

# Program Progress Performance Report for University Transportation Centers

**Federal Agency and Organization Element to Which Report is Submitted:**

U.S. Department of Transportation  
Research and Innovative Technology Administration

**Federal Grant or Other Identifying Number Assigned by Agency:** DTRT12-G-UTC14

**Project Title:** National Center for Intermodal Transportation for Economic Competitiveness (NCITEC)

**Program Director (PD) Name, Title and Contact Information (e-mail address and phone number):**

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**Name of Submitting Official, Title, and Contact Information (e-mail address and phone number), if other than PD:** same as PD

**Submission Date:** January 31, 2015

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**Recipient Organization (Name and Address):** U.S. Department of Transportation  
Research and Innovative Technology Administration  
(Denise Dunn, UTC Grant Administrator)  
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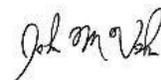
**Recipient Identifying Number or Account Number, if any:** 363277-061300-021000

**Project/Grant Period (Start Date, End Date):** 1/1/2012 – 1/31/2016

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**Report Term or Frequency (annual, semi-annual, quarterly, other):** Semi-annual, PPPR6

**Signature of Submitting Official:**



## 1. Accomplishments

As indicated in our grant application, NCITEC's major goals are to address the economic competitiveness and safety of the national intermodal transportation system. Economic competitiveness and safety are two of the five strategic goals that U.S. Department of Transportation (USDOT) has identified. The next section provides more specific goals of NCITEC.

### 1.1. What are the major goals and objectives of the program?

- Develop, implement and maintain a comprehensive research program that addresses the economic competitiveness and safety of the national intermodal transportation center.
- Develop educational programs in intermodal transportation that incorporate the multidisciplinary nature of intermodal transportation by drawing upon the resources of each university.
- Utilize modern educational technologies, and develop effective professionals in intermodal transportation.
- Enhance the public awareness, understanding, and appreciation of intermodalism and its role in the modern world, including career opportunities in the field.
- Offer interdisciplinary programs and experiential training in intermodal transportation operations to provide a steady source of transportation professionals to public and private organizations.
- Ensure the availability of research results to potential users in a form that can be directly implemented, utilized, or otherwise applied.
- Strengthen the collaboration between NCITEC consortium members as well as between federal, state, and local agencies.
- Develop ties with other University Transportation Centers (UTCs) and USDOT's research clusters to create opportunities for collaborative activities.

### 1.2. What was accomplished under these goals?

- *Develop, implement and maintain a comprehensive research program that addresses the economic competitiveness and safety of the national intermodal transportation center:* Some of the final reports have been submitted for 2012 projects and these have been posted on the TRID database. There are many projects still in the research phase of their study. As well, 11 other projects were completed during the last 6 month period. In the coming year a majority of the remaining projects will be completed with reports being submitted throughout the year.
- *Develop educational programs in intermodal transportation that incorporate the multidisciplinary nature of intermodal transportation by drawing upon the resources of each university:*
  - Continued support of the Master's Program in Intermodal transportation offered at the University of Denver through scholarships and other education activities.
  - Held a Summer Intermodal Transportation/Robotics Camps for one week in July 2014. Introduced students to the career concepts of transportation with activities related to the construction of bridges designed to transport payloads and clearance depending on

- construction materials and infrastructure (spaghetti bridges - understand weight distribution and be able to combine their understanding of shape strength with bridge design) – these activities demonstrated the effects of auto, trucks and heavy equipment impact on the longevity of roads and bridges. Students learned about process flow and supply chains along with other activities that identify safety techniques as well as economic competitiveness and environmental sustainability.
- Held a three-day professional development teacher workshop in July 2014. One day was focused on intermodal transportation.
  - *Utilize modern educational technologies, and develop effective professionals in intermodal transportation:* Two students were trained on use of a driving simulator for research experimentation. As both undergraduate and graduate students participate in research they are learning to make use of various methods and tools important in transportation studies, specific examples being a driving simulator and acoustic emission sampling equipment.
  - *Enhance the public awareness, understanding, and appreciation of intermodalism and its role in the modern world, including career opportunities in the field:*
    - Continued to support the awareness and appreciation of intermodalism through our seminars and outreach activities. The center sponsored a conference on Women in Transportation and also a conference on the “Global Supply Chain” which highlighted the role of intermodal transportation.
    - A South Mississippi Intermodal Conference was held at the University of Southern Mississippi on Feb. 26-27, 2014 for purpose of exploring issues and solutions to oilfield transportation. 42 persons attended.
    - A North Mississippi summit occurred December 11, 2014, at Itawamba Community College, in Belden, MS, with 61 people in attendance. The conference addressed public/private partnership of short-line rail and the impact on east/west transportation to/from the Tennessee Tombigbee Waterway. The Mississippi DOT, Mississippi Trucking Association, and Mississippi Railroad Association presented at the program.
    - Dr. Lucy P. Priddy a Research Civil Engineer with the ERDC Airfields and Pavements Branch in Vicksburg, Mississippi, visited the CAIT Lab at University of Mississippi and spoke with students about job opportunities.
    - University of Mississippi held a workshop on December 5, 2014 entitled: ““Extreme Flood Inundation Mapping and Risk Modeling of Transportation Infrastructure Assets.” The workshop was opened to all by email invitations and CAIT web page posting.
  - *Offer interdisciplinary programs and experiential training in intermodal transportation operations to provide a steady source of transportation professionals to public and private organizations:* The University of Denver offers an executive intermodal transportation management master’s degree designed to develop the next generation of leaders in the global transportation industry. Executive transportation management master’s degree. (<http://www.du.edu/transportation/masters-transportation/index.html>). Thirteen transportation-related courses were offered under this program during the last reporting period.

- *Ensure the availability of research results to potential users in a form that can be directly implemented, utilized, or otherwise applied:* The projects that began in 2012 and some from 2013 are being completed and their results have been posted on our website and on the TRID database. As listed later in this report, some of the methods and results of these projects have been presented at conferences.
- *Strengthen the collaboration between NCITEC consortium members as well as between federal, state, and local agencies:* We continue to work in close collaborations with state DOTs. The Mississippi (MDOT), Louisiana (LADOTD), Colorado (CDOT), and Virginia (VDOT) Departments of Transportation with them being one source of matching funds for projects. The table in section 3.1 lists many federal, state, and local agencies that have been involved in support projects.
- *Develop ties with other University Transportation Centers (UTCs) and USDOT's research clusters to create opportunities for collaborative activities:* The UTCs that were selected in 2012 and 2013 in Region 4 have been in communication to organize the third regional conference to be held in March 2015. We also participated in the CUTC meeting at the TRB conference in Washington DC in January 2015.

### **1.3. How have the results been disseminated? If so, in what way/s?**

- Research results have been published in peer-reviewed publications and conference proceedings. See listing of items under section 2.1
- See list of webpages and social media sites used for posting results and news under section 2.2.
- Other mechanisms include:
  - Dr. Uddin presented a project overview and examples of on-going work to visiting international university delegations during their scheduled visits to CAIT Transportation Modeling & Visualization Lab at the Univ. of Mississippi Jackson Ave Center (JAC).
  - Dr. Uddin provided an overview of the Lab facilities, the NCITEC projects, and history of the Lab (in cooperation with the Mississippi DOT Traffic Engineering Division) for visiting attendees of the winter workshop of the Gulf Region Intelligent Transportation Society (GRITS). The workshop was held at the University of Mississippi Campus in Oxford, Oct 29-30, 2015.
  - Dr. Uddin promoted his 2013 book "Public Infrastructure Asset Management" through blog pages and tweets. The book was published by McGraw-Hill in July 2013. The book includes several new sections on supply chain management, flood disaster impact examples, use of remote sensing imagery and geospatial technologies, asset management practice for transportation and other lifeline public infrastructure, and value engineering applications for investment decision making.
  - University of Mississippi held a workshop on December 5, 2014 entitled: ""Extreme Flood Inundation Mapping and Risk Modeling of Transportation Infrastructure Assets." The workshop was opened to all by email invitations and CAIT web page postings.

- Dr. Altinakar visited USDA NRCS in Jackson Mississippi to present flood models developed by NCCHE and to discuss their potential applications for the flood impact analyses to be performed by the USDA.

#### **1.4. What do you plan to do during the next reporting period to accomplish the goals and objectives?**

- We are hosting (in collaboration with the University of Alabama at Birmingham) the Regional UTC Conference that will take place March 26-27, 2015 in Birmingham, AL.
- We plan to hold a conference on “safety culture in the intermodal transportation industry” in the coming months at the University of Denver.
- Plan to have a group meeting with teachers that participated in summer camp, identify potential students and schools for a future camp, and have teachers collaborate with other subject matter experts.

## **2. Products**

### **2.1. Publications, conference papers, and presentations:**

- D’Souza, K. A. & S. K. Maheshwari (2014). A Methodological Approach for Studying Public Bus Transit Driver Distraction. To appear in the International Journal of Sustainable Development and Planning. Wessex Institute of Technology Press, Southampton, U. K.
- Maheshwari, S. K. & K. A. D’Souza (2015). Evaluation of a Texting-While-Driving Education Program Among Adult Drivers. Accepted for presentation at the 21th International Conference on Urban Transport and the Environment. Valencia, Spain, May, 2015.
- Maheshwari, Sharad K. & D’Souza, Kelwyn (2015). Impact of Education and Awareness Programs on The Usage And Attitude Towards Texting While Driving Among Young Drivers. Accepted for presentation in Urban Transport 2015, Valencia, Spain.
- Perl, A. D., & Goetz, A. (2014). Corridors, Hybrids and Networks: Three Global Development Strategies for High Speed Rail. Journal of Transportation Geography. (in press).
- Sherry, P. & Zucker, K. (2014) “Promoting Pedestrian Safety Through Community and Employee Intervention in the Rail Industry” World Congress of Health and Safety, Frankfurt, Germany, August 24-27, 2014.
- Sherry, P. (2014). "Fatigue Countermeasures for Shortline Railroad Operations." A paper presented to the Annual Meeting of the ASLRRA in San Diego CA. April 23, 2014.
- Zucker, K., Bondanza, A., & Sherry, P. (2014). ""The Effects of Shift Work on Women’s Health." A paper presented at the Annual Meeting of the Amalgamated Transportation Workers Union, Orlando, FL. May 23rd, 2014.
- Sherry, P. (2014). “Psychological Consequences of Transit Operator Assault. A presentation at the Transit Operator Assault Roundtable. A Paper presented at the US DOT FTA Operator Roundtable, Washington, DC on July 11, 2014.
- Mulholland, R. & Sherry, P. (2014). " Being Female in the Traditionally Male Industries: Exploring the Characteristics of Women in Transportation and Engineering." A paper presented at the Rocky Mountain Psychological Association Annual Convention. Salt Lake City, Utah. April 26, 2014.

- Sherry, P., & Zucker, K. (2014) "The Efficacy of Pedestrian Suicide Prevention and Safety Promotion Interventions in the Public Transit Industry" A paper presented at the Rocky Mountain Psychological Association Annual Convention. Salt Lake City, Utah. April 25, 2014.
- Sherry, P. & Zucker, K. (2014). "Effects of Suicide Prevention Training On Rail Transit Workers Knowledge and Attitudes." A paper presented at the Annual Meeting of the American Association of Suicidology, Los Angeles, CA. April 10, 2014.
- Sherry, P. (2014). "The Impact of Suicide by Train on the Community, First Responders and Rail Workers." A paper presented at the Annual Meeting of the Public Rail Safety Conference, Anaheim, CA. April 10, 2014.
- Zucker, K., Sherry, P. & Mulholland, R.A. (2014). "Women in Transportation: A Model for Job Seeking & Acceptance in the Transportation Industry." A paper presented to the Annual Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) Conference, Atlanta, GA. March 24, 2014.
- Sherry, P., Hedman, B., Garriott, P., & Mulholland, R. (2014). "Workforce Development: Recruitment, Retention & Turnover." A paper presented at the 55th Annual Transportation Research Forum, San Jose, CA, March 13, 2014.
- Sherry, P., Zucker, K., Bondanza, A., Trujillo, L., & Colarossi, D. (2014) "Safety Culture and Employee Health in the Transit Industry." A paper presented at the 55th Annual Transportation Research Forum, San Jose, CA, March 13, 2014.
- Presentation by Bishal Kasu (Research Assistant on this project): "The Demographic Impact of passenger rails in the United States". Great Plains Sociological Association conference, October 23-24, 2014, Sioux Fall, SD.
- Medal, H. - Presented research results to the City of Starkville's Transportation Committee.
- Li, X., Medal, H., and Wang, J. "A Network Design Model under Connectivity Constraints with Heterogeneous Services." In: Proceeding of the 93rd TRB Annual Meeting, Washington D.C., January 2014
- Beneficial Reuse of Very High Moisture Soils by way of Geotextile Tubes and Low Cementitious Dosage Rates. 2014 ASCE Mississippi Section Meeting, Sept 3-5, 2014, Vicksburg, MS, Abstract and Selected Podium Presentation.
- Boz, Mehmet\* and Islam El-adaway, "Systems Framework for Sustainability of the Built Environment", *Journal of Construction Engineering and Management*, American Society of Civil Engineers, online publication date 25 August 2014, doi: 10.1061/(ASCE)CO.1943-7862.0000911 , 04014067, pp. 1-11.
- Boz, Mehmet\*, Islam El-adaway, and Mohamed Eid\*(2014), "A Systems Approach for Sustainability Assessment of Civil Infrastructure Projects", 2014 Construction Research Congress, American Society of Civil Engineers, Georgia, United States, pp. 444-453.
- Boz, Mehmet\* and Islam El-adaway, "Managing Sustainability Assessment of Civil Infrastructure Projects using Work, Nature, and Flow", *Journal of Management in Engineering*, American Society of Civil Engineers, doi: 10.1061/(ASCE)ME.1943-5479.0000203, 04014019, pp. 1-13.
- Steven B. Worley, "Development and Validation of the Structural Health Evaluation (SHETM) Program," Master's Thesis, August 2014. Successfully defended May 2014.
- Elizabeth K. Ervin, "Three Experimental Applications of Health Algorithms to Improve Infrastructure Inspection," European Workshop on Structural Health Monitoring, July 2014. Refereed paper accepted. Presented.
- Steven B. Worley and Elizabeth K. Ervin, "Structural Health Indication on a Reinforced Concrete Test Bridge with Pier Damage," *ASCE Journal of Bridge Engineering* (submitted December 8, 2014).

- C. Mullen, "Damage Mapping and Collapse Vulnerability of Weakened Structural Systems," January 8, 2015, to NIST Structures Group, Gaithersburg, MD.
- Poster: Swain, K., "Social Media Presence and Reputational Threat of Companies Involved in Toxic Spills," Inter. Society for Risk Analysis annual convention in December 2014 in Denver. SRA provides an open forum for risk analysis research, including risk characterization, risk communication, risk management, and risk-related policy issues.
- C. Mullen, "Damage Mapping and Collapse Vulnerability of Weakened Structural Systems," January 8, 2015, to NIST Structures Group, Gaithersburg, MD.
- Uddin, W. (2014). Chapter 23 "Mobile and Area Sources of Greenhouse Gases and Abatement Strategies," Handbook of Climate Change Mitigation and Adaptation, edited by Wei-Yin Chen, John M. Seiner, Toshio Suzuki and Maximilian Lackner, Springer. (Updated Chapter 23 of the 2012 Handbook. The reference book will be available in early 2016).
- Headrick, Jessica and Uddin, W. (2014). Traffic Flow Microsimulation for Performance Evaluation of Roundabouts and Stop-controlled Intersections at Highway Overpass. *ATS - International Journal of Advances in Transportation Studies*, Issue, XXXIV, November 2014, pp. 7-18.
- Durmus, A., Nguyen, Q., McGrath, M.Z., Altinakar, M.S., and Uddin, W. (2014). Numerical Modeling and Simulation of Extreme Flood Inundation to Assess Vulnerability of Transportation Infrastructure Assets. Paper No. 15-1606, On-line Proceedings, Paper Presented at the 94th Annual Meeting of The Transportation Research Board, Washington, DC, January 10-15, 2015.
- Uddin, W. (2015). Aircraft Safety on Airfield Pavements with Standing Water and Slush. Workshop 143- Influence of Airfield Surface Irregularity on Aircraft Life, Presented at the 94th Annual Meeting of The Transportation Research Board, Washington, DC, January 10-15, 2015.
- Dr. Uddin attended the ITS3C regional conference and presented overview of NCITEC projects and Gulf Coast rail study results. The conference was organized by the Gulf Region Intelligent Transportation Society (GRITS), the Intelligent Transportation Society of Florida (ITSFL) and the Intelligent Transportation Society of Georgia (ITSGA). The joint conference was held September 14-17, 2014 at the Arthur R. Outlaw Convention Center in Mobile, Alabama.
- A. K. M. Azad Hossain, Yafei Jia, Xiaobo Chao, Mustafa Altinakar. (2014). Advances in Application of Remote Sensing Techniques to Enhance the Capability of Hydrodynamic Modeling in Estuary. Chapter in *Remote Sensing and Modeling: Advances in Coastal and Marine Resources*, Coastal Research Library (CRL) series, vol. 9, First edited by Charles W. Finkl, Christopher Makowski, 06/2014: chapter 12: pages 295-313; Springer International Publishing., ISBN: 9780123847034
- Singh, J., Altinakar, M.S., and Ding, Y. (2014). Numerical Modeling of Rainfall-Generated Overland Flow Using Nonlinear Shallow-Water Equations. *J. Hydrol. Eng.*, 10.1061/(ASCE) HE.1943-5584.0001124 , 04014089.
- Yan Ding, Yaoxin Zhang, Yafei Jia, Afshin Gazerzadeh, Mustafa S. Altinakar. (2014). Simulation and Prediction of Storm Surges and Waves Driven by Hurricanes and Assessment of Coastal Flooding and Inundation. DOI: 10.13140/2.1.5094.8164 Conference: 11th Int. Conf. on Hydro science and Engineering (ICHE-2014), Hamburg, Germany.
- Durmus, A., Nguyen, Q., McGrath, M.Z., Altinakar, M.S., and Uddin, W. (2014). Numerical Modeling and Simulation of Extreme Flood Inundation to Assess Vulnerability of Transportation Infrastructure Assets. Paper No. 15-1606, On-line Proceedings, Paper Presented at the 94th Annual Meeting of The Transportation Research Board, Washington, DC, January 10-15, 2015.
- Mokkaapati, A., Gudishala, R., and Wilmot, C. "Determining the Location of Congestion Hot Spots in Urban Areas using Image Analysis", Compendium of Papers, 93rd Annual Meeting of the Transportation Research Board, Washington D.C., January 16-20, 2014

## 2.2. Website(s) or other Internet site(s):

All products will be published on NCITEC's web site ([www.ncitec.msstate.edu](http://www.ncitec.msstate.edu)).

Mission Intermodal Excellence project websites:

- Overview: <http://www.bagley.msstate.edu/outreach/mission-eggcellence/2013-mission-intermodal-excellence/>
- Video: <http://www.bagley.msstate.edu/outreach/mission-eggcellence/2013-mission-intermodal-excellence/mission-intermodal-overview/>
- Resources: <http://www.bagley.msstate.edu/outreach/mission-eggcellence/2013-mission-intermodal-excellence/mission-intermodal-resources/>

Other project websites:

- UM CAIT web page: <http://www.olemiss.edu/projects/cait/ncitec/> The NCITEC project tab on CAIT web site, linked to the University of Mississippi web site, provides useful background of NCITEC goals and university partners.
- Blog: <http://infrastructureglobal.com/> - *InfrastructureGlobal* is a blog site created by Dr. Uddin after the devastating floods of the Mississippi River basin in May 2011. Several posts are related to efficient mass transit and benefits of intermodal integration, and freight supply chain, as well as community and supply chain disruptions from floods. Twitter is very effective for outreach and for accessing the latest data and info on project related topics. Over 2,300 followers in 46 countries see tweets by @drwaheeduddin and many more see through retweets (RTs) and mentions from over 91 countries.
- <http://biofuel.msstate.edu/>
- <http://walkandrideoptimization.msstate.edu/>
- Webpage posting: [http://www.cavse.msstate.edu/outreach/K12/STEP\\_MiddleSchool.php](http://www.cavse.msstate.edu/outreach/K12/STEP_MiddleSchool.php)
- <http://esitac.biz.hamptonu.edu/> - the Eastern Seaboard Intermodal Transportation Applications Center (ESITAC) website.
- Twitter: <https://twitter.com/drwaheeduddin> Started in 2012; several lists and "Global Infrastructure" timeline created; over 3,800 tweets.
- Twitter: <https://twitter.com/disasterglobal> Started in 2012 on topics of protection from natural disasters and managing infrastructure assets; over 2,200 tweets.
- Twitter: <https://twitter.com/InfrastructureG> Started in January 2014 to focus on built infrastructure and transportation assets; several lists on specific categories such as sustainable transportation.
  - Media Framing of Transportation Accidents: <http://www.tumblr.com/blog/mediaframing>

## 2.3. Technologies or techniques:

- The Driver Simulator was used in the Fall 2014 semester to conduct studies on distracted driving and Texting-While-Driving. The research team visited several schools in Hampton Roads and demonstrated the Driver Simulator application to high school students and staff. Texting-While-

Driving experiments for students and staff are planned during the Spring 2015 semester at these schools.

- A web-based logistics analyzer tool was developed to help evaluate a portfolio of intermodal transportation requests for a given customer. A request is a single intermodal contract to move product from a supplier to a customer and the current evaluation method is primarily manual with each portfolio containing hundreds of requests. This tool evaluates all defined intermodal (truck and rail) routes to determine the intermodal combination that results in the route which delivers the lowest monetary cost. In addition, this system be utilized to help identify key transportation hubs that would be candidates for inventory holding locations to support the overall VMI system.
- A custom computer program has been developed to automatically grab and save General Transit Feed Specification (GTFS) data.
- A method to automatically generate graph representations of multi-modal networks based on GIS data, and a travel cost function for multi-modal networks involving both automobiles and pedestrians.
- A new non-contact inspection technique for rail and road bridges is expected to more efficient, cost effective, and accurate than traditional techniques. With appropriate adjustments in data processing algorithms, the techniques herein will be applicable to any structure; however, the scope is limited to overall health so that subsequent local inspection may be indicated.
- The SSI modeling procedure applied to the bridges in this project is an extension of the technique developed by the Mullen (Univ. of Miss.). Explicit examination of the effect of local deterioration on deck level vibrations through SSI FE models is considered novel in the PI's opinion.
- Geospatial mapping of commodity flow from and to states, the Mississippi River ports and barge freight data, and highway and rail networks in the Middle American states and Western states:
  - Commodity flow by states and selecting top commodity data for the Mississippi River ports.
  - Commodity flow and linear distances to selected states for optimizing freight intermodal integration of highway truck traffic and barge traffic on the Mississippi River and states along the Mississippi River.
- Geospatial planimetrics and mapping of built infrastructure assets using aerial imagery.
- Geospatial mapping of floodplains created using NCCHE's two dimensional flood simulation models.

#### **2.4. Inventions, patent applications, and/or licenses:**

- The name of the structural health program has been trademarked by the University of Mississippi, but the software is not yet ready to be licensed.

#### **2.5. Other products, such as data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment**

- A database schema was developed in MS SQL Server to store the information of static and dynamic transit schedules and transit performance measures. The database could be shared and accessed by authorized users.
- Photographic survey of field geologic, site, scour, and structural conditions has been assembled for multiple bridge sites throughout the study region. This will provide a useful supplement to National Bridge Inventory and MDOT data collected during typical maintenance inspections. (UM-Mullen)
- SlideShare: Over 3,600 SlideShare views of 8 presentations. The top viewed slide presentation (1,251 views in less than two months) is "Mississippi Gulf Coast Rail Revival: NCITEC White Paper

Background – CAIT” <http://www.slideshare.net/waheeduddin/mississippi-gulf-coast-rail-revival-ncitec-white-paper-background-cait> and “Dr. Uddin/CAIT Infrastructure and Environment Research Areas” with 526 views. One post was on “NCITEC Intermodal Transportation and Disaster Safeguard Research Projects at CAIT.” <https://www.slideshare.net/waheeduddin/uddin-caitncitecprojects11-oct2013slsh>

- YouTube Videos: over 1,680 views of project related seven YouTube videos were reported to date. <http://youtu.be/8JjM2QEexFE>
- ACCESS Databases created for Intergraph’s GeoMediaPro geospatial software: 2014 United States All (including Alaska and Hawaii), US-Mexico-Canada, 2014 Word, Buffer-Mississippi-River-States. (These databases includes the 2010 population data of states and countries; highway and rail inventory maps of US-Canada, and Mexico; river port inventory maps and commodity maps for 2014 United States.)

### 3. Participants & Other Collaborating Organizations

#### 3.1. What other organizations have been involved as partners?

Organization Name	Location	Partner’s Contribution to Project
Mississippi DOT	Jackson, MS	Financial support and providing expertise and data. Provided superstructure and foundation design drawings and soil data for selected bridges.
Various High Schools	Hampton, VA	Provide data for texting study
Univ. of Tennessee	Knoxville, TN	Provide help with modeling
Virginia DOT	Richmond, VA	Coordination, support, expertise, and data
Mistras Group, Inc.	Princeton Jct, NJ	Acoustic emissions equipment, consulting, and training
American Short Line Railroad Association	Washington DC	Collaboration on identification of work schedules at risk for safety issues
RTD – Denver	Denver, CO	Identification of intersections and crossing that have high risk for pedestrians
Colorado DOT	Denver, CO	Exploration of components of an effective safety culture.
Norfolk Southern	Atlanta, GA	Provide data
DriveSquare, Inc.	Alexandria, VA	Provide technical support and help resolve issues
Brookhaven High School	Brookhaven, MS	Facilities, Collaborative research and Personnel exchanges
East Flora Middle School	East Flora, MS	Facilities, Collaborative research and Personnel exchanges
Goodloe Elementary	Canton, MS	Facilities, Collaborative research and Personnel exchanges
Camden Elementary	Camden, MS	Facilities, Collaborative research and Personnel exchanges
Huey Porter Middle School	Canton, MS	Facilities, Collaborative research and Personnel exchanges
Center for Advanced Vehicular Systems	Canton, MS	Financial support, facilities, and personnel exchanges

Extension		
Miller Intermodal Logistics	Ridgeland, MS	In-kind support, collaborative research and personnel exchanges
University of Arizona	Tucson, AZ	Providing expertise and data support, collaborative research, and personnel exchanges
St. Louis Metro Transit	St. Louis, MO	In-kind support, collaborative research, facilities, and personnel exchanges
City of Starkville Transportation Committee and City Engineer	Starkville, MS	Consultation
Director of Parking and Transit	Miss. State, MS	Consultation
Golden Triangle Planning and Development District	Starkville, MS	Data and consultation
Itawamba Community College	Fulton, MS	Financial support, facilities, collaborative research and personnel exchanges.
Innovate Mississippi	Ridgeland, MS	Financial support, facilities, collaborative research and personnel exchanges.
University of Southern Mississippi	Hattiesburg, MS	Financial support, facilities, collaborative research and personnel exchanges.
TenCate	Dayton, TN	Technical support and supplies
Hocim Inc.	Vicksburg, MS	Technical support and supplies
US Army ERDC Hydraulics Lab	Vicksburg, MS	Support
Coast Transit Authority	Gulfport, MS	Provide evacuation data and support software testing
Louisiana State Police Crime Lab	Baton Rouge, LA	Provide database of blood test results for analysis
Regional Planning Commission, and APA Louisiana Chapter	New Orleans, LA	Participation in pilot Stakeholder meeting; assistance in distribution of meeting invitation; participation in spring 2014 workshop
DOTD District 2	New Orleans, LA	Participation in pilot Stakeholder meeting
Lafayette Consolidate Government & IMCAL	Lafayette Region	Participation in planning Stakeholder meeting; offer of use of space to facilitate Lafayette/Lake Charles area meeting; facilitation/venue for spring 2014 workshop
LA Local Technical Assistance Program, and Center for Planning Excellence	Baton Rouge, LA	Assistance in development of survey distribution list and stakeholder meeting invitation distribution (series 1 and 2), distribution of survey invitation
Rapides Area Planning Commission	Alexandria, LA	Participation in planning Stakeholder meeting; offer of use of space to facilitate Central Louisiana area meeting (series 1 and/or 2)
South Center Planning & Development Comm.	Houma, LA	
North Delta Regional Planning District	Monroe, LA	
North LA Council of Gov'ts	Shreveport, LA	

### **3.2. Have other collaborators or contacts been involved?**

- After models are completed, railroad and waterways operators in the Hampton Roads area will be contacted for validation study of the models.
- CN Railroad Station Richland, MS – John Knight – Regional Logistics Manager
- Nissan - Canton, MS – Nissan Tours
- Quality Transportation Services in Mechanicsville, VA provide collaborative research and personnel exchanges.
- Mississippi Trucking Association; Jackson, MS
- Mississippi Department of Transportation; Jackson, MS
- Port of Fulton - Fulton, MS
- Three Rivers Planning and Development District Yellow Creek, MS
- Northeast Mississippi Community College; Fulton, MS
- Southern Rural Development Center; Starkville, MS
- Franklin Furniture Institute; Starkville, MS
- Dr. Kenneth Ned Mitchell, ERDC Hydraulics lab, Vicksburg, Mississippi
- Mr. Karl Y Petrow, Maritime Information Systems, Inc., Warren, Rhode Island
- MIS - Maritime Information Systems, Inc., Warren, Rhode Island (Mr. Karl Y. Petrow of MIS). They contacted W. Uddin at Univ. of Mississippi (UM) to access their extensive online data related to vessel movements. This company operates a large scale Automatic Information System (AIS) network to track vessel movements in all Navigable North American Waterways.
- As Intergraph Registered Research Lab, CAIT Remote Sensing and Transportation Modeling Laboratories received geospatial industry support for education and training of students in geographical information system (GIS) applications for the project research. This Intergraph software grant is a testimony of industry support to the UM researchers and a cooperative feature of this project.
- MDOT Transportation Information Director (Mike Cresap) and MDOT Director of Structures -State Bridge Engineer (Justin Walker) have been especially helpful to provide drawings and photos for the I-55/US-51 highway bridges on the Sardis site and updated geospatial database of all state maintained highways and bridges of Mississippi.
- Mississippi Automated Resource Information System: MARIS is a statewide resource agency in Mississippi for no-cost Landsat imagery and DEM data sources of selected counties in Mississippi.
- US Army ERDC Hydraulics Lab, Vicksburg, Mississippi (Dr. Kenneth Ned Mitchell)
- The Louisiana Chapter of the American Society of Civil Engineers T&DI committee will collaborate on the development of a seminar discussing this project for Spring 2015.

## **4. Impact**

### **4.1. What is the impact on the development of the principal discipline(s) of the program?**

- Advancement of non-destructive testing technology application expertise by utilizing the acoustic emissions technology for data acquisition and real-time analysis, and for prediction of factors that lead to deterioration and wear in the highway structural components under the stresses of traffic environment. This research also provides student education and training and builds the foundation

for transportation related courses within the department which serves to attract and educate more students and, in turn, impacts the development of the principal discipline.

- The developed intermodal capacity models and the relationship functions between transportation volume and travel time (or speed) at the macro level will have a significant impact on intermodal transportation management and planning. At the operational level, the congested traffic can be efficiently guided to alternative routes and other transportation modes that have extra capacity. The congestion could be recurrent or non-recurrent, such as disruptions caused by terrorist attacks or national disasters. At the strategic level, the predicted traffic demand can be assigned to an intermodal network to identify the best investment to improve transportation efficiency. The project directly responds to NCITEC's objective improving intermodal connectivity, enhancing operational integration, capacity enhancement, safety, and reduction of congestion in the nation's transportation system.
- Summer camp provided students with opportunities to understand how science, math and logistics concepts support engineering principles and processes. Students were challenged with complex, critical decision-making activities that could occur in industry environments.
- The research findings will be used to fill the gap in transportation geography and sociology of transportation by studying the economic and demographic impacts of passenger rail systems. The economic and demographic impacts of highways, airways, and public transportation have been studied in several disciplines, resulting in an assortment of theoretical and empirical studies. However, little work has been undertaken to study the economic and demographic impacts of passenger rail systems, especially in the U.S. To the best knowledge of the PI, no existing studies have examined intermodal passenger transportation accessibility as provided by passenger rails, highways, and airways as well as their collective impacts on the economy and population change.
- The developed Intermodal Passenger Travel Decision Support System can provide fruitful data support for intermodal passenger travel decision making.
- An integrated methodological framework is offered that takes advantage of optional expedited transportation services and addresses decision components in both planning and operational stages simultaneously. Development of an integrated methodological framework that bridges the gap between planning models of network logistics systems and operational models of multimodal transportation configuration and inventory management decisions in the logistics system design literature. It enables logistics planners to ponder all the involved critical decisions in an integrated manner and design a system that performs more reliably and runs at a lower cost compared to traditional results. The resultant model framework can efficiently and accurately solve an integrated logistics system design problem, and the optimal design solution can balance all cost components (including initial investment, regular and expedited transportation cost, and inventory management cost) and thus yields a minimum expected net cost.
- Results will allow intermodal infrastructure network planning for a community to be planned in an integrated and holistic manner. Promote safety in infrastructure network planning. Model formulation provides a methodological framework to model multi-modal networks into a unifying form.
- The largest potential impact of this project is to assist ports in transitioning their operations to the larger ships and freight quantities from the Panama Canal expansion. This project builds off previous research related to geotextile tubes use for disaster recovery. Geotextile tubes have been used at ports in the past, though the manners being described in this project are somewhat unique in that they plan to simultaneously incorporate several potentially beneficially items together. For example, dredging a port's harbor deeper to accommodate larger freight ships, and instead of building a

containment facility for the dredge spoils, they are cementitiously stabilized with more sustainable binders and used as part of a wall construction project that was needed at the port.

- Develop an innovative systems-based analytic framework to assess sustainability for new, reconstructed, or rehabilitated transportation infrastructure; and provide comprehensive life-cycle analysis using case studies to determine spatial interdependencies, interactions, and measurements of the different sustainability indicators to verify which factors and characteristics are interrelated. This will significantly improve intermodal transportation system planning, design, performance, and evaluation.
- Both the structural health monitoring and non-destructive evaluation communities will be affected by developed non-contact inspection technique for rail and road bridges. Structural health is addressed by researchers in such fields as computer science, civil engineering, mechanical engineering, reliability engineering, statistics, and electrical engineering. The determination of any damage threshold is an actively pursued research topic and is extremely complex for civil infrastructure. Thus, this project will increase the base of knowledge for low frequency structures.
- Further development of laser techniques and their adaptation to infrastructure has the potential to transform inspection and maintenance. The developed method for structural health monitoring and non-destructive evaluation will apply to broad classifications of structures and will significantly improve current infrastructure management. This methodology will apply to both railroad and highway bridges (both passenger and freight) as well as potentially extending to dams, levees, buildings, etc. The eventual goal is to provide condition-based maintenance via a cost-effective product that will transverse any structure and identify an overall change in its stiffness, indicating that localized inspection is required before a bridge collapse, for instance.
- The UM's CAIT Transportation Modeling & Visualization Lab was provided a video panel wall by the Mississippi DOT ITS section in October 2014 as a part of a model ITS lab to monitor real-time traffic flow on roads and barge under bridges over the Mississippi River. The CAIT lab expanded recently with new high performance computer equipment, new computer furniture, large video monitor for presentations, and seminar/meeting tables, chairs, and accessories. Geospatial course has taught in this facility since 2013 to: 3 UG and 3 graduate students in Fall 2013, 6 UG students in 2014 May Intersession, and 2 UG and 2 new graduate students in Spring 2015. Most of the NCITEC project research work is conducted in this lab.
- New CAIT graduate and undergraduate student workers were trained for data analysis, geospatial analysis, and transportation demand modeling research. The contents of Transportation and Geospatial course are enhanced using the NCITEC project products.
- The contents of geospatial courses CE495 and ENGR597 Section 25, taught by Dr. Uddin, were updated using NCITEC project work. CE495 was offered in the 2014 May intersession. These courses will be offered again in Spring 2015 and future intersemester and/or regular sessions.
- Research results will be incorporated in the existing CE 481 – Transportation Engineering I course (3 credit hours) and CE 570 – Infrastructure Management course (3 credit hours), CE 590 – Airport Planning and Design, and ENGR 692 Section 2 – Numerical Methods and Optimization and Nonlinear Time Series Modeling in the department of Civil engineering. CE 570 course was offered by Dr. Uddin in Fall 2013 and CE 585 – Highway pavement in Fall 2014 to UG seniors and graduate students. The new textbook for this course was 2013 McGraw-Hill book *Public Infrastructure Asset Management* (Uddin, Hudson, Haas). Dr. Uddin will offer ENGR 692 Section 2 in Spring 2015 and CE 590 in Fall 2015.
- A new graduate course, Advanced Transit Operations and Planning, will be created. Some of results of this project will be shared in the undergraduate/graduate courses, CE 3113/4143/6143-Traffic

Engineering, CE 8133-ITS and Traffic Control Systems. The materials from this research will help students obtain the skills and experiences of state-of-the-art transit planning and operation practice.

- This project is likely to make an impact on the base of knowledge on how state agencies, especially DOTs, can encourage local growth management policy development through incentives, technical assistance, and provision of a toolkit for municipalities, parishes, and regions in Louisiana. This project will also advance the state of research on growth management and transportation planning in rural communities and in a southern context, with applicability to other states. The project will demonstrate effective, politically palatable tools for developing and achieving livability, sustainability, and economic goals in a context where traditional growth management strategies have failed to take hold.

#### **4.2. What is the impact on other disciplines?**

- Summer camp provided activities that taught students about transportation and activities that highlighted the disciplines of chemical, mechanical, civil, and industrial engineering.
- This work will expand the field of sociology of transportation. To our knowledge, intermodal transportation has never been studied in the field of sociology.
- This research also contributes to the field of transportation planning. It is important to study the impact of passenger rails because there is an increasing debate over whether passenger rails, rail transit, and high-speed trains should be expanded or built in the U.S. It is also important to study them within the context of passenger intermodal transportation because intermodal systems have become increasingly important for transportation performance and efficiency, and planning practices are focusing more attention on intermodal systems as a whole rather than any single mode of transportation.
- Project developments can potentially be used to analyze social and environmental impacts of community multimodal transportation infrastructure.
- The project is investigating use of geotextile tubes to enhance intermodal freight operation of ports. Geotextile tubes enable beneficial re-use of degraded materials and in addition to positive technical impacts to the principle discipline, the project can lead to several environmental and economic impacts. The outcome of this project can also lead to a more sustainable solution where the structure built with geotextile tubes is in harmony with natural landscape.
- Dr. Uddin has interacted with: Dr. Mustafa Altinakar of the UM's National Center of Computational Hydroscience who is collaborating on the flood modeling project, UM's Department of Public Policy Leadership through Dr. Jody Holland's participation in the UM supply chain project team, Dr. Tyrus McCarty of UM's Mechanical Engineering Department who is PI of NCITEC project on harnessing energy from traffic, and Dr. Kristen Swain of UM's Journalism Department who is risk framing transportation toxic spills in news media. The NCITEC projects are also being carried out by two other UM's civil engineering faculty and the Mississippi Mineral Resource Institute. All these departments are supporting their graduate students on NCITEC projects and conducting graduate research.
- Students in the Journalism department at the University of Mississippi often contact Dr. Uddin for their video projects on sustainability related topics for George Washington University's Planet Forward web site every year. This is a part of the on-going collaboration of Dr. Uddin with another NCITEC project PI, Dr. Kristen Swain. Dr. Uddin discusses with potential journalism students the findings and significance of their project so that sustainable intermodal transportation integration topics can become one of their projects. The following example of Planet Forward video on the use of waste glass for sustainable road applications was produced by UM journalism student in May

2013. Earlier another student's YouTube video on life cycle analysis for sustainability projects was posted on Planet Forward web site. <http://infrastructureglobal.com/sustainable-infrastructure-by-recycling-waste-glass-to-enhance-road-safety-and-reduce-emissions-guest-post-22/>

- <http://planetforward.org/idea/life-cycle-analysis-of-sustainable-technologies/>
- A YouTube video by Mason Herman (Public Policy/Journalism UG student), "Dr. Uddin Interview on Transportation and Air Quality Mitigation," April 30, 2014. <http://youtu.be/ulcvqaOHVc4>

#### **4.3. What is the impact on the development of transportation workforce development?**

- The Women in Transportation Conference and our efforts in workforce development and career recruitment and selection have been noted by companies in the immediate workplace. There has been an increased awareness of the need for women in the intermodal transportation industry. In addition, the work in safety and health has increased awareness of the importance of understanding the role of shift work on the physical and emotional health of women in the intermodal work place.
- The Eastern Seaboard Intermodal Transportation Applications Center (ESITAC) located in Hampton Roads utilized resources of the University in partnership with state and city governments, local transit companies, private industries, and regional universities to conduct research on current transportation problems facing this Region, and provide students with special emphasis on minorities and women, the opportunities to pursue transportation careers.
- Research project offered students an opportunity to gain specific knowledge and hands-on experience with acoustic emission technology both in the laboratory setting and in the field enhancing the experience of the future workforce.
- The ESITAC Center has attracted students to on-going transportation-related programs at the undergraduate and graduate level through classroom courses and experiential learning. Examples include:
  - An undergraduate course, MGT 370 – Introduction to Transportation Management, was offered in Fall 2014 and will be offered in Spring 2015.
  - Ms. Imani Rhodes, an intern at the Hampton University Accident Research Center (HUARC) who graduated in May 2014 started on a permanent job at Norfolk Southern, Norfolk, VA as a Management trainee.
  - Mr. Hal McKinley, an intern at HUARC and a transportation management student is in the recruitment process at Norfolk Southern.
  - The project helped Hampton University and the University of Tennessee to build research capability and expose new models to other transportation researchers in the two universities, such as the Center for Transportation Research at the University of Tennessee and the Center for Transportation Analysis at the Oak Ridge National Lab.
- Camp and workshop participants were introduced to STEM concepts and Engineering methodologies that are focused on careers related to Intermodal Transportation. The transportation component will develop scenarios for moving people/product across several modes of transportation including, Rail, Interstate highways and shipping. Students will calculate the cost of moving and efficiency of delivery schedules models outlined. The introduction, planning, implementation and development of ideas and principles of the transportation industry were utilized as a major outcome from "The Student Technology Exchange Program Engineering/Robotics for Middle School" to implement programming techniques for robotics, engineering principles as well as experiments related to chemical, civil, mechanical and computer engineering. Students were tasks with math principles, measurements, gear ratio, design relationships, etc.

- Developed and offered a split-level course titled “Transportation and Society” in the Springs of 2012 and 2013 at Mississippi State University. Passenger travels and intermodal transportation systems are two of the main components. This course will be taught again in Fall 2015.
- Taught the “Spatial Analysis of Social Data” course in the Spring of 2014. Transportation was one element of this course as transportation plays an important role in spatial dynamics of social phenomena. One student developed a term paper focusing on the demographic impact of passenger rails.
- The project demonstration of the Intermodal Passenger Travel Decision Support System could be used in a transportation engineering class to show students the intermodal passenger transportation.
- A master’s student who developed the FE models for a project was hired to work for a local consulting engineering firm heavily involved in the design of bridges and other transportation related projects.

#### **4.4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?**

- Enhancement of the Hampton University Department of Engineering research, education, and training facilities with respect to the acoustic emissions (AE) technology. Several AE monitoring systems including Sensor Highway II, a portable 1284 Wireless AE system, and a Pocket AE system are now available at the university.
- One of the most apparent educational opportunities is educating students who work on this project about sustainability, intermodal operations, freight handling, dredging, and geotextile tubes. Additionally, opportunities exist to incorporate several concepts to be explored in this project such as engineering properties of stabilized dredged soils and stability of slopes/walls constructed with geotextile tubes into courses such as Soil Behavior (CE 8443) and Material Characterization (CE 8303) at MSU.
- New laboratory space in the National Center for Physical Acoustics building was made available to research expanding the Department of Civil Engineering’s research capabilities. Access to existing machine shop facilities greatly expands the PI’s vibration research abilities. This would not have been possible without the collaboration on this effort and a prior NCITEC project.
- Project purchases included vibration testing commodities and a five-volume state-of-the-art reference book on bridge design, monitoring, and construction which are being used by the research team to complete the scope of work of the project.
- Physical infrastructure resources: Computing facilities, geospatial laboratory, geospatial software, and transportation corridor/traffic flow simulation capabilities. Additionally, 8 new computer workstations and visualization equipment were procured using project funds and installed in CAIT Transportation Modeling & Visualization Laboratory in UM Jackson Center after approval by the DOT RITA sponsors. These new computers and 6 old computers from CE Graphics Lab have been functioning fully since Fall 2013 after installation of geospatial software and other programs. Most project staff and graduate students used this lab in 2014.
- The purchase of Bluetooth Probe Detection System (BPDS) will add significantly to the existing instrument inventory and will likely lead to new studies that will open new fields of interdisciplinary research.

#### 4.5. What is the impact on technology transfer?

- The resulting capacity models and findings will be shared with transportation companies and local transportation agencies.
- The resulting systems-based analytic framework will provide an effective tool government can use to examine suggested development strategies using concrete measurable sustainability indicators.
- UM will share freight corridor spatial maps, related decision support system methodologies, and intermodal integration strategies to local and state government transportation and public works agencies. The implementation of these research products will result in more efficient, safer, less polluting, economically competitive, and sustainable freight corridors.
- The intermodal freight corridor case studies will be used to develop a “best practice guide” for consideration by government transportation agencies, private transport operators, and all other stakeholders.
- Integration of surface and waterborne transport network services can reduce overall freight costs, save hours of delay due to traffic congestion on roads, avoid costs of millions of gallons of fuel wasted on congested highway corridors, and reduce transportation related emissions. DSS-WISE Software used for the NCITEC project is now being employed by several federal agencies and Mississippi state agencies. The agencies that use DSS-WISE include: (a) DHS Dams Sector Branch; (b) USACE HQ; (c) USACE MMC; (d) USACE-ERDC; (e) USACE Vicksburg District; (f) Mississippi Department of Environmental Quality.

#### 4.6. What is the impact on society beyond science and technology?

- Research study affects the passenger and freight transportation network by trying to predict and analyze potentially critical highway structure deficiencies therefore lowering the repair and maintenance costs and minimizing traffic flow disruptions that occur when elements of a transportation network need to be closed down for major repairs. Therefore, beyond science and technology, this study directly influences the economic competitiveness goal of the U.S. D.O.T.
- The broader impacts include 1) involvement of various stakeholders of the potential New Orleans-Orlando Corridor (NOOC), 2) outreach of restoring the NOOC in relation to community livability and environmental sustainability, and 3) recommendation of strategies for optimizing intermodal transportation systems to better facilitate passenger travel and proposed resilience enhancement strategies, especially for evacuation purposes and providing relief services after disasters.
- Workshop focused on real problems and allowed teachers and students to experiment on possible solutions that must adapt to changing variables: (1) Increased teachers’ ability to develop and integrate STEM inquiry-based projects embedded in their curriculum, (2) Increased teachers’ pedagogical content knowledge of Robotics/ Engineering/ Science/ Intermodal Transportation Logistics principles embedded in engineering, (3) Improved students’ disposition toward science and mathematics learning in ways which eliminate barriers to the pursuit of engineering-related careers, and (4) Encouraged students to pursue educational opportunities in STEM careers.
- The developments can be used to improve efficiency, livability, and safety of community transportation infrastructures.
- The use of geotextile tubes allows a beneficial re-use of soils dredged from nearby areas. Utilizing nearby resources will improve harmony between the man-made structure and natural landscape. Adding low dosages of cementitious materials and using more environmental-friendly cements (e.g., PLC and/or slag cement) are also appealing. This project compares sustainability aspects of using geotextile tubes in ports versus other conventional structures, as appropriate.

- This research will incorporate the broader economic, socio-cultural, and individual sustainability indicators together with the already known technical and environmental ones.
- Infrastructure loss of use and even loss of life are high profile bad news, such as the I-35 Minneapolis collapse. Better safety management will instill more public confidence in state DOTs. The economic benefits of condition-based maintenance are well established, including reduced visual inspection and potentially longer structural life. More accurate estimation of remaining life could potentially prevent collapse but, at a minimum, will aid decision-making on bridge upkeep.
- Appropriate use of online communications about toxic spills could help minimize the economic and environmental impacts of future toxic spills in intermodal transportation. The project identifies implications for changing practices in crisis communications about future transportation accidents, to improve crisis communications practice, increase public understanding, and minimize the economic and environmental impact of future accidents.
- Offering geospatial products for infrastructure asset management, landuse planning, and waterway traffic control policies.
- Implementing the developed methodologies and web-based social networking tools to build better public understanding of sustainable intermodal freight policies, supply chain management, and reduction of degrading effects on the environment and communities.
- The project's resulting tool will help reduce the number of fatalities during the next emergency evacuation.
- Results from this research could potentially change route choice behavior. If the public have advance knowledge of congestion hot spots then they could use that information to adjust their route's in real time and potentially save time that otherwise would be lost in traveling through congested corridors.

## **5. Changes/Problems**

### **5.1. Changes in approach and reasons for change:**

- After beginning to work on this project, we decided to change our mathematical model from what was described in the proposal. Our new model is more general and includes road congestion as well as a generic framework for modeling "traffic calming." Our original model only included one method of traffic calming: constructing sidewalks. We believe that this change will result in better project deliverables for NCITEC.

### **5.2. Actual or anticipated problems or delays and actions or plans to resolve them:**

- Many of the project have been "no-cost" extend to December 31, 2015 due to various research delay issues.
- Data collection on one project was delayed due to weather.
- The PIs on two separate projects changed universities resulting in delays.

### **5.3. Changes that have a significant impact on expenditures:**

### **5.4. Significant changes in use or care of animals, human subjects, and/or biohazards:**

## **6. Special Reporting Requirements**