stakeholder surveys and livability metric to determine whether or not the approach is transferrable.
- Additional research should be conducted to determine if there should be development of different livability principles (or revised definitions of the existing) based on the environment being studied: urban, sub-urban, and rural. If consistent principles are to be used across settings, consideration should be given to establishing different measures, weights or thresholds for comparison for each principle based upon community setting.
- Additional research is needed to bridge the apparent gap between residential perspectives and established livability principles. For instance, the inclusion of personal safety which was identified as a primary concern of residential stakeholders in this study is one modification that should be considered within the definitions of the livability principles. This alignment is important to ensure that policies and funding are used to improve community livability reflecting needs of the stakeholders.
- Establishing a target for the quantity of trucks that needs to be shifted to achieve livability impact is a much-needed area of future research, as is identifying a means for obtaining emissions data for model validation.
- Finally, though Chamberlin and Talbot (2013) showed that the Operating Mode Distribution method produces the most accuracy out of the three methods of conducing a project-level MOVES analysis, the method is computationally intensive at the corridor level. While Chamberlain and Talbot (2013) only focused on a single intersection in their study and Alam and Hatzopoulou (2014) focused only on bus traffic in their corridor study, neither incorporated the volume of data utilized here. The vehicle trajectory files output by Quadstone Paramics measured 11.9 GB of data that needed to be processed prior to entry into MOVES. The development of a more efficient method for study at the corridor level would also be desirable.
- While this has been a pilot-scale study, the ultimate goal is to incorporate all recommendations above into a larger-scale study and then to integrate within this a measurement methodology that will provide a quantitative assessment of freight-centric communities using existing data related to influential factors affecting livability.
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- 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 improvement of the web-based expert system for the optimal selection of appropriate non-destructive methods for diagnose and assessment of common signs of the structural distress and deterioration found in highway infrastructure systems and components.
    - Continued adding NDT methods to the expert system.
    - Continued working on draft report.
  - 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.
  - Significant results:
    - Nothing to report.
  - Key outcomes:
    - Expert system is in the final phase of work.
    - A web-based tool is developed for this project. The tool has two components: a) a "Knowledge Center" that contains summaries of all of the data and information collected during this project on non-destructive methods applicable to infrastructure systems and materials, and b) a decision-making expert system for selecting appropriate methods for diagnose and assessment of structural distress.
- **RI-4: Mining Automatic Identification Systems (AIS) Data for Improved Vessel Trip Analysis Capabilities**
  USDOT Priorities: Economic Competitiveness
  Performing Institutions: Vanderbilt, University of Toledo, and University of Wisconsin-Superior.
  Start Date: July 1, 2012 End Date: June 30, 2015
  - Major activities:
    - Final report in preparation (project is otherwise complete).
  - Specific objectives:
    - Nothing to report.
  - Significant results:
    - Nothing to report.
  - Key Outcomes:
    - Preparation of doctoral dissertation on adaptation of AIS technology for vessel tracking in the Great Lakes by Samir Dhar, PhD candidate, University of Toledo.
- **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:

        - Held conference calls/had email correspondence involving participating institutions to review work progress and discuss project.
        - Investigated a preliminary risk index that would link precipitation extremities to highway infrastructure damages and delays. Unfortunately, little data exists to facilitate development of the risk index.
        - Performed Hazus damage model simulations to estimate impacts/damages in Arkansas "hot spot" region to identify inundation areas for 100-yr, 500-yr, and 1000-yr flooding for three counties of interest.
        - Began development of manuscript(s) to report project findings.
    - 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:
        - Identified "hot spots" where the key freight corridors intersected areas of higher frequency of 2" average daily precipitation for multiple 15-year increments and across multiple climate model pairs. The identified "hot spots" were three counties in Arkansas: Jefferson, Lonoke, and Pulaski.
    - 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.

- **RI-7: Enhancing Rail Connectivity to Underserved Rural Communities**
  USDOT Priorities: Livability/Economic Competitiveness
  Performing Institutions: University of Memphis, University of Wisconsin-Superior and Madison, University of Alabama in Huntsville, and University of Southern Mississippi.
  Start Date: July 1, 2012 End Date: June 30, 2015
  - Major activities:
    - Final report completed and submitted in February 2015.

- **CFIRE 08-01: Laboratory Study of High Performance Curing Compounds for Concrete Pavement, Phase II**
  Performing Institution: University of Wisconsin-Madison
  Start Date: September 1, 2012 End Date: March 31, 2015
  - Major Activities:
    - The effect of curing compound application time after concrete finishing was examined in this laboratory study. Times of 30 minutes, 2 hours and 4 hours for curing compound application to laboratory Portland cement concrete pavement specimens were considered and repeatability was evaluated with comparisons to a Phase I portion of the study. This two and half year project concluded during this time frame.
  - Specific Objectives:
    - The primary goal of this research was to evaluate the influence of membrane-forming curing compound application time on the freeze-thaw scaling damage resistance of concrete made with materials common to Wisconsin paving.
  - Significant Results:
    - Scaling resistance varied with mix type and curing compound type. None of the curing compounds provided scaling resistance that approached that of wet room curing. The effectiveness of most curing compounds appeared tied to the surface condition of the concrete. The presence of bleed water varied with mix type and if bleed water was present, the effectiveness of the curing compounds were typically compromised. Polyalphamethylstyrene (PAMS) resin based curing compound appeared to be equally effective regardless of application time but this was not true for wax-based, linseed oil and acrylic curing compounds. Generally for these compounds 2 to 4 hours was needed for best results depending on cementitious additives.
  - Key Outcomes:
    - The precise timing of curing compound application can have significant impacts on the resulting freeze-thaw durability of concrete pavements. In a matter of a few hours during construction inappropriate application versus appropriate application can likely result in years of difference in durability and the need for rehabilitation.

- **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:
    - The project team will develop analytical models of complex bridges and validate these models using load test data. All modelling work, using the CSiBridge software, for the two bascule bridges and the three arch bridges was completed. Simplified methods of predicting the impact of OSOW vehicles are now being examined.
    - As the freight industry grows, the need to move oversize and overweight loads increases every year. Loads such as pressure vessels, transformers used in power plants, boilers, military hardware, and wind turbine components require vehicles with unusual configurations. These vehicles may also weigh five to six

times the normal legal truck weight. The combination of uncommon configurations and carrying loads of these trucks make common bridge evaluation methods inapplicable.

- Specific Objectives:
  - This study aims to develop a simplified analytic method to determine the effects of oversize and overweight vehicles on a variety of complex bridge configurations, such as steel tied arches, rigid frame, truss, and bascule bridges. There are no established procedures and the possibility of errors in estimating the impact of oversize and overweight loads on these structures could affect safety and restrict the flow of goods. The specific objective during this period was to complete OSOW bridge response analysis work on the selected target bridges using accurate 3-D modelling.
  - Determining the effects of oversize and overweight loads on complex bridges has become a time consuming task for the Wisconsin and other state DOTs. This study is developing a simplified analytic method to determine the effects of oversize and overweight vehicles on a variety of complex bridge configurations, such as steel tied arches, rigid frame, truss, and bascule bridges.
- Significant Results:
  - Response analysis of most of the target bridges under OSOW loading was completed. The Mirror Lake bridge analysis is still ongoing with difficulties in obtaining good correlation between the measured field behavior and the software predicted response. OSOW results show that the bridge members are more severely loaded by the design HL93 truck (with 1.3 load factor) than the selected single lane width and dual lane width OSOW vehicles.
- Key Outcomes:
  - OSOW response modelling of the selected bridges (except Mirror Lake) has been completed.
- Changes:
  - The project is behind schedule. We are still behind schedule partially due to delays caused at the beginning of the project when the initial PhD research student dropped out of school and was replaced. The replacement researchers did not have the level of skill of the original researcher and needed extra time to come up to speed on the analysis work.
  - No fiscal constraints have occurred and we are currently under budget with a likelihood of having funds remaining at the scheduled (10/2015) end date.

- **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:
    - 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.
    - The researchers held a regional stakeholder engagement meeting (in cooperation with the MTWC) in April 2015 in Madison, WI
    - In preparation for the meeting, the conducted data analysis of high-wage, high-skill, and high-demand jobs in each state of the region. Charts were developed showing the regional outcomes of the data analysis.
  - 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:
  - Brought together key participants from multiple agencies and industry and established opportunities for collaborative partnerships in transportation workforce development.

- Key Outcomes:
  - Identified eleven initiatives that would serve as a means to continued communication with advisory members.
  - Identified individuals to serve as Board Members and as a (future) Summit Steering Committee.

- **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 08-06 Comparison of Fresh Concrete Air Content Methods & Analysis of Hardened Air Content in Wisconsin Pavements**

  Performing Institution**:** University of Wisconsin-Madison
  Start Date: October 17, 2013 End Date: October 16, 2015

  - Major Activities:
    - Seventy-six (76) hardened concrete field samples from pavements (approximately 92% of the total samples) were tested according to ASTM C457 during this and the prior period. Some data analysis was also completed.
  - Specific Objectives:
    - The primary objective of this study is to gain a thorough and valid definition of the air void systems of Wisconsin pavement concrete associated with the use of synthetic air entraining agents (AEA). In creating this data set, we seek to answer two questions that are of significant interest to the concrete pavement

industry and the State of Wisconsin as project owners: i) are current methods of measuring fresh concrete air content suitable for concrete with synthetic AEAs, and ii) what are the differences in the air void system of concrete with synthetic AEAs before and after the paver? Successful completion of the project will provide input for changes in concrete paving practice in Wisconsin.

- Significant Results:
  - There are significant differences between air content in samples taken during paving and those taken from cores after the concrete has hardened. Core samples from hardened concrete can have air contents up to 5% higher than comparable samples taken from fresh concrete.
- Key Outcomes:
  - Nothing to Report
- Changes:
  - Collaboration provided by Schmidt Technical Services was withdrawn unexpectedly mid-project resulting in project delay.

- **CFIRE 09-04 A Guidebook for Freight Transportation Planning Using Truck GPS Data**
  Performing Institution: University of Memphis
  Start Date: September 1, 2013 End Date: December 31, 2014
  - Major Activities:
    - Estimating freight PMs for transportation facilities.
    - Design of an O-D algorithm for computing the number of trips.
    - Development of an ArcGIS too for processing truck data.
  - Specific Objectives:
    - Develop a set of FPMs for transportation facilities using the available truck GPS data.
    - Compute the number of truck trips between specific areas of TN.
    - Perform snapping of GPS records and calculating link FPMs within the ArcGIS domain.
    - Outline the main steps and results of the conducted work.
  - Significant Results:
    - Computed facility FPMs can be used to determine peak periods for each facility, identify facilities that may require future improvements, allocate workforce and equipment, etc. Accuracy of truck turn time prediction models can be improved if more GPS records are provided. Development of freight facility trip generation models is left for the future research due to lack of the data.
    - It was found that the majority of trips were originated/destined near large metropolitan areas of TN (i.e., Memphis, Nashville, Knoxville, Chattanooga, etc.). A substantial number of origins and destinations were observed along the major freight corridors (I-40, I-24, I-65, I-75, and I-81). It is more likely that in the latter case truck drivers stopped for refueling, rest, or other activities, not involving commodity pick-up/drop-off. OIDA does not include logical tests for identifying those stops due to a number of reasons (i.e., high GPS signal frequency is required, locations of rest stops should be provided, lack of commodity data, etc.).
    - The designed ArcGIS application will assist private and public transportation agencies in computing FPMs for specific freight transportation corridors, identification of segments that require improvement projects, and improving travel time reliability. The user is not required to install any additional software (e.g., PYTHON SHELL, MATLAB), except ESRI ArcGIS.
  - Key Outcomes:

        - Development of procedures for estimating facility FPMs, including truck turn times, facility occupancy, and truck entry/exit volumes.
        - Both OIDA and earlier developed Trip Detection Algorithm (designed for analysis of individual truck travel patterns and defining the status for each observation) can be used for a detailed analysis of truck trips based on the available GPS data.
        - Design of an integrated ArcGIS application for processing truck GPS data and estimated link FPMs.
        - Completed the final project report.

- **CFIRE 09-05 Effect of Primary and Secondary Crashes: Identification, Visualization, and Prediction**

  Performing Institution: University of Memphis

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

    - Major Activities:
        - Crashes occurring in Shelby County, TN within the time period of January 1, 2010 to December 31, 2012 were analyzed.
    - Specific Objectives:
        - Identify primary and secondary crash "hot spots" that are demonstrated to have a significant impact on freight operations in the four major urban areas identified. The freight impacts could be measured based on several factors such as percentages of local vs through truck traffic, hot spots with a higher-than-average incidence involving trucks, lack of alternate truck, hot spots in close proximity to major freight generators and hot spots on designated truck routes.
        - Identify and evaluate strategies that could be used to reduce the impact to freight operations for hot spots (e.g. hours of operation to avoid hot spots, establishing redundant truck routes to facilitate detour, truck-suitable incident management areas, in-route travel information to non-local trucks to assist with re-routing etc.).
    - Significant Results:
        - Past studies utilized static and dynamic approaches to identify SCs but a robust methodology had not been proposed to identify SCs with considerable accuracy on large networks. For the static approach, temporal thresholds of 30, 60, 120, 180 and 300 minutes were used along with spatial thresholds of 0.5, 1, 2, 3, and 5 miles. The dynamic approach proposed was based on the shockwave principle and impact area analysis where a crash was identified as secondary if it occurred within the impact area of the PC. The proposed methodology was implemented in Shelby County, TN. SCs were identified for two types of facilities: freeway and arterials to account for the different traffic conditions and data availability of each. Analysis revealed that the static approach consistently under- or over-estimates SC frequencies (depending on the spatio-temporal threshold used). Based on the density of SCs a hotspot map was generated for the study area which shows the locations where SCs are more likely to occur and supports identification of problematic facilities. Future research could focus on identifying primary contributing factors of SCs and development of prediction models for incident duration, probability of SC occurrence, associated delays and queue lengths.
    - Key Outcomes:
        - With the help of prototype secondary crash models, a transportation agency will be able to identify hazardous locations of secondary crash occurrence by static and dynamic method, determine the potential factors involved in occurrence of such crashes, and predict their occurrences given traffic exposure, highway geometry, and environmental conditions.

        - Earlier studies suggest that up to 15% of reported crashes have occurred partly or entirely as the result of a primary crash. Though a relatively small percentage of all crashes are secondary, it is important to identify contributing factors and characteristics, and mitigate their effect on congestion, delay, fuel consumption and emission. SCs are non-recurring in nature and contribute up to 50% of congestion in urban areas. Outcome of this project suggests that with appropriate techniques it is possible to identify secondary crash occurrence and provide adequate measures such to minimize traffic congestion, delay and maximize road safety.

- **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) levelized 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 NO2 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.
    - 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.
        - Impact on expenditures: None.

- **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:
        - Identified heavy vehicle (HV) sample from the NGSIM (Next Generation Simulation) dataset.
        - We have conducted CF model calibration against three major or typical CF models (Newell's model, Gipps' model, and IDM).
        - We have conducted thorough analysis on the CF and LC behavior of HVs.
        - We have conducted simulations to confirm and further examine the CF behavior of HV.
    - Specific objectives:
        - The objective of this study is to characterize the CF and LC behavior involving HVs at the individual vehicle level. Specifically, the study paper aims to examine (i) the differences in CF behavior, particularly reaction patterns to oscillations, among three cases: HV-following-PC (HV-PC), PC-HV, and PC-PC, (ii) the differences in LC rates around HVs as opposed to PCs, and (iii) the unique impact of these differences in development of oscillations.
    - Significant Results:
        - Firstly, we identified heavy vehicle (HV) sample from the NGSIM (Next Generation Simulation) dataset. We define an HV as a vehicle with vehicle length equal or larger than 50ft (with buses excluded). For the CF study, we have identified a total of 19, 19, and 30 CF pairs for PC-HV, HV-PC, and PC-PC types, respectively. For the LC study, we identified 82 HVs. Note that we selected sample only from I-80 because the US 101 site has than 15 HVs and the traffic condition of US 101 varied significantly from I-80.
        - Secondly, we have conducted CF model calibration against three major or typical CF models (Newell's model, Gipps' model, and IDM). The IDM model shows the best performance, but overall the three models do not differ substantially. Given the advantages of Newell's model (e.g., simplicity and capability to capture stop-and-go), this study uses Newell's model as the basic framework to revise and build a model for HV car-following.
        - Thirdly, we have conducted thorough analysis on the CF and LC behavior of HVs and the results are further confirmed by simulations. For CF behavior, based on empirical trajectory data, we find that HVs have different behavior from PCs when experiencing traffic oscillations. Particularly, HV-PC and PC-HV pairs maintain much larger spacing levels compared to PC-PC. Additionally, HV-PC and PC-HV tend to adopt convex or constant reaction patterns during oscillations. A model based on modification of the AB model is developed to capture that. It's particularly worth noting that, HVs show the dampening effects: they reduce the oscillation amplitude (speed variation and time duration). This effect is confirmed and evaluated through simulations, which shows that HVs reduce the formation and growth of traffic oscillations and that reduces the overall capacity-drop effect. For LC behavior, our empirical analysis shows that HVs have the discouraging effect; i.e., they discourage other vehicles to move in behind the HVs. The discouraging effect could help to improve traffic stability by reducing potential disturbance imposed by LCs, but

could undermine roadway utilization by creating large space gap behind the HVs. In short, considering both the CF and LC behavior, HVs lead to more stable traffic and produce compound effects on flow efficiency: they require large car-following gaps, which results in smaller flow (measured in vehicle/hour); meanwhile, they reduce the roadway underutilization (i.e., capacity-drop) induced by traffic oscillations.

- Key Outcomes:
  - We have uncovered the basic characteristics for trucks in traffic streams, which differ significantly from cars and the impacts on traffic flow are complex. We have developed a CF model for HVs based on modification of the AB model. We have developed simulations that can be used to explore behavior of HVs and their impacts on the traffic stream.

- **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:
    - Working on two journal research papers. One was recently submitted 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. Another is be submitted to Transportation Research Part D: Transportation and Environment due on December 31st, 2015. The paper investigates an online en-route cargo consolidation problem with time-dependent travel time in the context of real-time customer requests on-the-fly and varying traffic conditions over the course of vehicle daily operation. It compares this new delivery strategy that facilitates the same delivery with the traditional hub-and-spoke delivery system.
    - One NSF proposal to continue this research was awarded, starting September 2015. Two PIs on this CFIRE grant, Drs. Yu (Marco) Nie and Jane Lin, along with three other PIs are on the NSF award. The NSF project will investigate the pricing/matching mechanisms, consumer/courier management strategies, collaborative delivery/routing algorithms and real-time data collection and analysis tools of the emerging field of crowd-sourced urban delivery. The total award is $1,000,000 for three years.
  - Specific objectives:
    - To conduct high quality research and produce high quality journal papers.
    - To disseminate the research at leading conferences and other venues.
    - To attract more funding for the research.
  - 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 " An Online En-route Cargo Consolidation Problem with Real-time Demand On-the-Go": This paper presents an online en-route cargo consolidation problem with time-dependent travel time in the context of real-time customer requests on-the-fly and varying traffic conditions over the course of vehicle daily operation. The proposed online en-route cargo consolidation problem incorporates the environmental costs, i.e., fuel cost and vehicle emission (PM2.5) cost, into the total vehicle operational cost. The fuel and emission costs herein are a function of both vehicle speed and load distribution on the route. In addition, this paper reveals both visually and mathematically a unique underlying relationship of optimal solutions between the total cost and the emission cost function. This relationship is then utilized to theoretically guide the design of a unique emission based heuristic search algorithm to greatly reduce computation time and make it suitable for a fast online application such as the online en-route cargo consolidation strategy. The computational efficiency of this search algorithm is demonstrated through a large case study based on the Austin TX network setting. Furthermore, the investigation of the optimal case suggests that the minimal total cost strategy represents a trade-off between travel time and fuel consumption, and also fuel cost and emission cost are important inputs when green routing is considered. The proposed online en-route cargo consolidation strategy allows truckers to effectively manage and utilize on-board spare cargo space in real time, and at the same time be greener with minimized fuel consumption and vehicular emissions (PM2.5). Furthermore, this strategy facilitates the same day delivery service that is increasingly popular among customers, and could increase the customer base (market share) for carriers compared with the traditional hub-and-spoke system.

- Key Outcomes:
  - One NSF grant ($1,000,000) that builds on this CFIRE project.

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:
  - Implementing the database/information of selected corridors (Michigan and NEC corridors) in the capacity simulation tools (RailSys and OpenTrack).
  - Development of proposed operational scenarios over the selected case studies.
  - Run the Individual and hybrid simulation runs over the NEC, and Michigan corridor (partially) to identify and evaluate alternative operational management scenarios.
- Specific Objectives:
  - To develop a fully directional operation pattern for NEC corridor using rerouting/ rescheduling practices of heuristic modeling or using optimization approach (HOTS Model).

        - To add new freight and commuter trains to the initial schedule considering the existing services as well as existing infrastructure.
    - Significant Results:
        - Each tool used in the study had certain strengths that justified its use:
            - RTC: Extensive U.S. signaling and rolling stock database, animation features. Format of original database.
            - RailSys/OpenTrack: various rescheduling and rerouting features to automatically adjust the train schedules.
            - HOTS model: Customized rescheduling features, quicker procedure, and optimization algorithm.
        - Duplicating the RTC database in other simulation tools to conduct the combined simulation approach is time consuming and challenging particularly in terms of converting the signaling and rolling stock characteristics.
        - Applying operational management techniques (rerouting and rescheduling) were successful in the NEC case study.
        - Results of rescheduling practices in the Michigan case study show that both scenarios were successful in adding additional services (new freight and new commuter services, respectively), based on applying minor schedule changes.
    - Key Outcomes:
        - Nothing to Report
    - 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 research team asked for extending the project duration until end of November 2015, instead of August, 2015.

- **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:
        - Project activities are generally divided into two categories: 1) site characterization and 2) outreach.
        - Site characterization: Activities focused on laboratory testing and analysis of dredged material sampled obtained from the Milwaukee and Green Bay disposal facilities.
        - .
    - Specific Objectives:
        - The objective of this project is to advance the beneficial use of dredged materials as a sustainable material resource for construction operations in the Great Lakes region.
        - Emphasis is placed on laboratory characterization of dredged materials from select confined disposal facilities (CDF) in Wisconsin, using this information to enhance web-based tools for dredged material management, and disseminating this information to a targeted audience of stakeholders in the region.
    - Significant Results:
        - Outreach: D. Knight convened web development specialists at the Great Lakes Commission to plan for updating the GLC-hosted website “Recycling Dredged Material in the Great Lakes,” http://projects.glc.org/rsm/index.html , (Task 2) with 1) data developed by W. Likos in Task 1, and 2) up-to-date information from the U.S. Army Corps of Engineers Great Lakes Navigation Team on Great

Lakes confined disposal facilities (CDFs) including any changes in material characteristics, accessibility and contact names and coordinates.

- Key Outcomes:
  - Nothing to Report

- **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 Tasks 1 (Develop GIS and Conduct Spatial Analysis) and 3 Literature Review); Task 2- the shipper surveys have been completed with researchers currently drafting the report for this task; Task 4- researchers are in the process of completing the potential modal conversion estimate focusing on four commodities: food and beverage, plastics, machinery, and paper products.
  - Specific Objectives:
    - Nothing to report.
  - Significant Results and Key Outcomes:
    - Nothing to Report

- **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:
    - Weekly meetings have been conducted with the advising professors and the research assistant assigned to the project.
    - Instrumentation plan was finalized and all instruments have been procured. The planned polyurethane field injection still did not occur this quarter because of the early freezing conditions. Although an inconvenience, progress on the other part of the project was made. Research assistant performed several experiments to validate instrumentation plan in a laboratory scale. Results showed that using accelerometers coupled with strain gages will provide dynamic monitoring for the track. Whereas, geodetic survey will be used to monitor the accumulation of plastic deformation on the track.
  - 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 their 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 budget changes. The field work has been a major hurdle. It is very difficult to secure a rail section for testing and then have the URETEK develop appropriate injection plan. We

conduct geophysical surveys before the injection plan is developed to delineate subsurface conditions. After spending significant time and effort our original rail site owners pulled back. So we are now focusing on a new site.

- **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:
    - Made site visit to Mississippi and met with various stakeholders involved in the fracking process.
    - Completed a literature review to understand the state-of-the-practice of hydraulic fracturing, including transportation requirements associated with well construction and operation.
    - Investigated the efficacy of FracFocus as a tool for state regulators to monitor fracking activities in various states.
  - 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:
    - While data is available from a variety of sources, fracking activities in the case study area (Mississippi) have subsided due to the current price per barrel of oil and geological challenges with the shale.
    - A recent Transportation Research Board study performed a comprehensive national evaluation of the impacts to roads and bridges from energy development, as well as an overview of national best practices that states are using to understand and address these impacts. The synthesis also reported on tools states are using to determine current and future costs associated with energy development and how they are obtaining funds to address current damages to transportation infrastructure.
  - Key Outcomes:
    - Nothing to report.
  - Changes:
    - Due to these developments, the project is taking a different form, with the following goals under consideration: 1) using data collected in Mississippi, map routes of concern and provide estimates of trucks than can be expected per well so planners have meaningful data to use in performing pavement evaluations, 2) analyze contributions to road repairs due to fracking operations by company size, and 3) perform a study on the impacts of oil and gas development on transportation employment.
- **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.
    - In addition to monthly conference calls, a webinar was conducted by Harry Moser to share Reshoring Initiative's library of database and tutorial of his tool called "Total Ownership Cost".
    - Advisory board member Harry Moser provided data regarding reshoring companies in the US.
    - Task 1 (Literature review) was completed and shared with the team.

        - Tasks 2-6 are in progress – Tasks 2 & 3 are 50% done, task 4 is 50% done, and tasks 6 & 7 are 25% done.
    - Specific Objectives:
        - An abstract will be submitted to the Industrial & Systems Engineering Annual Conference, 2016.
        - PI of this project and Harry Moser (advisory board member of this project) will talk to 100s of attendees in the Federal Highway Administration (FHWA) and will request data related to reshoring and its potential impacts on US transportation.
        - PI & Co-PIs will talk about this project with Congressional staff members at Hardy Hall, University of Southern Mississippi on Aug 03, 2015.
        - Tasks 2-6 are ongoing and looks like the team is behind schedule.
    - Significant Results and 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:
        - Constructed Advisory Board.
        - Met with Advisory Board – had initial meeting with Advisory Board. Discuss responsibility of Advisory Board and answered their question. We also discuss the program and started some initial discuss on the direction of the program.
        - A program website was developed.
        - Developed a Work Breakdown for project team.
        - Held bi-weekly teleconferences to discuss program.

        - Begin to identify educational unit with transportation programs.
        - Presented research findings at TRF in Atlanta in March 2015.
        - Completed preliminary research.
        - Worked with research team to define "Best Practices".
        - Held bi-weekly teleconferences to discuss program.
        - Continued to identify educational unit with transportation programs.
    - Specific Objectives:
        - Start to 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:
        - Performed statistical analysis of the available raw truck GPS data for the state of Tennessee. The following statistical metrics were considered: distribution of observations by year, month, day of week, and time of day; frequency of daily observations for a single truck; frequency of hourly observations for a single truck, etc.
        - Finalized the GPS Data Processing and Extracting Tool for importing raw tuck GPS data, processing raw truck GPS data, and extracting the data for certain time periods specified by the user in SHP and/or CSV format.
        - Updated the ArcGIS toolbox "GPS-based FPMs Estimation". The current version the toolbox includes four scripts, 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; and 4) Analysis of truck parking locations.
        - Estimated the average travel speeds, travel times, and travel time reliability measures for the Freight Analysis Framework (FAF) transportation network available for the state of Tennessee.
        - Developed a methodology for estimation of path-based FPMs.
        - Developed a methodology for assessing seasonal variation of travel times for a given transportation network.
        - Developed a methodology for assessing variation of peak and off-peak travel times for a given transportation network.
        - Developed a framework for calculation hours of delay and congested lane miles for a given transportation network.
    - Specific Objectives:
        - The objective of a statistical analysis was to identify specific features and limitations of the available truck GPS data.
        - The developed GPS Data Processing and Extracting Tool will allow the user importing raw tuck GPS data, processing raw truck GPS data, and extracting the data for certain time periods.
        - 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 proposed methodologies for estimation of path-based FPMs, assessing seasonal variation of travel times, assessing variation of peak and off-peak travel times, and calculation hours of delay and congested lane miles for a

given transportation network may provide insightful outcomes for different stakeholders.

- Significant Results:
  - Results of the statistical analysis of truck GPS data available for the state of Tennessee indicate that 56.7% of trucks had less than 30 observations per day. Frequency of the transmitted GPS signal was not fixed. Approximately 98.6% of trucks had up to 19 observations per hour, while around 40.8% out of 98.6% of trucks had only 4 observations per hour (which translates into 1 observation per 15 minutes). The low frequency of observations for certain trucks may cause difficulties in the analysis of truck trips and origin-destination identification.
  - The developed tools (i.e., GPS Data Processing and Extracting Tool and GPS-based FPMs Estimation toolbox) will be used for analysis of freight corridors 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 path-based FPMs, assessing seasonal variation of travel times, assessing variation of peak and off-peak travel times, and calculation hours of delay and congested lane miles will be implemented using the available truck GPS data and results will be provided in the final report.
- Key Outcomes:
  - Performed the statistical analysis of truck GPS data available for the state of Tennessee.
  - Finalized the GPS Data Processing and Extracting Tool.
  - Updated the GPS-based FPMs Estimation toolbox.
  - Estimated the average travel speeds, travel times, and travel time reliability measures for the FAF transportation network available for the state of Tennessee.
  - Proposed methodologies for estimation of path-based FPMs, assessing seasonal variation of travel times, assessing variation of peak and off-peak travel times, and calculation hours of delay and congested lane miles for a given transportation network.

- **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:
    - Obtained IRB approval.
    - Developed and administered survey to freight infrastructure-associated users/managers across TN.
    - Began analyzing survey responses (109 responses).
    - 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.
    - 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.
    - 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.).
    - 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 and Key Outcomes:
        - Nothing to Report.
    - Changes:
        - We were unable to obtain a graduate student to work on the project full time and have thus utilized an undergraduate student worker.
        - Due to not having a fully dedicated graduate student, we have not spent out the funds as quickly as anticipated.

- **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.
    - 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 and Key Outcomes:
        - Northing 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.

- **CFIRE 09-21 University Transportation Center Simulation Project: Investigating UW Partnerships in Sustainable Transportation**
  Performing Institution: University of Wisconsin-Madison
  Start Date: January 1, 2015 End Date: June 30, 2015
    - Major Activities:
        - The major activity for this project was to organize a UW-Madison campus-wide workshop on "Next Generation Transportation for a Sustainable Future".
    - Specific objectives:
        - To explore synergistic partnerships within the UW in the field of transportation sustainability.
    - Significant results
        - The discussions during this summit took a holistic view towards sustainability by considering social, economic, and technological factors surrounding the risks and trends facing the global community as highlighted in the World Economic Forum's 2015 Global Risks Report.
    - Key outcomes
        - Created a network of collaborators for research on transportation for a sustainable future following the Triple Bottom Lines of Sustainability.
- **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:
        - Field monitoring of strains in the ends of 72W girders upon de-tensioning was completed in January and February 2015 at the Spancrete precast production plant in Valders, WI.
    - Specific objectives:
        - The objective of field monitoring was to compare end strains in normal and debonded girders.
    - Significant results
        - The tension strains at the ends of the debonded girders were measurably lower than those in normal Wisconsin design girders.
    - Key outcomes
        - Nothing to report.

ii. Education and Workforce Development- The following progress has been made on CFIRE's commitments to education and workforce initiatives.

- University of Memphis:
    - IFTI hosted Assistant Secretary for Aviation and International Affairs, Susan Kurland for a two-day event on making transportation a career of choice. This is the second annual event that the Assistant Secretary attended. The event began with presentation by the Assistant Secretary and a panel of professionals on the many job opportunities available

in the transportation industry. The panel also met to discuss challenges and opportunities for females in the transportation industry. That night we hosted the Second Annual Blue Pump Gala where Kurland served as the Keynote speaker. The next day we hosted a conference for professionals across the area and across different modes to discuss how to increase the number of women who choose transportation as a career. We plan to take the event and expand it to become a regional event. The event also included a high school track that was a huge success. We plan to increase that portion in 2016 to include 200 high school participants from across the region.

- University of Southern Mississippi:
  - Attended ProMat 2015 Conference and Shows. A group of 2 professors and 9 students participated this event in Chicago from March 18-20, 2015.
  - Attended the MIST Cluster 2nd Quarter Small Business Summit & 2015 Federal SBIR-STTR Road Tour.
  - Attended Education Fair at Ingalls Shipbuilding at Pascagoula, Mississippi to share LTT educational opportunities with attendees on April 29, 2015
  - Organized a lunch & Learn event at Ingalls Shipbuilding at Pascagoula, Mississippi to share LTT educational opportunities with attendees on June 22, 2015
  - Hosted a webinar on Reshoring Initiative's library of database and a tutorial called "Total Ownership Cost".
  - Provided assistance to 2 economic development organizations seeking information related to site location transportation issues
  - Assistance to the Mississippi Development Authority (MDA) on Destination Port Fees and Terminal Handling Charges
  - USM has awarded 4 Masters Degrees in logistics, trade and transportation in Spring 2015
  - USM has delivered 3 logistics & supply chain courses on-line in the Spring 2015
  - The MS-LTT program invited 2 practitioners as guest speaker to support the inclusion of practical relevant interdisciplinary knowledge in IET 570 and IET 671 courses.
  - At least 20 MS-LTT students performed research projects on logistics transportation areas as part of their course requirement in the Spring 2015.
  - ED 722 Research Methods class on using transportation data for economic development research by guest lecturer, Bruce Lambert, Director of ITTS.
- University of Wisconsin – Madison:
  - UW Transportation Management and Policy Program. Conducted spring colloquium course on how transportation projects are funded around the world.
  - UW Transportation Management and Policy Program. Conducted spring practicum course on the community and operating impacts of a satellite garage for Madison Metro Transit.
  - Conducted the Midwest Transportation Workforce Center Strategic Advisory Meeting on April 21-22, 2015 in Madison, Wisconsin.
  - Hosted the Next Generation Transportation for a Sustainable Future Summit on May 29, 2015 in Madison, Wisconsin.
  - 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.
  - Sponsored and conducted the Wisconsin Transportation Reception at the TRB Annual Meeting, held in conjunction with the TRB Annual Meeting in January 2015.
- University of Wisconsin – Superior:
  - Continue to teach and host the Certification in Transportation & Logistics program.
  - Sponsored the Transportation Day for Girl Scouts (June 25, 2015)
  - Conducted outreach to local industry (visits to manufacturers and transporters and participation in monthly trade organization meetings).
  - Researchers and students attended TRB Annual Conference, January, 2016

- Michigan Technological University:
  - Conducted a TRAC Educator Workshop on March 5, 2015 at Michigan Technological University.
  - Conducted 3 Transportation Education Teacher Workshops for Urban Detroit Teachers
- Vanderbilt University
  - Participated in meetings of the Middle Tennessee Freight Advisory Committee and the Executive Committee of the Tennessee Freight Advisory Committee
  - Sponsored travel to relevant transportation, GIS and risk assessment forums and training sessions
- University of Toledo
  - Provided funding for the Ohio Conference on Freight to be held September 2015 with the theme Breaking Boundaries: Building a Future Together.

iii. Technology Transfer - The following progress has been made on CFIRE's commitments to T2:

- The University of Southern Mississippi:
  - LTT Symposium. The Center for Logistics, Trade and Transportation (CLTT) at the University of Southern Mississippi (USM) in partnership with the Naval Air Command System hosted the Logistics, Trade and Transportation (LTT) Symposium, May 12-14, 2015 at the USM Gulf Park Campus in Long Beach, Mississippi.
  - ITTS Freight in the South. Provided logistical support for Institute for Trade and Transportation Studies for their annual conference held in Biloxi, MS March 16-19.
- Vanderbilt University:
  - Hosted and participated in meetings of the Middle Tennessee Freight Advisory Committee and the Executive Committee of the Tennessee Freight Advisory Committee
- University of Wisconsin-Milwaukee:
  - An app was developed for work zone activity report and incident alert for WisDOT or relevant agencies.
  - A truck routing program is being developed for WisDOT with additional funding provided by WisDOT to expand our work so that more answers are provided with respect to truck permitting and routing research.
- University of Wisconsin-Madison:
  - Sponsored two CFIRE rail short course scholarships in collaboration with the UW Department of Engineering Professional Development. Fundamentals of Traction Power Systems and Overhead Contact Systems (April 28-29, 2015 in Chicago, IL) and Introduction to Railroad Engineering and Operations (May 6-8, 2015 in Madison, WI)

C. Next Reporting Period

i. Research Initiatives: In the upcoming reporting period, research initiatives that are not already complete are scheduled to be completed.

ii. Education and Workforce Development:

- UW-Madison:
  i. Sponsoring of Railroad Engineering Short Courses in Fall 2015
  ii. Sponsoring the Ohio Conference on Freight/Mid-America Freight Coalition Annual Meeting
  iii. Conducting the Midwest Transportation Workforce Summit.
  iv. Awarding the 2015 Student of the Year in Transportation.
  v. Provide support for the 2015 Mid-Continent Transportation Research Symposium to be held in August 2015 in Ames, Iowa.
- University of Memphis:
  i. Stakeholder Meeting of Southeast Transportation Workforce Center
  ii. Conducting the 9th Annual Intermodal Freight Conference on December 10, 2015 at the Fedex Institute of Technology in Memphis, TN.

iii. Technology Transfer:

- All partners: will be submitting papers and presentations for the TRB Annual Meeting to be held in January 2016.

- Products

A. Publications and conference papers:

Publications:

I. 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. The paper is accepted for presentation and under review of the Transportation Research Record: Journal of the Transportation Research Board for publication.

II. Chen, W., Liu, Y., Yang, X. (2015), "A Platoon-based Speed Control Algorithm towards Eco-driving at A Signalized Intersection," Transportation Research Record, in press.

III. Chen, W., Liu, Y., Yang, X. (2015), "Platoon-based eco-driving speed guidance at signalized intersections," Transportation Research Part C, in press.

IV. Engstrom et al. (2015). Moving Freight Transport Forward: Green Smart and Efficient. Final Report Technical Committee B.3 Freight Transport. World Road Association (PIARC).

V. Flaskou, M., Dulebenets, M. A., Golias, M., Mishra, S., & Rock, B. (2015). Analysis of Freight Corridors Using Truck GPS Data. Transportation Research Record: Journal of the Transportation Research Board, 2478, pp. 113-122.

VI. Frost, E.A. (2015). Evaluating Air Emissions from Urban Transportation in Eight U.S. Cities. Masters Thesis. Environment and Resources. UW-Madison.

VII. Gao, Y., Liu, Y., Hu, H., Ge, Y.E. (2015), "Signal optimization for intersections without the explicit permissive left-turn yielding rule," Transportation Research Part C, in press.

VIII. Gholston, Sampson, MD Sarder, Richard Stewart, Amit Mokashi, Joan Chadde, "Analyzing What Works Best for Transportation Education" Transportation Research Forum, February 12, 2015.

IX. 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.

X. Kim, J.; Anderson, M.; Sarder, MD.; and Miller, C. (2015). Multimodal Freight Distribution & Economic Development due to International Capacity Expansion, International Journal of Traffic and Transportation Engineering, (In Press).

XI. Li, X. , Liu, Y. (2015), "An artificial intelligent approach to develop temporal and spatial linkage between urban rail transit station demand and land-use patterns," ASCE Journal of Urban Planning and Development, in press.

XII. Li, X. , Liu, Y., Liu, D., Gao, Z. (2015), "Evaluating Transit Operator Efficiency: An Enhanced DEA model with constrained Fuzzy-AHP Cone and Case study in Nanjing City, China," Journal of Traffic and Transportation Engineering, in press.

XIII. Li, X. , Liu, Y., Liu, D., Gao, Z. (2015), "Incentive-based urban transit subsidy allocation: Framework, models, and case studies," Transportation Research Part A, in press.

XIV. Li, X. , Liu, Y., Liu, D., Gao, Z., Li, P. (2015), "Multi-criterion assessment of urban public transportation system development toward Transit Metropolis in China," ASCE Journal of Urban Planning and Development, in press.

XV. Liu, Y., Luo, Z. (2015), "Traffic management in a dynamic evacuation network: trade-off between signal and cross-elimination strategies," Transportation Research Part C, conditionally accepted.

XVI. Liu, Y., Luo, Z. (2015), "Optimal conversion of an evacuation network to signalized and uninterrupted flow intersections," Transportation Research Part B, in press.

XVII. Liu, Y., Yu, J. (2015), "Cluster-based optimal hierarchy and location planning of multimodal transit hubs," Transportation Research Part A, in press.

XVIII. Ma, W., Liao, D., Liu, Y., Lo, H-K (2015), "Optimization of pedestrian phase patterns and signal timings for isolated intersection," Transportation Research Part C, doi:10.1016/j.trc.2014.08.023

XIX. Mishra S., Golias M.M. Sarker A., Naimi A. (2014). Effect of Primary and Secondary Crashes: Identification, Visualization and Prediction. Draft final report. Prepared for the Tennessee Department of Transportation.

XX. Sakai, T., K. Kawamura, and T. Hyodo. 2015. "Location Dynamics of Logistics Facilities: Evidences from Tokyo". Journal of Transport Geography. Published online May 2015.

XXI. 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

XXII. Sarker, A., Naimi, A., Mishra, S., Golias, M. M., and Freeze, B. (2015) Identification of Secondary Crashes in Large Scale Highway Networks. In proceedings of the 94th Annual Meeting of Transportation Research Board.

XXIII. Sarker, A., Naimi, A., Mishra, S., Golias, M.M., and Freeze, B. Development of a Secondary Crash Identification Algorithm and Occurrence Pattern Determination in Large Scale Multi-Facility Transportation Network. Transportation Research Part C: Emerging Technologies, 60, pp. 142-160.

XXIV. Simkins, Zamira, Richard Stewart, "Factoring a real value of cargo in port investment and funding decisions", Journal of Maritime Economics and Management, Taylor and Francis, 2015, Peer Reviewed.

XXV. 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.

XXVI. Zhao, J., Liu, Y. (2015), "Integrated signal optimization and non-traditional lane assignment for urban freeway off-ramp congestion mitigation," Transportation Research Part C, in press.

XXVII. Zhao, J., Liu, Y., Di, D. (2015), "Optimization Model for Layout and Signal Design of Full Continuous Flow Intersections," Transportation Letters, in press.

XXVIII. Zhao, J., Liu, Y., Li, P. , Yang, X. (2015), "A network enhancement model with integrated lane reorganization and traffic control strategies," Journal of Advanced Transportation, in press.

XXIX. Zhao, J., Liu, Y., Wang, T. (2015), "Increasing signalized intersection capacity with unconventional use of special width approach lanes," Computer-aided Civil and Infrastructure Engineering, in press.

XXX. Zhao, J., Ma, W., Liu, Y. (2015), "Optimal Operation of Freeway Weaving Segment with Combination of Lane Assignment and On-ramp Signal Control," Transportmetrica A, in press.

XXXI. Zhou, W., J. Lin (in review) Is Electric Vehicle a Cost-effective Alternative to Diesel Commercial Vehicle in Urban Delivery? Transportation Research Part E: Logistics and Transportation Review.

XXXII. Zhou, W., J. Lin, L. Du (in preparation) A Green En-route Cargo Consolidation Problem, Transportation Research Part D: Transportation and the Environment.

Presentations:

I. Abkowitz, M., Assessing the Resilience of Critical Infrastructure to Climate Change and Extreme Weather Events, Inter-American Development Bank Seminar, Washington, DC, January 2015.

II. Adams, T. M., (2015). Next Generation Transportation for a Sustainable Future. Presentation. University of Wisconsin-Madison. May 29.

III. Adams, Teresa. CUTC Summer Meeting, Workforce Development Breakouts, Midwest, June 3 2015.

IV. Adams, T.M. "Midwest Transportation Workforce Center." Presented at the 2015 CUTC Summer Meeting. New Brunswick NJ. June 1-3, 2015.

V. Adams, T.M. "Midwest Transportation Workforce Center." Presented at the MTWC Strategic Advisory Meeting. Madison, WI. April 21-22, 2015.

VI. Adams, T.M. S. Albert, S. Ivey, G. McRae, and T Obrien. "Transportation Workforce Centers Panel' Annual Meeting of the Transportation Research Board. January 2015.

VII. Adams, T.M. "Stakeholder Input for New Regional Surface Transportation Workforce Centers." TRB Session 840. Washington DC. January 14, 2015. Conference Session Organizer and Facilitator.

VIII. Adams, T.M. Next Generation Transportation for a Sustainable Future. Madison, WI. May 29, 2015. Conference Chair.

IX. Adams, T.M. Midwest Transportation Workforce Center Strategic Advisory Meeting. Madison WI. April 21-22, 2015. Meeting Chair.

X. Ashraf Al Hajjeh, Rani Elhajjar, Hani Titi, and Alex Laflin (2015). “A Non-Destructive Expert System Technology for Application to Highway and Railway Systems,” the Mid-Continent 2015 Mid-Continent Transportation Research Symposium in Ames, IA.

XI. Camp, J. and B. Shah. Cross-Disciplinary Data Integration Using Web-Based Geodatabase and Mapping Platform. Tennessee Geographic Information Council Annual Meeting, Montgomery Bell State Park, TN. April 2015.

XII. Camp, J. Use of Hazus for Adaptation Planning of Transportation Infrastructure Under Extreme Conditions, Federal Emergency Management Association (FEMA) National Hazus User Group, April 2015.

XIII. Dulebenets, M. A. Development of Algorithms and Tools for Processing Truck GPS Data and Estimating Freight Performance Measures. 2015 Southern District ITE Annual Meeting, April 19-22, 2015, the Beau Rivage Resort, Biloxi, Mississippi – on going.

XIV. Flaskou, M., Dulebenets, M. A., Golias, M., Mishra, S., & Rock, B. Analysis of Freight Corridors Using Truck GPS Data. Transportation Research Board, 94th Annual Meeting. Washington DC, January 11-15, 2015 - lectern session.

XV. Gholston, S., Sarder, MD., Stewart, R., Chadde, J., and Mokashi, A. (2015). Analyzing What Works Best for Transportation Education, Proceeding of the 56th Annual Transportation Research Forum, Georgia, Atlanta.

XVI. Identifying Best Practices of Logistics & Transportation Graduate Education at ASEE Annual Conference, Seattle, Washington, June 14-17, 2015

XVII. 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.

XVIII. Jermier, A., E. B. Perry, and T. M. Adams, “Leveraging Our Comparative Advantage: State Funding for Inland Waterways and Ports.” Presentation at the Annual Meeting of the Transportation Research Board, Washington, DC, January 2015.

XIX. Jones, A., L. Dundon and M. Abkowitz, Tennessee DOT Extreme Weather Vulnerability Assessment, Annual Meeting of the Transportation Research Board, Washington, DC, January 2015.

XX. Jones, A., L. Dundon, M. Abkowitz and J. Camp, Assessing the Vulnerability of Tennessee Transportation Assets to Extreme Weather, National Adaptation Forum, St. Louis, MO, May 2015.

XXI. Kawamura, K. and P.S. Sriraj. “Building Freight-Friendly Environment” The 9th International Meeting of the Institute of City Logistics, Tenerife, Canary Islands, June 17, 2015

XXII. Ko, S., J. Kim, M. D. Anderson, A. Mohammadian, “Changes in Containerized Freight Distribution by Capacity Increase on the Maritime Network into the United States”, in proceedings of 94rd Annual Transportation Research Board Meeting, Washington D.C., January 2015.

XXIII. Lin, J., W. Zhou (2015) EV Routing Problem, The 9th International Meeting of the Institute of City Logistics, Tenerife, Canary Islands, June 19, 2015

XXIV. Lin, Jane, "Green Urban Freight Consolidation Strategies", invited talk, Department of Civil and Environmental Engineering, Northwestern University, May 14, 2015.

XXV. Oliva, Michael (2015). Midasoft seminar, "Wisconsin Highway Research Program", Mar. 4, Milwaukee Marriot Downtown.

XXVI. Oliva, Michael (2015). Midasoft seminar, "Wisconsin Highway Research Program", Mar. 5, Madison Marriot Courtyard East.

XXVII. Nelson, K., M. Abkowitz, J. Camp. A Method for Creating High Resolution Maps of Social Vulnerability, American Association of Geographers Annual Meeting, Chicago, IL, April 2015.

XXVIII. Pan, S., Yu, J., Yang, X., Liu, Y., Zou, N. (2015), “Design a flexible feeder transit system for Chinese cities: service area determination and feeder route planning,” ASCE

XXIX. Pouryousef, H, Lautala, P., Applying a New Rescheduling Model (HOTS) to Improve the Capacity of a Single Track Shared-use Corridor, ASME/ASCE/IEEE 2015 Joint Rail Conference, San Jose, CA, March 23-26, 2015. (Abstract and presentation only)

XXX. Pouryousef, H, Lautala, P.; Capacity Evaluation of Directional and Non-directional Operational Scenarios along a Multiple-track U.S. Corridor; Transportation Research Board 94th Annual Meeting of the National Academies, Washington, DC, January 11-15, 2015.

XXXI. Qi Gong, Q., T. M. Adams and B. Wang, "Estimating Link Travel Time Using Sparse GPS Data on Highway Corridors." Presentation at the Annual Meeting of the Transportation Research Board. January 2015.

XXXII. 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.

XXXIII. Sakai, T., K. Kawamura, and T. Hyodo. "Logistic Facility Distribution in Tokyo Metropolitan Area: Experiences and Policy Lessons". The 9th International Meeting of the Institute of City Logistics, Tenerife, Canary Islands, June 18, 2015

XXXIV. Sarder, MD. (2015). Identifying Best Practices of Logistics & Transportation Graduate Education, Proceeding of the American Society of Engineering Education Conference (ASEE), Seattle, Washington.

XXXV. Sarder, MD. (2015). Reshoring – A Driving Force to US Manufacturing, Proceeding of the Annual Industrial & Systems Engineering Research Conference (ISERC), Nashville, Tennessee.

XXXVI. Student's Career Development at IIE Applied Solutions Conference. Nashville, Tennessee, May 28 - June 1, 2015.

XXXVII. Titi, H. H. (2015). "Characterization of Resilient Modulus of Fine-Grained Soils for Mechanistic-Empirical Pavement Design," Presented at the Transportation Research Board Meeting, Session 315: Subgrade Characterization for Roadways and Railroads and Vibratory Compaction for Resistance to Liquefaction, Washington, D.C.,

XXXVIII. Titi, H. H. (2015). "Characterization of Resilient Modulus of Soils for Mechanistic-Empirical Pavement Design," Invited presentation at the 2015 ASCE Iowa Geotechnical Conference, Ames, Iowa State University.

XXXIX. Titi, H.H., Latifi, V., and Coley, N. (2015). "Evaluation of Pavement Performance due to Overload Single Trip Permit Truck Traffic in Wisconsin," Presented at the Transportation Research Board Meeting, Session 701: Managing Pavement Use Under Heavy Vehicle Loads, Washington, D.C.,

XL. Transitioning to Post-War Supply Chain System in Afghanistan at PICMET Conference, Portland, Oregon, August 2-6, 2015

XLI. Zhou, W., J. Lin (2015) Electric Vehicle Routing Problem, Vehicle Routing and Logistics Optimization (VeRoLog) 2015, Vienna, Austria, June 8-10, 2015.

XLII. Zhou, W., Q. Chen, J. Lin (2015) Green Vehicle Routing Problem Considering Joint Effect of Vehicle Load and Speed, 94th Transportation Research Board Annual Meeting, paper no. 15-1112, Washington D.C., January 11-15, 2015.

B. Websites (does not include the academic partner institution websites reported in the Fall 2012 PPPR):

i. Vanderbilt Center for Transportation Research (VECTOR) web site: http://www.vanderbilt.edu/vector/

ii. University of Wisconsin-Superior CTL program online: http://www.uwsuper.edu/cee/certificates/transportation/index.cfm This online program satisfies the academic requirements to achieve CTL certification, an industry leading certification, through the American Society of Transportation and Logistics (ASTL). The University of Wisconsin-Superior CTL online program is offered in partnership with the American Society of Transportation and Logistics and the Center for Continuing Education.

iii. Oversize-Overweight Program History Analysis Program: http://pavement.ceas.uwm.edu:8080

iv. Midwest Transportation Workforce Center (mtwc.org)

v. A web-based tool is developed for the RI-3 project. The tool has two components: a) a "Knowledge Center" that contains summaries of all of the data and information collected during this project on non-destructive methods applicable to infrastructure systems and materials, and

b) a decision-making expert system for selecting appropriate methods for diagnose and assessment of structural distress.

vi. Visualization for the RI-2 project: http://www.wistrans.org/livability/MemphisLamarAve.htm.

vii. Proceedings for the 09-21 Project: http://www.wistrans.org/cfire/events/ric-next-gen/.

viii. Proceedings for the initial phase of the 08-04 project: http://mtwc.org/events/regional-workforce-summit/

C. Newsletters:

ix. The USM CLTT produces a monthly e-newsletter for over 5000 subscribers
- http://www.usm.edu/logistics-trade-transportation/news-and-events

- Collaboration - The following progress has been made on CFIRE's commitments to collaboration.

A. Collaborating Organizations

I. Allied Coop
II. American Society of Transportation and Logistics
III. American Transportation Research Institute
IV. AMTRAK, The Northeast Corridor Infrastructure and Investment Development Department
V. Applied Research Associates
VI. Ashley Furniture
VII. Ayres Associates
VIII. Beijing Wuzi University, China
IX. Bella Sand
X. BNSF Railroad
XI. Business Transportation Solutions
XII. California State University-Long Beach
XIII. Canadian National Railroad
XIV. Capitol Area Regional Planning Commission
XV. Center for Integrated Agricultural Studies
XVI. Conway
XVII. Cornerstone Systems
XVIII. Council of Supply Chain Management Professionals (Twin Cities and Northeast Wisconsin Roundtable)
XIX. CSX Railroad
XX. Detroit Public Schools Office of Science
XXI. Duluth Superior Transportation Association
XXII. Enbridge
XXIII. Ericson Logging
XXIV. FedEx
XXV. FracFocus
XXVI. Franklin Furniture Institute
XXVII. Fraser Shipyard
XXVIII. Great Lakes Fleet
XXIX. Great Lakes Maritime Research Institute
XXX. Halvor Lines
XXXI. Hofstra University
XXXII. Illinois Department of Transportation
XXXIII. Indiana Department of Transportation
XXXIV. Institute for Trade and Transportation Studies
XXXV. Intermodal Association of North America
XXXVI. Iowa Department of Transportation
XXXVII. Iowa State University
XXXVIII. Kansas Department of Transportation
XXXIX. Kennrich Foods

XL. Kentucky Department of Transportation
XLI. Kimley-Horn
XLII. KK Warehouse
XLIII. Kraft
XLIV. Lake Michigan Air Directors Consortium (LADCO).
XLV. Lake Superior Pilot Program
XLVI. Lake Superior Railroad Museum
XLVII. Landscape Stone
XLVIII. Livable Memphis
XLIX. Madison Regional Economic Partnership
L. Madison Sustainable Commerce Center
LI. Marten Transport
LII. Maryland Department of Transportation
LIII. Metro Nashville Government
LIV. Metropolitan Interstate Committee
LV. Michigan Department of Transportation
LVI. Michigan Tech University Rail Transportation Program
LVII. Michigan Technological University
LVIII. Middle Tennessee State University
LIX. Minnesota Department of Transportation
LX. Mississippi Oil and Gas Board
LXI. Mississippi State Port Authority
LXII. Missouri Department of Transportation
LXIII. Montana State University
LXIV. National Association of Purchasing Managers (Lake Superior Chapter)
LXV. National Oceanic and Atmospheric Administration (NOAA)
LXVI. Natures Way
LXVII. North American Regional Climate Change Assessment Program (NARCCAP)
LXVIII. North Shore Scenic Railroad
LXIX. Northwestern University
LXX. Ohio Department of Transportation
LXXI. Peer Power
LXXII. Polyfab Corp
LXXIII. Port of Green Bay
LXXIV. Prime Focus LLC.
LXXV. Purdue University
LXXVI. Research Innovation Committee
LXXVII. Reshoring Initiative
LXXVIII. RGL Logistics
LXXIX. Rihm-Kenworth Trucking
LXXX. RoadOne Intermodal Logistics
LXXXI. Sanimax
LXXXII. SCA Tissue
LXXXIII. SE Michigan Council of Governments (SEMCOG)
LXXXIV. Seneca Foods
LXXXV. St. Lawrence Seaway Development Corporation
LXXXVI. Technical University of Braunschweig- Germany
LXXXVII. Tennessee Department of Transportation
LXXXVIII. The French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR, University of Paris-Est, France)
LXXXIX. The Maritime Academy of Toledo
XC. Tokyo University of Marine Science

XCI. Transportation Development Association of Wisconsin
XCII. Twin Cities Transportation Club
XCIII. U.S. Army Corps of Engineers
XCIV. U.S. Energy Information Administration
XCV. U.S. Office of Naval Research
XCVI. University of Alabama-Huntsville
XCVII. University of Illinois at Chicago
XCVIII. University of Iowa, Public Policy Center
XCIX. University of Le Havre, France
C. University of Memphis
CI. University of Minnesota
CII. University of Minnesota Duluth
CIII. University of Missouri
CIV. University of Oregon
CV. University of Southern Mississippi
CVI. University of Toledo
CVII. University of Utah
CVIII. University of Vermont
CIX. University of Wisconsin-Madison
CX. University of Wisconsin-Milwaukee
CXI. University of Wisconsin-Superior
CXII. Alexander
CXIII. Vaco Logistics
CXIV. Verson
CXV. Virginia Department of Transportation
CXVI. Washington DC Department of Transportation
CXVII. Wayne State University
CXVIII. William A. Irvin Ship Tours
CXIX. Wisconsin and Southern Railroad
CXX. Wisconsin Commercial Ports Association
CXXI. Wisconsin Counties Association
CXXII. Wisconsin Department of Administration – Wisconsin Coastal Management
CXXIII. Wisconsin Department of Transportation
CXXIV. Wisconsin Highway Research Program
CXXV. Wisconsin Economic Development Corporation
CXXVI. Wisconsin Manufacturers and Commerce
CXXVII. Wisconsin Sustainability Business Council
CXXVIII. Wisconsin Transportation Builders Association