Semi-Annual Program Progress Performance Report
for the
Mid-Atlantic Universities Transportation Center
The Pennsylvania State University
201 Transportation Research Building
University Park, PA 16802

January 1 – June 30, 2013

Submitted to:

U. S. Department of Transportation
Research, Innovation and Technology Administration
1200 New Jersey Avenue, S.E.
Washington, DC 20590

Grant No. DTRT12-G-UTC03
Grant Period: January 1, 2012 – January 31, 2016
DUNS No: 00-340-3953 EIN No: 24-6000-376

Submitted by: _____ **Date:** October 14, 2013
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INTRODUCTION

The Mid-Atlantic Universities Transportation Center (MAUTC) is comprised of six universities—Morgan State University, The Pennsylvania State University (Penn State)(lead),University of Maryland, University of Virginia, Virginia Polytechnic and State University (Virginia Tech), and West Virginia University—and is located in Federal Region 3. MAUTC has served as the Region 3 regional UTC since the program's inception in 1987.

In the past, MAUTC primarily served as a conduit of research funding for its member institutions. Each institution conducted its own program of activities—research, education, and technology transfer—to respond to the priorities of the U.S. Department of Transportation's strategic goals as well as the institutions' state departments of transportation, which were the primary sources of matching funds, and other in-state stakeholders.

ACCOMPLISHMENTS

Major Goals:

MAUTC is organized as a single entity serving multiple, non-university stakeholders who are part of the transportation enterprise of the mid-Atlantic region. Each member institution received $300,000 (base funds) to be used for any purpose eligible under the grant, including research, student support, workforce development, technology transfer and administrative costs. The remaining funds are distributed, through a competitive proposal process, among the following programmatic areas:

Pooled Research Funds ($1,500,000)

Under the previous grant, DTRT07-G-0003, MAUTC began to move toward a more collaborative approach for conducting research. A portion of Penn State's funds was escrowed for pooled research projects to encourage member institutions to conduct joint research that would address regional transportation issues. Each member institution participated in at least one regional proposal.

The pooled research program will build on the success of the earlier "regional program." Advanced or applied research that is performed by multiple universities or funded by multiple sponsors will be eligible for funding. Any combination of universities and public and/or private matching funds are eligible. Public sector stakeholders, i.e. the Region 3 state DOTs, are given the right of first refusal for use of the federal funds in this program area. Proposals will be solicited quarterly by the MAUTC Project Selection Committee, comprised of representatives of each of the MAUTC universities and from the DOTs in the states that are home to the MAUTC universities.

<u>Accomplishments:</u>

Requests for proposals are issued quarterly. During the current reporting period seven collaborative research proposals were submitted for review, and three were selected by the project selection committee for funding. To date, 22 proposals have been submitted and ten have been funded. All of the $1,500,000

allotted for collaborative research has been awarded with a match commitment of $1,067,498 from the region's state DOTs and Center's universities.

The following collaborative proposals were funded during the current reporting period:

- Use of Probe Data for Arterial Roadway Travel Time Estimation and Freeway Medium-term Travel Time Prediction – VT (lead) and UMD

  Urban traffic congestion is a problem that plagues many cities in the United States. One approach to alleviating this congestion is to provide drivers with better travel time information so that they can make better departure time and routing decisions. This research project focuses on two efforts: (1) validating the use of probe data to estimate arterial travel times and (2) validating and developing techniques to predict freeway travel times over a two to four-hour window. With regards to arterial travel time estimation the objective is two-fold. The first goal is a comprehensive validation of INRIX arterial probe data. In the validation the variability and reliability of arterial data in different corridors equipped with permanent and portable Bluetooth detectors will be studied under different traffic conditions. The second objective is to develop a methodology for augmenting INRIX data with other data sources in order to improve the data quality. With regards to freeway travel time prediction the objective is also two-fold. The first objective is to validate existing medium-term travel time prediction algorithms along one or two corridors in the state of Virginia. The second objective is to enhance the medium-term prediction accuracy using various artificial intelligence and traffic modeling techniques.

- Drivers' Willingness to Pay a Progressive Rate for Street Parking – MSU (lead) and VT

  While parking citations are a major source of revenue for cities, they cause disputes and frustrating among drivers who would desire to avoid them. Expired meter violation is among those manageable and avoidable codes of violations due to economy efficiency rule. With the assistance of technology this should be resolved for the drivers and still raise revenue for the cities. The researchers have proposed an innovative solution to street parking fee collection. The solution would streamline the collection process for the city, while drivers would more operatively disburse for the length of stay at the street parking spots. Demand for parking, turnover, and parking duration is controlled by an efficient pricing scheme rather than by enforcement. What guarantees the success of this plan as a substitute to citation revenue is the users' willingness to pay meter fees when the rate is designed to rise progressively by occupancy. This study conducts a stated preference survey among drivers of different age, gender, and socioeconomic background to find their willingness to pay escalating parking meter rate. This information assists researchers to develop a realistic pricing scheme for the proposed meter fee collection system.

- Integration of Multi-modal Transportation Services – MSU (lead), Penn State, and UMD

  Flexible route paratransit services may complement as well as compete with conventional public transportation services (that have fixed routes and schedules). Flexible routes are especially suitable for service areas or time periods with low demand densities (and especially rural areas) and may be used to concentrate the low demand for conventional bus and rail services. Excess drivers and vehicles from conventional services can be leveraged to provide higher quality door-to-door services during off-peak periods. In the proposed project, practical methods will be developed for planning and operating integrated multi-modal public transportation services. In particular, these methods will focus on (a) formulating demand relations for integrated multi-modal transportation services, (b) improving the efficiency of algorithms for managing

ridesharing and taxi services, (c) improving the coordination of transfers among vehicles from various routes and modes, and (d) exploring the potential benefits of managing demand through service options, pricing and other incentives.

Research project-specific accomplishments this period include:

Two site visits to a precast plant in Cresson, Pennsylvania, that is a Maryland-certified precast plant to assess the plant operations and procedures for pouring, testing, storing and handling precast concrete beams.

Workforce Development/Student Support ($600,000)

Developing the next generation of transportation professionals is a critical component of MAUTC's mission. Each member institution may submit a proposal to provide direct support to university students, graduate or undergraduate, or to fund activities that encourage pre-college or pre-engineering college students, especially those from underrepresented or disadvantaged groups, to students in science, technology, engineering, and mathematics (STEM) fields and consider transportation a career, improve the content knowledge and professional skills of the STEM teacher workforce, or improve the transportation-related resources available for learning STEM subjects.

Ten students and one K-12 project were selected to receive support:

- Maha El-Metwally, Virginia Tech, will be conducting research to reduce evacuee travel time through crossing elimination. Through his research, he aims to identify the types and characteristics of intersections and restricted movements that lead to the most improved evacuation times.

- Andrea Hamre, Virginia Tech, will study the impacts of bike sharing on travel behavior and the local economy in Northern Virginia. The City of Alexandria and Arlington County participate in Capital BikeShare (CaBi), the Washington, DC area regional bicycle sharing program. The research project will evaluate the impact of CaBi on travel behavior and the local economy.

- Maryam Hojati, Penn State, is working on the development of high performance, green concrete materials. Ms. Hojati will develop several alkali activated fly ash concrete mixtures comparable to PennDOT class A and AA concretes that can be used for construction of durable and eco-friendly concrete elements. Essential material properties such as setting behavior, strength development, early-age and long-term shrinkage, and carbonation risk of alkali activated fly ash concrete (AAFAC) will be measured.

- Arash Jahangiri, Virginia Tech, is working on a project to enhance work done by the Massachusetts Institute of Technology's (MIT) CO2GO smartphone application that automatically detects the traveler's mode of transportation while tracking the distance covered and computes the CO2 emissions. The outcome of the project will be a smartphone application that allows the user to quantify the CO2 emissions associated with a trip. It is anticipated that users will be able to share the information and identify modes, routes, and times of departures that minimize their carbon footprint.

- Elnaz Kermani, Penn State, has been studying rapid flow-like landslides which pose significant risk to various components of transportation infrastructure. He will perform numerical

simulations using the discrete element method to investigate landslide runout and its effects on transportation systems.

- Pezhouhan Kheiry, Penn State, will prepare a series of laboratory compacted asphalt concrete specimens containing recycled asphalt shingles (RAS) and high amounts of reclaimed asphalt pavement (RAP) and conduct a series of nondestructive resonant column tests on the specimens. Proper characterization of asphalt concrete engineering properties containing RAS and RAP is essential to adequately design these mixes and predict their performance.

- Amir Manafpour, Penn State, will assist with research to identify the causes of early-age cracking in concrete bridge decks, provide recommendations for effective prevention of early-age cracking, assess the effect of cracks on the long-term durability and performance of concrete bridge decks and identify the best and most cost-effective remediation practices and optimum time to remediate to achieve a 100-year bridge service life.

- Ben Meguia, University of Virginia, will conduct research to assess the use of ultrasonic tomography method for condition assessment of bridge deck systems. Reliable and rapid non-destructive evaluation techniques and guidelines are needed to assist engineers in assessing the condition of bridge deck systems since the traditional deck condition assessment methods can only identify defects that are large and close to the surface.

- Milos Mladenovic, Virginia Tech, is focusing his research on developing a larger and more general set of signal operation functional requirements that address safety needs in Virginia and sharing the knowledge and expertise obtained from working with VDOT Northern Regional Operations (NRO) staff on developing special and temporal system assessment and upgrade plans.

- Nayel Serulle, University of Maryland, aims to identify indicators that can be used for transportation resilience evaluation. The indicators will incorporate the network, community and manager's perspective of resilience by considering metrics that influence their performance at different stages of resilience. A clear estimate of such impacts with appropriate sustainable indicators will inform the design of proactive land use, economic, and transportation policies that decrease a region's vulnerability to disasters.

- Teacher Transportation Institute (TTI), Morgan State, will expose high school science, technology, engineering and math (STEM) teachers to higher education level engineering and planning and to transportation professionals. The program will engage teachers in hands-on, inquiry-based lessons that will include the use of current trends in transportation, engineering, and technology. The teachers will visit transportation and transportation-related work sites. They will gain insights into the careers and work environment of engineers and transportation planners. Guest speakers will discuss opportunities and careers in the transportation industry. TTI participants will explore the design, planning and impact of the modern traffic roundabout and connected vehicles on the environment and safety. Participants will conduct traffic feasibility studies and use scientific and mathematical principles to analyze data. They will use computer-aided design (CAD) to construct model roundabouts. TTI participants will also learn the hazards of distracted driving when they perform behind the wheel of a driving simulator. The teachers will conduct extensive research on transportation systems and careers that emphasize the use of STEM.

Workforce Development/Professional Development ($300,000)

The development of tomorrow's transportation workforce is critical to maintain and improve the safety and efficiency of our transportation system. As much as 50 percent of the transportation workforce is due to retire in the next several years, which will create a large knowledge gap that must be filled.

These funds are available for activities that will help to further develop the knowledge, skills, and abilities of the transportation professionals for both personal development and career advancement. Activities may include, but are not limited to, on-site or distance education in the form of conferences, short courses, webinars, seminar series, tutorials, communities of practice, individual consultation, and technical assistance.

- Preston Educational Engineering Resources (PEER), West Virginia University

  The goal of this project is to promote awareness of STEM opportunities related to transportation and engineering and the educational background needed among female and minority high school students in Preston County, West Virginia. The Preston County Schools Technology Integration Specialists, PEER mentors (successful female and minority graduate and undergraduate engineering students from WVU) and WVU engineering professors will work with The EdVenture Group to develop exercises for middle and high school students which focus on finding solutions to common transportation problems.

- Conference on Agent-based Modeling in Transportation Planning and Operations, Virginia Tech

  Agent-based modeling allows researchers and users to keep the personal traveler identity or a collection of them as agents intact through the modeling process and consequently allows the users to make use of the agents' characteristics in their planning and operations of transportation facilities. In contrast to aggregate-based modeling, agent based modeling by definition looks at a system not at the aggregate level, but at the level of its constituent units. Agent-based modeling provides a natural description of the system, flexibility in representing the system, and captures emergent phenomena as a result from the interactions of individual entities.

  The conference objectives, to be held October 1-3, 2013, are to present the current state of the art/science in agent-based modeling in transportation; provide the lessons learned from the current research efforts in this field; and define where the future lies in this type of modeling effort and what steps and research agenda need to be taken to ensure its success. http://www.cpe.vt.edu/abmconf/

Implementation and Tech Transfer ($350,000)

Publications and presentations are the standard method by which faculty, researchers and students disseminate the knowledge garnered through their research. In addition, MAUTC will use social networking sites such as Facebook, LinkedIn, and Twitter to communicate research activities and findings.

These funds will be available to help fund conferences, workshops, webinars, etc. to further the adoption of new-to-the-user products or procedures by the transportation community.

No additional technology transfer projects have been funded since the previous reporting period.

Base Funds

Each of the Center universities has solicited proposals and is working with their respective departments of transportation to select projects. Faculty are also reaching out to others within the Center to find common interests for collaborative proposals.

The following projects began during the current reporting period:

- The Development of Optimal On-premise Electronic Message Center Lighting Levels and Sign Lighting Measurement Techniques, Phase II, Penn State

  Research conducted recently for the United States Sign Council Foundation (USSCF) found that there is no consensus on lighting measurement or appropriate lighting levels of on-premise Electronic Message Centers (EMCs) (Garvey, 2010). This is the second phase of a two-phase study to remedy this situation. In Phase 1, standard EMC light level testing procedures are being established and EMC lighting levels that optimize sign legibility at night from the prospective of a motorist who is viewing the EMC are being developed. Phase 2 will result in EMC lighting levels that optimize sign legibility during daylight.

  Two tasks will be conducted: Task 1 uses The Larson Institute's test track to conduct original human factors research with the goal of optimizing daytime EMC lighting levels based on sign legibility. Task 2 is the development of a Final Report that will include standards for daytime EMC light levels based on the results of Task 1.

- Evaluating the Clearview Typeface System for Negative Contrast Signs, Penn State

  Clearview was specifically designed to improve guide sign readability at night for older drivers when used with high brightness sign materials by reducing or eliminating the negative effects of halation and over glow. However, the Clearview Typeface System also includes negative contrast versions to be used on regulatory and warning signs. The difference between positive contrast versions of Clearview and negative contrast versions are limited to stroke width; with negative contrast being heavier to counter-balance the halation effect of the lighter background when viewed at a distance and with high brightness retro reflective materials. While the research discussed above led to the development of guidelines and approval for the use of Clearview in positive contrast, definitive studies have not been conducted for negative contrast applications. Without this research, Clearview's approval will remain restricted to positive contrast applications and full adoption will not take place.

  The objective of this research is to compare the legibility distance of the negative contrast (i.e., darker letters on a lighter background) Clearview Typeface System with that of Standard Highway Alphabets on regulatory signs in the daytime and nighttime with older and younger motorists. The researchers will identify the legibility distances and evaluate the effects of letter spacing of sign legends using: mixed case Clearview (Clearview 2B, 3B, and 4B) and both mixed and all upper-case Standard Highway Alphabets (Series C, D, and E) on white signs with black legends.

- Estimating the Post-earthquake Capacity of Damaged Bridge Columns, Penn State

  Bridges are typically the most restrictive links in the United States transportation network. Following an earthquake, damage to bridges might reduce their traffic load carrying capacity necessitating partial or total closure that will disrupt traffic operations on the network potentially

resulting in significant social and indirect economic impacts. The post-earthquake traffic load carrying capacity is subjectively determined after the event based largely on visual inspection and "engineering judgment." Despite over five decades of research and numerous studies on the seismic performance of bridges, a paucity of research studies have critically examined the post-earthquake traffic capacity of damaged bridges. Yet the post-earthquake capacity of the bridge will dictate the permissible traffic load and hence the impact to the network operations. The objective of this research is to develop a high fidelity meta-model to accurately and efficiently estimate the post-earthquake capacity of damaged bridge columns. The significance of the high fidelity meta-model is that it will provide a tool to state DOT officials for the rapid post-earthquake assessment to support decision-making regarding the functionality of the bridge following an earthquake and to provide a fundamental link between agents (infrastructure and transportation network) to facilitate multi-agent simulation of large, distributed, dependent infrastructure systems with minimal computational demand.

- Potential Use and Applications for Reclaimed Millings, Penn State

  The key overall objective of the project is to provide support to PennDOT District 1-5 in the effective use of milled asphalt material. Specifically, District 1-5 has a shortage of high-quality available coarse aggregate, and has developed the innovative procedure of breaking down and sorting Recycled Asphalt Pavement (RAP) to recover the older high-quality aggregate for use on higher volume roadways. The focus of this project is on the usage of the remaining asphalt and fines, either separately or in conjunction with the use of the coarse aggregate. Potential uses for the remaining fines include an adapted fog/sand seal, and cold-recycled asphalt leveling course.

- Maintenance Executive Development Program (MEDP) Innovation Day

  PennDOT and the Larson Transportation Institute co-hosted a one-day MEDP Innovation Day at the Larson Institute Test Track. The event included vendor displays as well as new product and technology demonstrations.

  The technology transfer peer exchange event was attended by PennDOT district personnel from construction, design, municipal services and maintenance; municipal public works directors and staff, LTAP, and Penn State students and faculty. Participants had the opportunity to learn about state-of-the-practice materials and equipment and shared best practices.

- Evaluation of Waste Concrete Road Materials for Use in Oyster Aquaculture-Field Test, Phase II, Morgan State University

  The overall objective of this project is to determine the suitability of waste concrete from road projects as bottom conditioning material for on bottom oyster aquaculture in the Chesapeake Bay. Objectives for Phase 2 are: (1) Evaluate the potential introduction of organisms attracted to the reclaimed concrete aggregate (RCA) pile that may be potential predators of oyster spat. (2) Determine potential impacts or disruptions in the use of traditional harvesting gear on aquaculture areas conditioned with RCA. As appropriate, recommendations of thickness of native shell overburden will be provided to mitigate any identified impacts.

- Durability Assessment of Prefabricated Bridge Elements and Systems, Morgan State University

  There is a critical need to develop quality control measures to ensure quality processes and inspection, quality monitoring requirements, and disqualification criteria of prefabricated bridge

elements and systems (PBES) for durability assessment. Durability assessment of PBES is critical since cracks can grow as a result of differential shrinkage and creep, which in turn, can lead to the ingress of moisture and corrode the top steel thereby reducing the strength and durability of the PBES. Previous research has noted that a critical role during construction is the use of continuous fiberboard material to be used as a bearing material to help minimize damage of deck panels. Such practices and others will be identified as strategies to help limit damage of PBES in addition to checklists needed for inspection and qualification criteria. The research methods for evaluation consist of visiting precast plans, conducting statistical analyses of data collected, and developing qualification and disqualification flowchart standards.

- Stainless Steel Prestressing Strands and Bars for Use in Prestressed Concrete Girders and Slabs

  Stainless steel alloys such as 2205 and 2304 show promise for use to address the corrosion deterioration of steel in prestressed concrete girders and slabs given their inherent properties. The expectation is that the stainless steel will provide durable corrosion protection and prevention of premature spalling or corrosion-induced cracking. Results from past studies will be investigated and examined to determine the feasibility and accessibility of these materials to be considered for use in prestressed concrete girders and slabs.

- Feasibility of Using Shape-Memory Alloys to Develop Self Post-Tensioned Concrete Bridge Girders, University of Virginia

  Post-tensioned (PT) structural elements are used quite often in bridges due to their ability to span long widths economically while providing an aesthetically pleasing structure. PT systems are also preferred in bridge construction because they greatly increase structural capacities and are fairly easy to implement effectively. Although PT systems provide many advantages for designers and constructors, these systems have raised concerns regarding corrosion of the PT tendons. The degree of corrosion of PT tendons is critical to the structural performance of PT systems and the cost to replace tendons can exceed several hundred thousand dollars per tendon.

  Shape memory alloys (SMAs) are a class of smart materials that have unique properties such as excellent re-centering ability, good energy dissipation capacity, excellent fatigue resistance, and high corrosion resistance. This project investigates the feasibility of developing self-post-tensioned (SPT) bridge girders by activating the shape memory effect of SMAs using the heat of hydration of grout. In particular, the project will investigate the mechanical response of the SMA tendons and the temperature increase due to the heat of hydration of grout.

- A Statistical Analysis of County-level Emission Data, West Virginia University

  Air quality issues have been plaguing a majority of the urban areas in the United States. Several agencies and media outlets have been consistently raising this issue and focusing on developing strategies which can control the air pollution in the United States. The health effects of poor air quality in terms of lung diseases and even cancer are well known and documented. Recognizing the issue, the government has passed three clean air acts in an effort to control the processes which lead to poor air quality. Transportation is a major contributor to air pollution and poor air quality. According to the EPA transportation activities accounted for 31% of United States CO2 emissions. The contribution of transportation to greenhouse gas emissions has been increasing rapidly since the early 1990s. Currently transportation activities contribute to 26% of the total greenhouse gas emissions in the United States.

The objective of this proposal is to: (i) to understand the spatial variation in county level CO2 emissions, and (ii) to develop statistical models which can help correlate CO2 and potentially other greenhouse gas emissions at the county level to the variables which can approximate transportation activities.

PRODUCTS

Submitted:

Chandrashekar, S. and Banerjee, S. "Optimal Bridge Retrofit for Resilient Highway Transportation Systems", abstract submitted for publication in a special issue of the Journal of Structural Engineering, ASCE

Chandrashekar, S. and Banerjee, S. "Enhancing bridge resilience under natural disasters", abstract submitted for 2014 Structures Congress, April 3-5, 2014, Boston.

Chandrashekar, S. and Banerjee, S. "Optimal retrofit strategy for disaster resilience of highway bridges", abstract submitted for 10th US National Conference on Earthquake Engineering (10NCEE), July 21-25, 2014, Alaska.

Nagle, A.S. and Gayah, V.V. (2013) A method to estimate the macroscopic fundamental diagram using limited mobile probe data, 16th Annual IEEE Conference on Intelligent Transportation Systems , 6-9 October, The Hague, Netherlands.

Gheitasi, A. and Harris, D.K., "A Systematic Approach for Quantifying System Reserve Capacity of Redundant Composite Steel Girder Bridges", Structure and Infrastructure Engineering.

Gheitasi, A. and Harris, D.K., "Relating the Effect of System Reserve Capacity on Resilience and Remaining Life of Composite Girder Bridges" Abstract submitted to ASCE Structures Congress 2014 (Boston, MA)

Venkittaraman, Ashok and Swagata Banerjee. "Enhancing Resilience of Highway Bridges through Seismic Retrofit", submitted on May 12, 2013 to the Journal of Earthquake Engineering and Structural Dynamics.

Smith, Brian L., "Next Generation Traffic Management Centers" Final report.

Accepted:

Gayah, V.V. and Dixit, V.V. (2013) Using mobile probe data and the macroscopic fundamental diagram to estimate network densities. Accepted for publication in *Transportation Research Record*.

Presented/Published:

Banerjee, S. and Venkittaraman, A. (2013). "Seismic Hazard Mitigation through Risk- and Resilience-Based Optimization", will appear in the proceedings of 11th International Conference on Structural Safety and Reliability (ICOSSAR 2013), June 16-20, New York.

Banerjee, S. and Venkittaraman, A. (2013). "Seismic Retrofit of Bridges to Enhance Disaster Resilience of Highway Transportation Systems", 2013 Structures Congress, May 2-4, 2013, Pittsburgh (abstract only).

"Seismic Retrofit of Bridges to Enhance Disaster Resilience of Highway Transportation Systems" – Presented by Dr. Banerjee during technical session RA130 in 2013 Structures Congress conference, May 2, 2013, Pittsburgh.

"Seismic Hazard Mitigation through Risk- and Resilience-Based Optimization" – Will be presented by Sandhya Chandrashekar during technical session 05 in the 11th International Conference on Structural Safety & Reliability (ICOSSAR 2013), June 19, 2013, New York.

Gayah, V.V. and Dixit, V.V. (2013) Using mobile probe data and the macroscopic fundamental diagram to estimate network densities: Tests using micro-simulation. *92nd Annual Meeting of the Transportation Research Board*, 13-17 January, Washington, D.C.

Gayah, V.V. and Dixit, V.V. (2012) Using mobile probes to estimate network-wide traffic conditions. *LATSIS – 1st European Symposium on Quantitative Methods in Transportation Systems*, 4-7 September, Lausanne, Switzerland.

Ghasemi-Fare, O. and Basu, P. (2013). An annular-cylinder source model for heat transfer through energy piles. *Compendium of papers and technical presentation* in *92nd Transportation Research Board Annual Meeting*, Washington, D.C., January 13-17.

Ghasemi-Fare, O. and Basu, P. (2013). A practical heat transfer model for geothermal piles. Under review in *Energy and Buildings*, Elsevier.

Kramer, A. C. and Basu, P. (2014). Performance of a model geothermal pile in sand. Will appear in *Proceedings of 8th International Conference on Physical Modeling in Geotechnics*, Perth, Australia.
Olgun, C.G. and Bowers, G.A. (2013). Chapter 12: Ground-Source Bridge Deck Deicing Systems Using

Energy Foundations. *Energy Geostructures: Innovation in Underground Engineering*, Eds. L. Laloui and A. DiDonna, Iste-Wiley, in press.

Sutman, M. and Olgun, C.G. (2013). Temperature Effects on Soil Behavior In Relation to Ground-Sourced Bridge Deck Deicing Systems. *92nd Annual Meeting of the Transportation Research Board*, Washington, D.C., January 13-17, 2013.

Lijie, T., and Flintsch, G. W., "Use of Precipitation Records in Drainage Design of Porous Asphalt Surface Layer," presentation 13-2720, 92nd Annual Meeting of the Transportation Research Board, Washington, DC, January 2013

McGhee, K. K. de Leon Izeppi, E.D., Flintsch, G. W. Mogrovejo, D. E., "Virginia Quiet Pavement Demonstration Projects: Initial Functional Assessment," paper 13-3150, 92nd Annual Meeting of the Transportation Research Board, Washington, DC, January 2013

Venkittaraman, A. and Banerjee, S. (2013). "Seismic Retrofit of Bridges to Enhance Disaster Resilience of Highway Transportation Systems", accepted. Abstract will appear in the proceedings of 2013 Structures Congress, May 2-4, Pittsburgh, Pennsylvania.

Venkittaraman, A. and Banerjee, S. (2013). "Seismic Hazard Mitigation through Risk- and Resilience-Based Optimization:, accepted. Will appear in the proceeds of ICOSSAR 2013: 11th International Conference on Structural Safety and Reliability, June 16-20, New York, New York.

"Seismic Resilience of Highway Bridges" - MS Thesis by Mr. Ashok Venkittaraman, The Pennsylvania State University, University Park, PA, 2013.

Presentation by John Sangster at Transportation Camp conference in Washington, D.C., January 12, 2013. Hour-long discussion session led on the potential and the pitfalls of alternative intersection designs.
Kluger, Robert and Brian L. Smith, *Next Generation Traffic Management Centers*, final report

Other products:

Database of survey data collected from approximately 1,200 drivers in Virginia, Maryland, and Pennsylvania.

Three instructional laboratory videos on the following tests: Specific Gravity and Course- and Fine-Grained Grain Size Analyses have been produced for the project, "Development of Digital Instructional Modules for Transportation Engineers Overviewing the Fundamentals of How to Obtain Soil Properties in Practice"

http://www.theatlanticcities.com/commute/2013/01/could-these-crazy-intersections-make-us-safer/4467/
Article: "Could These Crazy Intersections Make Us Safer?" by Emily Badger in The Atlantic Cities, January 23, 2013

University of Maryland Travel Survey, www.travel-survey.org

Travel Helper. Smartphone applications have been developed for IOS and Android platforms, which are capable of collecting complete location information continuously all through the day without needing any interaction from the user.

Health and Travel Survey: An online health and travel survey has been designed and hosted online at the Travel Survey website http://www.travel-survey.org/survey-participation-11. The objective was to collect information about the general health status as well as individual health behavior of the user.

Pre-pilot study for Exploring the Linkages among Urban Form, Travel Behavior and Health with Peron-Level Data from Smart-phone Applications. Data was successfully received from 16 subjects out of 23 installations.

PARTICIPANTS AND COLLABORATORS

MAUTC is forging a strong relationship with the state departments of transportation within the region. Representatives from the Pennsylvania Department of Transportation (PennDOT), Maryland State Highway Administration (MSHA), Virginia Department of Transportation (VDOT)/Virginia Center for Transportation Innovation and Research (VCTIR) and West Virginia Department of Transportation are on the committee to review and select pooled projects for funding.

Nine collaborative research projects are currently underway with faculty and graduate student participation from two or more Center universities:

- A Feasibility Study of Bridge Deck Deicing Using Geothermal Energy – Penn State and Virginia Tech
- Drivers' Willingness to Pay Progressive Rate for Street Parking, Morgan State University and Virginia Tech
- Integration of Multimodal Transportation Services – Morgan State University, Penn State, and University of Maryland
- Modeling the Dynamics of Driver's Dilemma Zone Perception Using Machine Learning Methods for Safer Intersection Control – Virginia Tech, Morgan State University, Penn State
- Needs, Barriers, and Analysis Methods for Integrated Urban Freight Transportation – University of Maryland, Morgan State University, West Virginia University
- Smart Concrete Bridge Girders Using Shape Memory Alloys – University of Virginia, Penn State
- Structural Health Monitoring to Determine Long-term Behavior of AFRP Composite Bars in Pre-stressed Concrete Panels for Field Deployment – Morgan State University and University of Virginia
- Use of Probe Data for Arterial Roadway Travel Time Estimation and Freeway Medium-term Travel Time Prediction – Virginia Tech and University of Maryland
- Using Mobile Probes to Inform and Measure the Effectiveness of Macroscopic Traffic Control Strategies on Urban Networks – Penn State and Virginia Tech

Other partners and collaborators external to the MAUTC consortium include:

EdVenture Group, Morgantown, West Virginia
Contribution: Secondary Education expertise and curriculum certification; in-kind cost share

Maryland State Highway Administration, Hanover, Maryland
Contribution: Financial support

North Carolina State University, Raleigh, North Carolina
Contribution: Field data, in-kind support

Pennsylvania Department of Transportation
Contribution: Financial support; in-kind support

Science Applications International Corporation (SAIC), McLean Virginia
Contribution: Field data; financial support

University of New South Wales, Sydney, Australia
Contribution: Collaborative research

University of Florida, Gainesville, Florida
Contribution: Facilitating work with the HCS software and the HCQS committee

Virginia Center for Transportation Innovation and Research, Charlottesville, Virginia
Contributions: Financial support; personnel; collaborative research

Wayne State University, Detroit, Michigan
Contributions: Data collection

West Virginia, Department of Transportation, Morgantown, West Virginia

IMPACT

- More high school students from rural areas will be exposed to engineering and related fields as a course of study through West Virginia University's PEER project. High school students will have role models as WVU students who are from rural West Virginia mentor them in STEM fields. There will be an increase in the available workforce for application of STEM disciplines in transportation.

- More than 40 graduate students are involved in research projects which expose them to cutting edge research, and provide opportunities for them to increase understanding of transportation issues in the region and improve their skills of analyzing data and formulating solutions. Students are often working in multi-disciplinary teams, which increase their understanding of the complexities of transportation issues.

- Digital instructional modules on how to obtain soil properties being developed by the University of Virginia will help to enhance transportation education by giving professionals a reference by which to learn or review the geotechnical tests that are used to classify soils. The videos can be used in the geotechnical discipline as a teaching tool for undergraduate students. The lab videos will increase the informational resources offered by the Transportation Training Academy (TTA) and the University of Virginia.

- Developing a Real-time Energy and Environmental Monitoring System will identify spatial and temporal energy and environmental hot spots. The completion of the proposed study can help the public to identify spatial and temporal energy and environmental hot spots on transportation facilities.

- Modeling driver's dilemma zone (DZ) perception expands the knowledge of transportation researchers on dilemma zone drivers' behavior and learning aspect. Improved modeling of driver definition and behavior in dilemma zone will have significant impact on the design of optimal control methods and the assessment of intersection safety. A graduate student and research associate are being trained on driver behavior, simulation, and agent-based modeling techniques. The new model will be embedded in VISSIM simulation through the use of external driver model dynamic link library (DLL). A workshop will be conducted in the next reporting period and will be instrumental in disseminating knowledge obtained in this project. Improved modeling of driver definition and behavior in DZ will have significant impact on the design of optimal control methods and the assessment of intersection safety. This will ultimately lead to safer intersection designs and can save lives. Furthermore, as this study is focusing on driver learning aspect, it sheds light on the benefits of training and educating drivers about DZ issues. This information could be applied to the driver education process when applying for a driver's license.

- The research team has opened up a channel of communication with various stakeholders in the Baltimore area to listen to practitioners' thoughts on needs and barriers for integrated freight transportation. The mathematical models developed in this project are large-scale nonlinear or linear mixed integer programs. These are extremely difficult problems to solve and normally require intelligent solution techniques and heuristics. The solution algorithms developed for solving the complex formulations in this work can be applied to a number of real-world domains

with location and routing decisions such as transit routing. Transportation costs comprise a significant component of the final commodity prices. Optimizing urban delivery systems can

lead to reduced commodity prices and increased profit margins for the freight operators. An optimized urban freight system will also help alleviate congestion, emissions, and poor air quality related issues.

CHANGES/PROBLEMS

Nothing to report.