

# TranSearch

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## IPA and DCT Co-Host Mid-Atlantic Sustainable Transportation Funding Workshop

*BILL STAVRU, RESEARCH  
FELLOW, INSTITUTE FOR  
PUBLIC ADMINISTRATION,  
SCHOOL OF PUBLIC POLICY  
AND ADMINISTRATION*

On Friday, December 5, 2014, the Delaware Center for Transportation (DCT) and the Institute for Public Administration (IPA) at the University of Delaware cohosted the Mid-Atlantic Sustainable Transportation Funding Workshop at the Westin Hotel in Wilmington. Sponsored by the Mileage-Based User Fee Alliance (MBUFA) in partnership with the I-95 Corridor Coalition, the workshop brought together transportation experts from the public, private, and nonprofit sectors to discuss the state of highway funding in the United States. The Wilmington event focused on current funding levels, new legislation, and future revenue options, with the viability of a mileage-based user fee (MBUF) central to the discussions. The workshop comprised four panel discussions and a keynote talk by Delaware's own U.S. Senator Thomas Carper, who served as chair of the Subcommittee on Transportation and Infrastructure, Environment and Public Works Committee through the end of 2014.

Barbara Rohde, executive director of MBUFA; George Schoener, executive director of the I-95



*Barbara Rohde Executive Director,  
MBUFA*

Corridor Coalition; and IPA's director Dr. Jerome R. Lewis welcomed the attendees on behalf of their respective organizations. MBUFA is a national nonprofit organization comprising government, business, academic, and transportation policy leaders who provide education and outreach on the potential of mileage-based user fees as a source of alternative funding for the U.S. transportation system. The I-95 Corridor Coalition is an alliance of East Coast transportation agencies, toll authorities, and related organizations that provides a venue for key leaders and policymakers to address common transportation management and operations issues.

Shailen P. Bhatt, former secretary of the Delaware Department of Transportation (DelDOT), delivered the opening remarks, saying, "In many ways, we have a 19th century infrastructure as we move into the 21st century, and we're using funding models from the 1950s and 1960s.

## ***Why the U.S. needs a new funding mechanism for surface transportation infrastructure***

Maintenance of the national highway transportation system is currently financed by the federal Highway Trust Fund (HTF). The fund was established as part of the 1956 legislation enacted by President Dwight D. Eisenhower that created the federal interstate highway system. Managed by USDOT's Federal Highway Administration, the fund is sustained by a federal gasoline tax. Because federal highway spending has increased from \$33 billion to \$53 billion annually during the past 15 years and the current federal gas tax rate of 18.4 cents per gallon has not increased since 1993, the HTF is on the brink of insolvency.<sup>1</sup> While many states have increased their own gas tax to help defray the cost of state highway maintenance, these additional revenues do not address the looming HTF shortfall.

The decrease in gas-tax revenue is attributed to a combination of factors, which include a decline in the purchasing power of gas tax revenues due to inflation, new federal fuel-efficiency mandates, an overall reduction in vehicle-miles traveled (VMT), and more people driving fuel-efficient and alternative-power vehicles (In 2012, the federal DOT set a new average fuel economy target for passenger cars of 54.5 miles per gallon by 2025). While some of these factors benefit consumers and the environment, they leave the nation's highways underfunded. For most of the past decade, several research institutions and governance organizations, including the National Surface Transportation Policy and Revenue Commission, have recommended shifting to a mileage-based user fee (MBUF), also known as a VMT fee, which charges consumers for the miles they travel rather than the amount of gas they purchase.

<sup>1</sup>Phillip, Matthew. "The gas tax is running on empty." Business Week. n.p., 17 July 2014. Web. 12 Jan. 2015. <<http://www.businessweek.com/articles/2014-07-17/gas-tax-cant-fill-up-federal-highway-trust-fund>>.

We are 12th in the world in terms of infrastructure quality. We have a lot of needs, so this is an incredibly important conversation to have."

Session I, moderated by Rohde, offered insights from five national transportation policy experts on the financing shortfalls of the federal Highway Trust Fund (HTF) and highlighted some of the MBUF pilot programs currently underway. Jack Basso, chair of MBUFA, reminded the audience that highway infrastructure



**Colin Peppard, Senator Tom Carper's transportation policy advisor**



**Senator Thomas Carper**

expenditures will exceed receipts by at least \$10 billion annually for the foreseeable future. Colin Peppard, a staff member with the Office of Senator Carper, said that because elected officials in Washington are reluctant to fund the HTF through an increased gas tax, states will become "laboratories of democracy" as they seek and adopt approaches to highway funding that the public

will accept. Jim Tymon (UD M.A. '97), chief operating officer and director of policy and management at the American Association of State Highway and Transportation Officials, a nonprofit organization that represents state departments of transportation (DOTs), said that government at every level is underinvesting in infrastructure. While most innovation and risk taking was occurring at the state level, those new revenue programs are not a substitute for the \$50 billion that the states rely on from the federal government.

To make a MBUF work on a national scale, systems need to be tested, piloted, and refined at the state and local levels. The state of Oregon has recently completed two MBUF pilots, according to Mike Warren, lead technologist with CH2M Hill, who is the consulting project manager for Oregon's Road Usage Charge Program. Five thousand drivers have opted-in for the program, which charges a user fee of \$.015 per mile. At public forums in Oregon, residents expressed concerns about violations of privacy, feeling that the

technology used to track mileage was intrusive. For the pilot, participants can select an account manager from either the Oregon DOT or a private firm. Oregon plans to commence a larger test on July 1, 2015. In California, Governor Jerry Brown signed a state senate bill that calls for a MBUF pilot in 2017.

Participants acknowledged both the promise and challenges of MBUFs as a new highway infrastructure-funding source. Said Adrian Moore, vice president of policy at the Reason Foundation, "None of us thought MBUFs were a good idea in the beginning, but we realize it's the best way to generate revenue for highway infrastructure." MBUFs present three primary challenges. First, user fees must be able to be operationalized across multiple states and toll agencies. Second, the public has raised serious concerns about privacy issues. Last, user fees raise questions of equity that need to be addressed.



**Dr. Ardeshir Faghri, Delaware Center for Transportation, UD**



**Brett Taylor, DeIDOT**

tax revenues and its broad implications for policy relating to land use, economic development, and road congestion. Other panelists offering a perspective on the future of transportation funding were John Lawson, Virginia DOT chief finance officer; Mike Boyer, manager, Office of Long-Range Planning and Economic Coordination at the Delaware Valley Regional Planning Association; Bryan Kendro, director, Public-Private Partnership Office, Pennsylvania DOT; and Soumya Dey, District DOT director of research and technology transfer.

Session III focused on the private sector's perspective on transportation funding and the economic health of the

region. Moderated by Bernard Dworsky, IPA senior policy fellow, the session featured comments by Cathy Rossi,



**Catherine Rossi, AAA Mid-Atlantic**

vice president for public and government affairs for AAA Mid-Atlantic, and James DeChene, director of government relations for Delaware State Chamber of Commerce. Rossi

cited research that indicates two-thirds of Americans are willing to pay more for road infrastructure in order to ease congestion and maintain mobility. However, new taxes or fees may be a hard sell to the private sector. DeChene cautioned, "The business community wants certainty. It's difficult to sell an idea that is conceptual rather than one that has been researched and the impacts are known."

Participants of the Workshop's final session discussed the administrative, technological, and governance issues pertaining to MBUFs. Gary Euler, senior engineering manager at Parsons Brinkerhoff, presented research conducted by the I-95 Corridor Coalition on MBUFs and how state DMVs, EZPass, and new private and public sector entities could help operationalize a multi-state system of revenue collection. P.J. Wilkins, executive director of the EZPass Group, in discussing how interstate tolling has helped usher in a compatible administrative system for user fees, remarked that 48 percent of revenues currently collected by EZPass are shared among interstate agencies. Mark Muriello, assistant director of Tunnels, Bridges and Terminals for the Port Authority of New York and New Jersey, and Ian Grossman, vice president of Member Services and



**Dr. Jerome Lewis, Institute for Public Admin., UD (left) Senator Thomas Carper (right)**

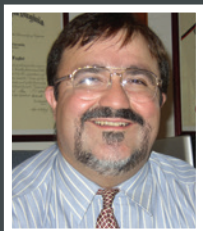
Public Affairs at the American Association of Motor Vehicle Administrators, also participated on the panel.

Senator Carper, in his keynote remarks, said it was critical

for U.S. economic growth that both political parties collaborate on seeking new funding sources for the nation's highway infrastructure. Carper stated, "I've always believed if something is worth having, it's worth paying for."



## Message from the Director



**Ardeshir Faghri,**  
**Director**

*As always, I'd like to start our first newsletter issue of the New Year by wishing all of our readers a healthy and prosperous 2015. Last year was a good year for the Delaware Center for Transportation. As I wrote in our last newsletter, besides our research and technology transfer programs with the State of Delaware, and our existing federal University Transportation Center (UTC) program with Rutgers University, we were able to receive a second (nationally competitive) UTC program with the University of Virginia. Themed "Environmental Sustainability in Transportation" the research component of this new UTC program consists of a Core Program and a Competitive Program. For the Core Program, we received funding for two projects – one headed by Marcia Scott, Policy Scientist with the Institute of Public Administration (IPA) in the School of Public Policy and Administration, and the second, by Nii Attoh-Okine, Professor in the Department of Civil and Environmental Engineering. Marcia Scott will*

*lead a project entitled "Land-Use Master Planning for Environmental Sustainability". She and her team will conduct a comprehensive survey of literature including exploratory research on the use of Smart Growth scorecards as the basis of evaluating community sustainability goals that are set forth in comprehensive plans. In the second core project, Professor Attoh-Okine will lead a project entitled "Multimodal Transportation Facility Resilience Index". He and his team will attempt to develop Resiliency Index most appropriate for transportation systems for the ability of the system to recover and adapt to external shocks, which include natural, intentional and technogenic disasters and failure due to poor design.*

*For the competitive portion of the program, the lead institution, University of Virginia, received a total of 22 proposals. These proposals were thoroughly reviewed by a team of external expert evaluators, and the top 5 proposals were selected for funding. I am happy and indeed proud to say that University of Delaware was the only academic institution that had more than one winning proposal in the top five. In fact, two of our proposals were approved for funding. The first one by Professors Ajay Prasad and Suresh Advani of the Department of Mechanical Engineering, and the second by Professors Pei Chiu and Paul Imhoff of the Department of Civil and*

*Environmental Engineering. Professor Prasad and his team will develop a system based on principles of Connected Vehicle Technology to optimize both the transportation system as well as the vehicle's control system in real-time to reduce congestion, improve fuel economy and reduce emissions. The solution will be based on a two-way communication system to upload vehicle data to a server located within the Traffic Management Center (TMC) in real-time, and download navigation guidance from the TMC to the vehicle. For the second project, Professor Chiu and his team will attempt to improve the treatment of storm water by using a new technology that utilizes zero-valent iron and biochar, two reactive granular media derived from waste products, in bioretention cells to remove multiple nutrient species from storm water simultaneously. A more comprehensive description for all these 4 projects are found in the research section of this newsletter.*

*All of the projects being conducted at our Center have and will always have local, regional, national and international significance and our world class researchers will continue publishing the results of their work in the most prestigious journals and conferences. For the latest news, programs and events, please visit our web site at [udel.edu/dct/](http://udel.edu/dct/).*

## Celebrating C.P.



In September 1974, a newly appointed assistant professor by the name of Chin-Pao (C.P.) Huang started his tenure with the Department of Civil and Environmental

Engineering at the University of Delaware. Dr. Huang, who received his bachelor's degree in Taiwan, completed his graduate work in the states at Harvard University. Throughout his forty-year distinguished career, he has focused his research work on industrial wastewater management, aquatic chemistry, soil and groundwater remediation, as well as environmental nanomaterials and processes.

C.P. has lent his expertise on a number of DelDOT sponsored projects. His early project was related to an environmental impact study of the Route 13 expansion

on ambient water bodies. The most recent project investigated the chemical effects of bird droppings and deicing salts on highway and bridge structures. Dr. Huang and his research team found that there was concrete dissolution when exposed to bird fecal material and that this material contained both fungal and bacterial components so precautions should be taken during the maintenance of structures. In addition, it was recommended that new materials being tested such as epoxy coated rebar, would slow the corrosion of the metal used to strengthen concrete.

## Big Data and Railroad Research

On December 9, 2014, an international mini-conference on "Track Maintenance Planning in the Era of Big Data" was held at the University of Delaware. The focus of the one day mini-conference was "converting the mountain" of inspection data collected by railway systems into effective maintenance planning information".

The mini-conference brought together academics and members of the railroad industry from the United States and abroad to address ways to harness and manage data to ensure safe and efficient operation of railways. The 100+ attendees included representatives from all of the major US freight railroads, Amtrak, commuter and transit agencies, railway suppliers, researchers and academics from US and Europe.

The mini-conference addressed the problems modern railways are facing in making increasing use of new generation track inspection technology and the corresponding mass of data on the condition of the track. This has led to a condition known as "big data" where the volume of data is such that traditional analyses techniques are no longer able to make use of all of this large volume, and important information is often buried in this "mountain" of data. Since railways need to convert this data into useable information to help them plan their maintenance program, there is a need for application of new and improved analysis techniques to make this conversion from data into information. One such area of improved data analysis is the use of "big data" statistical analysis techniques. Others include improved engineering more traditional statistical analysis techniques.

This mini-conference looked to introduce some of these new and emerging analysis techniques and to show how they can be applied to the large volume of track

inspection data collected by railways to improve their planning of the critical track maintenance programs.

To accomplish this, the program featured 20 speakers from the railroad industry and universities across the country who addressed both the needs and

the volume of data has mounted, rail companies are challenged with making sense of it all. Big data tools allow professionals to analyze information in huge volumes, so that they can make better forecasts in large and complicated systems like railways. Such techniques include new and traditional types of statistical analysis,

along with computer engineering models.

The conference is one of many collaborative efforts between Professor Zarembski and Professor Nii Attoh-Okine. Co-chairs of the conference, the two are also working on a project assessing the relationship between rail breaks and track geometry defects. These defects — for example, when the track is not straight enough, or when one rail is higher than the one next to it — are one of the main causes of track failure and train



challenges faced by the railroad industry and the emerging solutions. The five major sessions included an introduction to the needs of the railroad industry, a session on track inspection and data collection, a session on traditional railroad maintenance planning, a session on emerging data analysis techniques, and a session on applications and case studies.

The mini-conference was sponsored by the Railroad Engineering and Safety Program of the University of Delaware's College of Engineering together with the College's Engineering Outreach program, and corporate sponsors Harsco Rail and Georgetown Rail.

According to Professor Allan M. Zarembski, Director of the Railroad Engineering and Safety Program and Chairman of the Organizing Committee, this conference was aimed at introducing railroads and railroad suppliers to the new generation data analysis techniques and how they can be used to help railroads more effectively plan maintenance. Railway companies deploy state-of-the-art technology to constantly monitor the condition of railroad tracks for defects that could pose safety and transportation problems. As

derailments.

This study was presented at the mini-conference as a case study for the application of Big Data analysis techniques to large volumes of railroad track inspection data. Professor Zarembski described how he and Attoh-Okine are aggregating and analyzing millions of pieces of inspection information to help predict failure of the track structure. This complemented Professor Attoh-Okine's presentation on emerging analysis techniques.

Properly using and keeping track of all this information is not just an issue for American railroads, Professor Zarembski notes. "The railroad industry has a commonality of issues that transcends national borders. Our nation's rail infrastructure is generally in good shape, but the railroad companies are always looking for ways to improve."

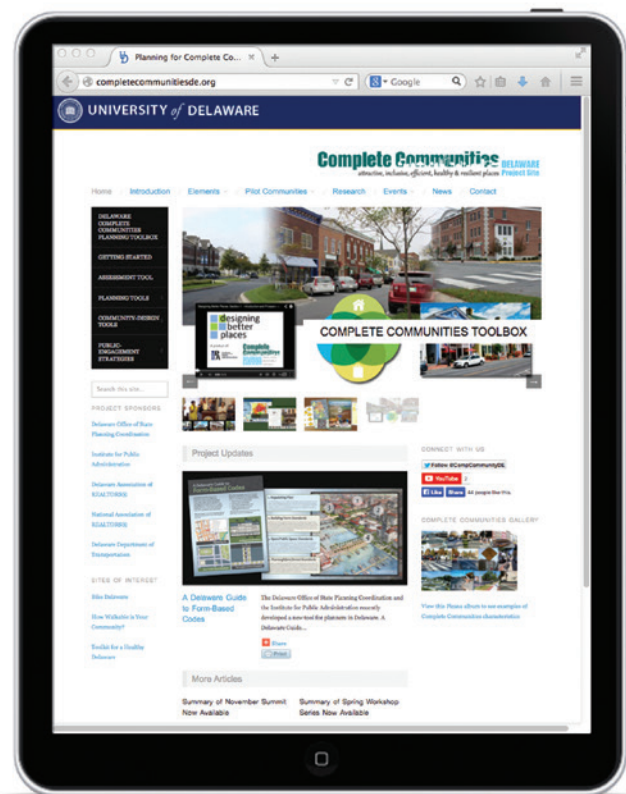
Feedback from the railroad industry attendees indicated that the mini-conference addressed an important issue and provided new and valuable insights into how to deal with their growing "mountain of data"

## CompleteCommunitiesDE.org

A “complete” community promotes healthy lifestyles, economic growth, and sustainability through an integrated approach to transportation, land-use, and community design.

The *Delaware Complete Communities Planning Toolbox* is a resource for community leaders and local government officials to utilize:

- **Complete-Communities Planning Approaches** in 5 key areas of land-use and development.
  1. Complete Streets
  2. Efficient Land Use
  3. Healthy and Livable
  4. Inclusive and Active
  5. Sustainable and Resilient
- **Community-Design Tools** to create places that are dynamic and reflect community changes, oriented toward people not cars, reflective of a town’s architectural and cultural heritage, visually attractive and enjoyable, accessible and inclusive, and economically vibrant.
- **Public Engagement Strategies** to foster communication with residents about community development plans.



*Explore the Toolbox,  
then give us your feedback  
by taking a quick survey at  
[www.surveymonkey.com/  
s/QTPHYWY](http://www.surveymonkey.com/s/QTPHYWY)*

**Complete Communities** DELAWARE  
attractive, inclusive, efficient, healthy & resilient places **Project Site**



## Delaware Local Government Guide to Transportation Improvement Districts (TIDS)

BY MARCIA S. SCOTT, IPA POLICY SCIENTIST

PHOTO COURTESY OF JAMES PERNOL, DELDOT

Local communities are the backbone of Delaware's economy and economic growth depends on a well-maintained transportation network that efficiently moves goods and people. Transportation infrastructure (highways, roads, bridges, and capital for transit systems) has largely been funded by an indirect user fee, in the form of gasoline taxes, at the federal and state levels. However, gas tax revenues have declined significantly in the last decade as a result of less driving, increasing fuel efficiency of cars, and decreasing purchasing power. In addition, federal and state transportation trust funds have experienced substantial shortfalls due to inflationary costs, limited resources, substantial increases in construction costs and debt financing, and declining revenues. It is estimated that only 40 percent of what is necessary is being invested to meet surface transportation infrastructure needs at all levels of government.

Many states are eyeing or have adopted alternative funding mechanisms, including TIDs, to supplement traditional transportation revenue streams. As a transportation-based impact fee, TIDs are designed to achieve fair-share mitigation of transportation impacts. TIDs provide a way to equitably distribute the costs of development-related growth and long-term transportation infrastructure improvements to the private sector that benefits from the facilities, rather than costs being absorbed by the general public.

TIDs can also be an effective tool to ease land development pressures and prepare targeted growth areas for market-ready (re)development. Economic development and growth can bring jobs and additional revenue to a community. However, unintended consequences of poorly planned growth include sprawl, traffic congestion, environmental problems, and increased costs for necessary public services and transportation infrastructure. A TID provides a framework for managing transportation impacts of development in areas intended for growth. A TID can attract business investment by expediting preconstruction phases and leveraging state and federal funds for improvements to state-owned transportation assets.



In Delaware, the Department of Transportation (DelDOT) recently adopted amendments to its existing regulations regarding subdivision streets and state highway access, which revise Traffic Impact Study (TIS) regulations and expand TID regulations. The new regulations provide a proactive and comprehensive approach to fund long-range transportation system improvements on an area-wide basis. Intergovernmental coordination is the key to the success of creating a TID and integrating land use and transportation planning. The new rules stipulate that TIDs are to be created by agreement between DelDOT, the relevant local government(s), and possibly the federally designated MPO responsible for coordinating transportation planning and programming in the proposed TID area. There are several avenues for a Delaware local government to plan for a TID. It may be considered as part of an update/amendment to a local government's comprehensive (land use) plan. A TID may also be proposed in conjunction with the development of an area-wide master plan, which provides more detailed planning for infrastructure than a local government's comprehensive plan.

To help Delaware local governments better understand DelDOT regulations that govern the process to

plan for and establish a TID, the Institute for Public Administration (IPA) at the University of Delaware recently developed an electronic publication, *Transportation Improvement Districts: A Guide for Delaware Local Governments*. Funded by the Delaware Department of Transportation (DelDOT), the guide discusses the purpose, benefits, and TID planning framework in Delaware. It also provides a step-by-step process for Delaware local governments to follow to create TID(s) and two best-practice examples for planning (City of Newark) and implementation (City of Dover) of TIDs in Delaware. The publication may be downloaded from IPA's website at [www.ipa.udel.edu/publications/transportation.html](http://www.ipa.udel.edu/publications/transportation.html).

The downloadable guide is also part of a comprehensive set of online tools on TIDs within the Complete Streets element of IPA's online Delaware Complete Communities Planning Toolbox (<http://completecommunitiesde.org/planning/complete-streets/tid/>). The Toolbox provides user-friendly information and resources for local governments on complete-communities planning approaches, implementation tools, and community engagement strategies.

## Newark Cycle Track: Pre-Engineering Assessment

BY MARCIA SCOTT, IPA POLICY SCIENTIST AND  
KIRSTEN JONES, IPA PUBLIC ADMINISTRATION  
FELLOW

Research by Dr. Peter Furth of Northeastern University's Civil and Environmental Engineering program asserts that the most fundamental need in a bicycling network is low-stress connectivity. A transportation system needs to provide routes between origins and destinations that do not require cyclists to exceed tolerable levels of traffic stress or considerable detours. High-stress streets are considered to be those with high speed limits, limited or non-existent lanes/markings and signage, long distances to cross at intersections, and other conditions that increase the potential for conflict between motorized and non-motorized travelers.

While a transportation system may already have bicycle-facility related improvements (e.g., signage and shared-pavement markings) to make bicycling safer and more appealing, these improvements may not provide a sense of safety to "interested, but concerned" cyclists. This term, coined by the Portland Bureau of Transportation bicycle coordinator Roger Geller, describes the large majority of cyclists who do not have the skill level and confidence to ride with traffic on busy streets. Research points to the need for transportation systems to provide low-stress connectivity for cyclists that provide route options that do not exceed the average cyclist's tolerance for traffic stress, or require a cyclist to detour from the most expedient route of travel.

As part of its work planning for healthy and complete communities for Delaware local governments, the Institute for Public Administration (IPA) at the University of Delaware has been conducting research on low-stress bicycling and network connectivity. The goal is to determine how low-stress connectivity approaches can attract the mainstream population in Delaware to bicycle networks, including "captive users" or "non-choice" bicycle riders who predominantly use this form of transportation.

IPA recently conducted a pre-engineering assessment study for a possible cycle track along Delaware



*A cyclist's perspective traveling on Newark's Delaware Avenue*

Avenue in Newark. The assessment builds upon recommendations of the 2014 Newark Bicycle Plan, which was created by the Newark Bicycle Committee in collaboration with Newark city officials, residents, WILMAPCO, the Delaware Department of Transportation (DelDOT), and local advocacy organizations. According to the Plan, "one of the critical missing links to bicycling in downtown Newark is the lack of an adequate westbound bike route through the downtown. To provide for this missing link, it is recommended that Delaware Avenue be reconfigured to include a two-way, separated bike lane known as a cycle track."

Cycle tracks have now been used successfully in many cities across North America. A cycle track is an exclusive bike facility, physically separated from motor traffic and distinct from the sidewalk, where bicycles travel. IPA public administration fellow Kirsten Jones (MA'16) assisted in completing a pre-engineering assessment for the City of Newark. Jones reviewed cycle track best practices, considered design options, and proposed alternative route scenarios to provide for low-stress

connectivity and address the need for bicycle-friendly transportation improvements along Delaware Avenue. As part of the assessment, Jones prepared a YouTube video that shows her navigating as a cyclist and reacting to potential conflicts between motorized and non-motorized travelers along Delaware Avenue, between Orchard Road and the Newark High School. Data and source material, used to prepare the video and assessment, were provided by DelDOT and WILMAPCO. The YouTube clip, presented by Jones to the Newark Bicycle Committee at their meeting on January 15, 2015, was highly acclaimed and generated positive feedback on the pros and cons of Delaware Avenue cycle track alternative route options. The YouTube clip will soon be rebranded and available for Delaware local governments to view as a Complete Street "best practice" within IPA's online Delaware Complete Communities Planning Toolbox (<http://completecommunitiesde.org/>). The YouTube may be seen at: <http://youtu.be/mJaPsZYwYp0>

# MULTIMODAL TRANSPORTATION FACILITY RESILIENCE INDEX

One of the core research projects funded by the MATS-UTC award is research being conducted by Drs. Nii Attoh-Okine of the University of Delaware and Lindsay Ivey-Burden of the University of Virginia. This collaboration, which just got underway January 1, will delve into the resiliency of transportation facilities – the ability

of the system to recover and adapt to external shocks, which include natural, intentional and technogenic disaster and failure due to poor designs. In most cases, transportation facilities are interconnected and interdependent. Their development of a resilience index will use a cross-disciplinary approach incorporating concepts

from both transportation engineering and datascience. An outcome from the research will be a "cookbook" with detailed examples provided to serve as guides for engineers in calculating the resilience index of a specific multimodal transportation facility.

# NEW TECHNOLOGY FOR VEHICLES

A new project just getting underway as of January 1 under the guidance of Drs. Ajay Prasad and Suresh Advani, will investigate a novel way for reducing traffic congestion in the mid-Atlantic area. Connected vehicle (CVs) would be a means to increase traffic capacity and reduce travel times plus fuel consumption. CVs are equipped with on-board technologies to communicate wirelessly with each other (vehicle-to-vehicle, V2V), infrastructure (V2I), and other mobility means (V2X). The principle investigators from Delaware along with their collaborator, Dr. Heyon-Shic Shin of Morgan State University, were awarded funding by the Mid-Atlantic Transportation Sustainability

Center at the University of Virginia.

The goal of the research teams is to develop a two-way communication system to upload vehicle data to a server located within the Transportation Management Center (TMC) in Smyrna in real-time, and download navigation guidance from the TMC to the vehicle. To pursue this task, a computational optimization model will first be developed on the server and the optimal control strategies will be fed back to the vehicle. The model's results will be analyzed to evaluate reductions in traffic congestion and improvements in vehicle efficiency and

fuel economy. The optimization model will be integrated with an on-board control system to maximize fuel economy based on real-time traffic inputs and navigational guidance.

All the PIs involved with this project feel that this research will advance the mid-Atlantic region to the forefront of CV technologies. The software tools for vehicle system management and optimization represent an ideal platform for traffic data communication and analysis to reduce congestion and save fuel. Such a program can show this region as a test bed for implementing future connected vehicle technologies.

# Upcoming Training Opportunities from the Delaware T<sup>2</sup>/LTAP Center

- OSHA with Preventing Rollovers/Backovers
- Designing Pedestrian Facilities for Accessibility
- Low Cost Safety Improvements

Check our website <http://sites.udel.edu/dct/t2-center/courses-workshops-seminars/> for dates and times.



## TREATING STORMWATER IN A SUSTAINABLE WAY

Building on their successful results in the laboratory and a small-scale pilot stormwater treatment project funded by the Delaware Department of Transportation, Drs. Pei Chiu and Paul Imhoff will be continuing their research on using zero-valent iron ZVI and biochar to remove nutrients such as phosphorus and nitrogen from stormwater.

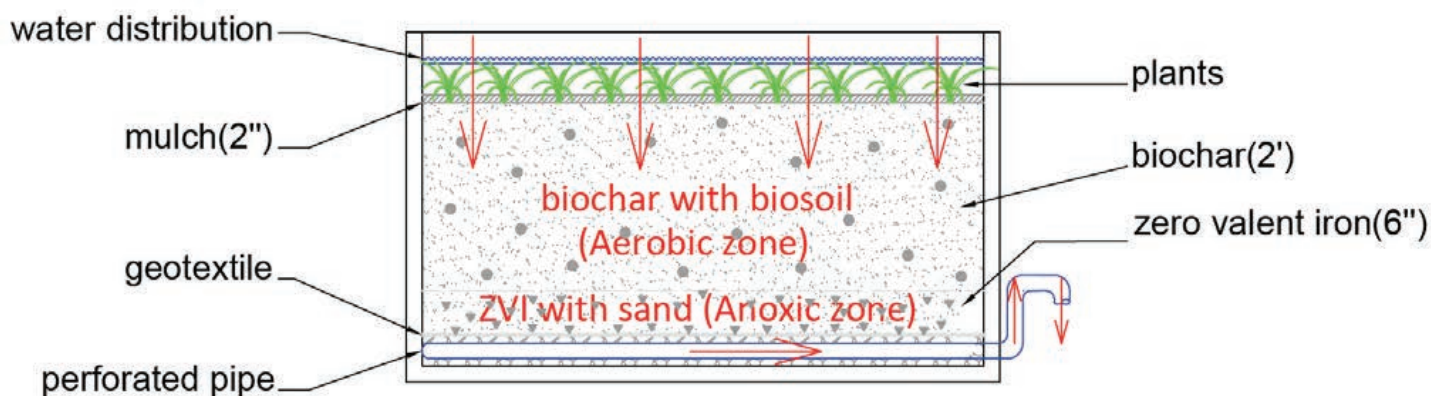
The design for this new project was submitted in response to a call for proposals from the Mid-Atlantic Transportation Sustainability University Transportation Center (MATS-UTC), a consortium of six institutions headed by the University of Virginia. Of the 22 proposals submitted in this competitive program, only five were selected for funding by the external reviewers and among them was this project.

Pei Chiu and his research team will utilize two reactive granular media derived from waste products (zero-valent iron and biochar) in bioretention cells to remove multiple nutrient species from stormwater simultaneously. These nutrients are a leading cause of impaired water quality in the U.S. and worldwide. This research is being conducted since current stormwater treatment technologies, such as bioretention systems, do not always treat nitrogen and phosphorus sufficiently and may require large tracts of land to achieve the necessary removal. Also, the research team will investigate the removal mechanism for nitrate which is the most prevalent nutrient species in stormwater.

"This project is the first field study to evaluate the

combination of biochar and ZVI for removal of both nitrogen and phosphorus from stormwater. In addition, the laboratory study should provide a better understanding of nitrate removal, which would guide the design of bioretention cells containing these novel media".

Drs. Imhoff and Chiu will be collaborating with Dr. Teresa Culver of the University of Virginia on this project. Her research background is in the area of computational modeling for effective and sustainable water resources management. Dr. Culver has worked on many stormwater field projects and will be leading the work on the field study in Charlottesville.



*Schematic of bioretention cell with biochar and zero-valent iron*

# RESEARCH

Following are the projects selected for funding from the 1687 Request for Proposals process for academic year 2014-15. The start dates and end dates are based on when the notices to proceed are issued by the Delaware Department of Transportation.

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## 1687-A LIGHTING-URBAN DESIGN

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Notice to proceed not yet issued by DelDOT

**Principal Investigator:** Ardeshir Faghri, Department of Civil and Environmental Engineering

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## 1687-B PAVEMENT-STORMWATER

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Notice to proceed not yet issued by DelDOT

**Principal Investigator:** Ardeshir Faghri, Department of Civil and Environmental Engineering

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## 1687-C SURVEYING-STATISTICS

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Utilizing publicly and privately held sources along with a qualitative survey of state transportation agencies, this project will collect current best practices in travel monitoring techniques. End date: 12/08/15

**Principal Investigator:** Tibor Toth, Center for Applied Demography and Research

**Project Manager:** Mike DuRoss, Division of Planning

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## 1687-D STORMWATER-NUTRIENT REMOVAL

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Leveraging results obtained from preliminary laboratory research, this project will continue evaluation of two promising technologies involving the addition of biochar and/or zero-valent iron to existing and new stormwater bioinfiltration facilities. Ending 12/14/15

**Principal Investigators:** Paul Imhoff, Daniel Cha, Pei Chiu and Julia Maresca, Department of Civil and Environmental Engineering at Univ. of Delaware; Mingxin Guo, Department of Agriculture and Natural Resources, Delaware State University

**Project Manager:** LaTonya Gilliam, DelDOT Stormwater Quality Program

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## 1687-E BRIDGE-ENGINEERING SPECIFICATIONS

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The objective of the research is to develop a better understanding of the factors that influence the dynamic impact factor used in the design and load

rating of buried culvert/frame structures. End date: 12/15/15

**Principal Investigator:** Harry Shenton, Department of Civil and Environmental Engineering

**Project Manager:** Ping Jiang, Bridge Design

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## 1687-G PAVEMENT-INSPECTION

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This project will investigate what is an acceptable variation in values between pavement evaluation surveys that use visual and auto-visual surveys.

**Principal Investigator:** Sue McNeil, Department of Civil and Environmental Engineering

**Project Manager:** Susan McDougall, Procurement Management Engineer

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## 1687-H TRAFFIC-SAFETY

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Notice to proceed not yet issued by DelDOT

**Principal Investigator:** Mingxin Li

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## 1687-J MULTI-MODAL TRAVEL MODELING

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Using estimates of accessibility developed in previous research and using data available from the Delaware Trip Monitoring System Survey, this project will develop and refine a repeatable process to estimate a more detailed set of trip generation rates at the tax parcel level that incorporate a multimodal accessibility index. Trip generation rates will be provided by trip purpose as well as travel mode. End date: 12/08/15

**Principal Investigator:** David Racca, Center for Applied Demography and Research

**Project Manager:** Mike DuRoss, Division of Planning

---

## 1687-K TRAFFIC-SAFETY

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The goal of this research project is to develop Delaware-specific values for determining work zone lane capacities along multilane signalized corridors.

This has safety implications for both users and construction personnel in work zones. Ending 12/8/15

**Principal Investigator:** Mingxin Li, Department of Civil and Environmental Engineering

**Project Manager:** Adam Weiser, Division of Transportation Solutions

## CONTINUING ACTIVE RESEARCH PROJECTS SPONSORED BY DELDOT

*As each project is completed, a final technical report will be available on the DCT website: <http://www.ce.udel.edu/dct>.*

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## REHABILITATION OF FATIGUE-CRACKS IN STEEL BRIDGES: EVALUATION OF FATIGUE-CRACKS IN THE FIELD AND LABORATORY TESTING

---

This project aims at creating a new holistic strategy to rehabilitate and monitor these problematic areas. Field measurements to determine actual experienced strain will be performed combined with laboratory experiments to evaluate solution strategies. Ending 8/31/15

**Principal Investigators:** Thomas Schumacher, Jennifer McConnell and Erik Thostenson, Departments of Civil and Environmental Engineering and Mechanical Engineering

**Project manager:** Barry Benton, Bridge Management

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## AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS – PILE DOWNDRAG DESIGN PROVISIONS

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This project focuses on assessment of the new AASHTO LRFD bridge design specifications for pile downdrag, and the associated implications for the design of future deep foundation projects in the State of Delaware. Ending 8/31/15

**Principal Investigator:** Chris Meehan, Department of Civil and Environmental Engineering

**Project Manager:** Jason Hastings, Bridge Design

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## DELAWARE TRANSPORTATION LIGHTING INVENTORY AND ASSESSMENT

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Lighting infrastructure needs will be inventoried and assessed in selected areas in Delaware that feature multiple modes of transportation and motorized and non-motorized transportation routes. The inventory will consist of mapping formal and informal lighting stock within a given geographical area to determine target areas for enhancement. The research will result in a compilation of lighting policies for areas within Delaware. Ending 8/31/15

**Principal Investigators:** Martin Wollaston and Ted Patterson, Institute for Public Administration

**Project Manager:** Ralph Reeb, Division of Planning

---

## DEVELOPMENT OF CAPACITY ADJUSTMENTS FOR ADAPTIVE CONTROL SYSTEMS

---

This research will compare data on current practices around the country and compare this to conditions along Delaware roads to see if the computed capacities compare to observed behavior. Comparing predicted behavior with data from the Traffic Management Center, this research will further develop the "true" capacity for a segment. Ending 8/31/15

**Principal Investigator:** Rusty Lee, Department of Civil and Environmental Engineering

**Project Manager:** Gene Donaldson, Transportation Management Center

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## FY14 DELAWARE SIGNAL TIMING ENHANCEMENT PARTNERSHIP (DSTEP), CORRIDORS 7 & 8

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The goals of the DSTEP project are to involve students in traffic engineering services for DelDOT, to develop a continuous research program that addresses DelDOT's needs while minimizing the use of DelDOT's resources, and to maintain a high level of quality so that DelDOT may apply the results to improve intersection operations across the state. Ending 8/31/15

**Principal Investigator:** Rusty Lee, Department of Civil and Environmental Engineering

**Project Manager:** Gene Donaldson, Transportation Management Center

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## FY14 LAB BASELINE SERVICE

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The objectives of this project are to establish the Delaware Center for Transportation ITS Lab as a state of the art facility with three main focus areas: 1) service to DelDOT; 2) training for DelDOT and support classroom instruction; and 3) research for faculty and students. Ending 8/31/15

**Principal Investigator:** Rusty Lee, Department of Civil and Environmental Engineering

**Project Manager:** Gene Donaldson, Transportation Management Center

---

## PAVEMENT MARKINGS AND SIGNING TO SUPPORT SENATE BILL 120

---

The various treatment options and signing to assist with safer bike lanes and intersections as mandated

by state code will be evaluated through a survey instrument and test sites. Ending 8/31/15

**Principal Investigator:** Rusty Lee, Department of Civil and Environmental Engineering

**Project Manager:** Mark Luszcz, Traffic Management Center

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## DELMARVA FREIGHT STUDY

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The University of Delaware will work with Whitman, Requardt & Associates to develop a freight plan which reflects intra-regional, inter-regional, and national trends in freight movement and planning. Ending 5/31/15

**Principal Investigator:** Rusty Lee, Department of Civil and Environmental Engineering

**Project Manager:** Mike DuRoss, Division of Planning

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## VERIFICATION OF DESIGN OF A NOVEL MECHANICALLY STABILIZED EARTH (MSE) WALL AT THE CHRISTIANA INTERCHANGE

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During the construction of the Christiana Interchange, instrumentation donated by an Italian company will be utilized in an abutment to measure readings which will help DelDOT with future designs and specifications. Ending 7/31/15

**Principal Investigator:** Dov Leshchinsky, Department of Civil and Environmental Engineering

**Project Manager:** Barry Benton, Bridge Management



# Research Pays Off:

## DTALite: A light-weight dynamic traffic assignment simulator for fast model evaluation and calibration

XUESONG ZHOU, *Associate Professor, School of Sustainable Engineering and the Built Environment, Arizona State University, Email: xzhou74@asu.edu.*

A number of emerging dynamic traffic analysis applications, such as regional or statewide traffic assignment, require a theoretically rigorous and computationally efficient model to describe the propagation and dissipation of system congestion with bottleneck capacity constraints. An open-source light-weight dynamic traffic assignment (DTA) package, namely DTALite, has been developed to allow a rapid utilization of advanced dynamic traffic analysis capabilities. A number of real-world test cases are described to demonstrate the effectiveness and performance of the proposed models under different network and data availability conditions.

### PROBLEM

Simulation-based traffic simulation models are widely used for better understanding and operating traffic systems. Traditional travel demand forecasting models are unable to effectively evaluate improvement strategies across the full spectrum of operations, technology, and design for several reasons:

1. Simulation models used in transportation analysis are not well integrated for different levels of analysis (i.e., macro, meso, and micro).
2. There are shortcomings associated with integrated modeling applications, especially challenges to the exchange of data among multiple resolutions of analysis, modeling, and simulation (AMS) tools.
3. There is lack of a simplified emission model for accurate estimation of fleet average emission rates while accounting for individual vehicle speed profiles.

### SOLUTION

One solution to these challenges is to develop an open-source and open-data format that allows software vendors and planners to implement data conversion utilities from their own proprietary format. This research develops an open-source and open-data format through a publicly visible, vendor-independent process to ensure interoperability among diverse traffic modeling and simulation tools. The mesoscopic dynamic traffic assignment and simulation models, such as DTALite, are capable of capturing the traveler's route choice and modeling different scales of networks, for example, from a single freeway corridor to a large-scale regional network. It is also suitable for evaluating traffic control measures (TCM), such as road pricing, high occupancy vehicle (HOV) lanes and a variety of traveler information strategies. These TCMs, such as adaptive traffic signal control, ramp metering, incident management and dynamic capacity allocation, are likely to significantly impact fuel consumption and emissions. DTALite uses a computationally simple but theoretically rigorous traffic queuing model in its lightweight mesoscopic simulation engine. To reduce data preparation efforts, it only requires a minimal set of static traffic assignment data and some time-dependent OD demand pattern estimates. Its built-in parallel computing capability dramatically speeds-up the analysis process by using widely available multi-core CPU hardware.

### METHODOLOGY

The software architecture designed in DTALite aims to integrate many rich modeling and visualization capabilities into an open-source DTA model. Using a modularized design, the software suite of simulation engine and visualization interface can also serve future needs by enabling transportation researchers and software developers to continue to build upon and expand its range of capabilities. The streamlined data flow from static traffic assignment models and common signal data interfaces aims

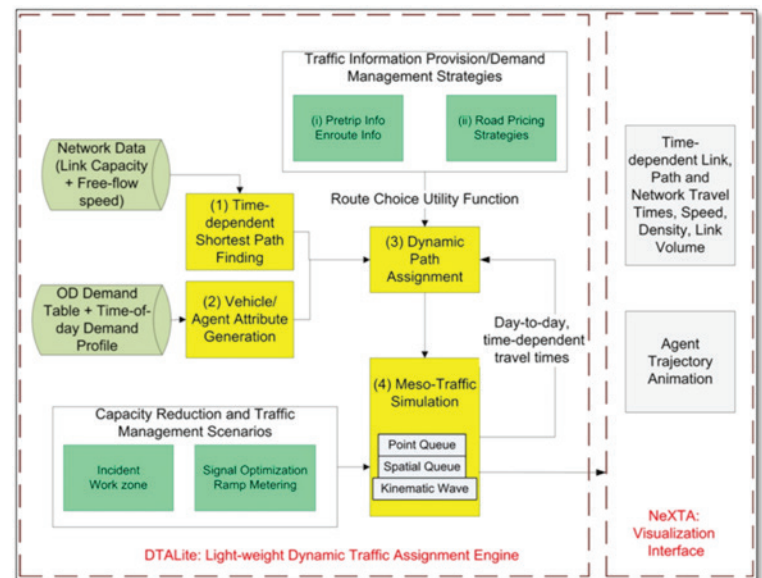


Figure 1. Software system architecture with key modeling components.

to allow planners and engineers to rapidly apply the advanced DTA methodology, and further examines the effectiveness of traffic mobility, reliability, and safety improvement strategies. The overall structure, illustrated in Figure 1, integrates the four major modeling components highlighted in yellow.

Compared with the existing research, practice and models, the system design presented here aims to eliminate the drawbacks that exist when integrating traffic assignment and traffic signal control, primarily through automating the process and removing the need for manual traffic control data inputs and manipulation. It also simplifies the process of multi-resolution modeling, where models at different levels (macro, meso and micro) are converted from one to another.

## APPLICATION

DTALite can be used for large-scale transportation modeling applications to help planning/engineering organizations and public officials make transportation infrastructure investment decisions. Particularly important applications may include modeling the traffic impacts of work zones, proposed freeways/highways, and tolling facilities. DTALite's route choice model also allows organizations to test the effects of multiple strategies to improve traffic operations and manage travel demand.

Figure 2 shows the final imported Portland network, which has 2,162 zones, 39,770 links, and 14,721 nodes. The research team tested the analysis, modeling, and simulation (AMS) data hub prototype for an arterial network in Portland. Results from the test applications show that the AMS data hub achieved the project goal of enabling the harmonious exchange of model data along with significant time savings. It should be noted that control type (signal, stop, and yield) is imported from the PTV VISUM network into DATLite. The data-hub system built in DTALite makes the network transfer easy and seamless.



*Figure 2. FHWA Project: The Effective Integration of Analysis, Modeling, and Simulation Tools*

DTALite takes into account the second-by-second acceleration, cruising, deceleration, and idling of thousands of vehicles operating on the network. Figure 3 shows the development and calibration of a network-wide mesoscopic simulation model of the Triangle Regional Model (TRM) network in Research Triangle Region, NC using the DTALite software tools. The impacts of different work zone scenarios on the average travel time and average volume of certain key routes of the network are presented. The flowchart at the bottom of Figure 3 illustrates how the traffic simulation model is incorporated with the microscopic emission estimation model. Starting with the traffic simulation model, typical data sources for simulation-based dynamic traffic assignment in the integrated model include 1) link-node network data, 2) origin-destination demand table (with optional departure time profile), and 3) different traffic mitigation strategies such as signal optimization, ramp metering and road pricing.

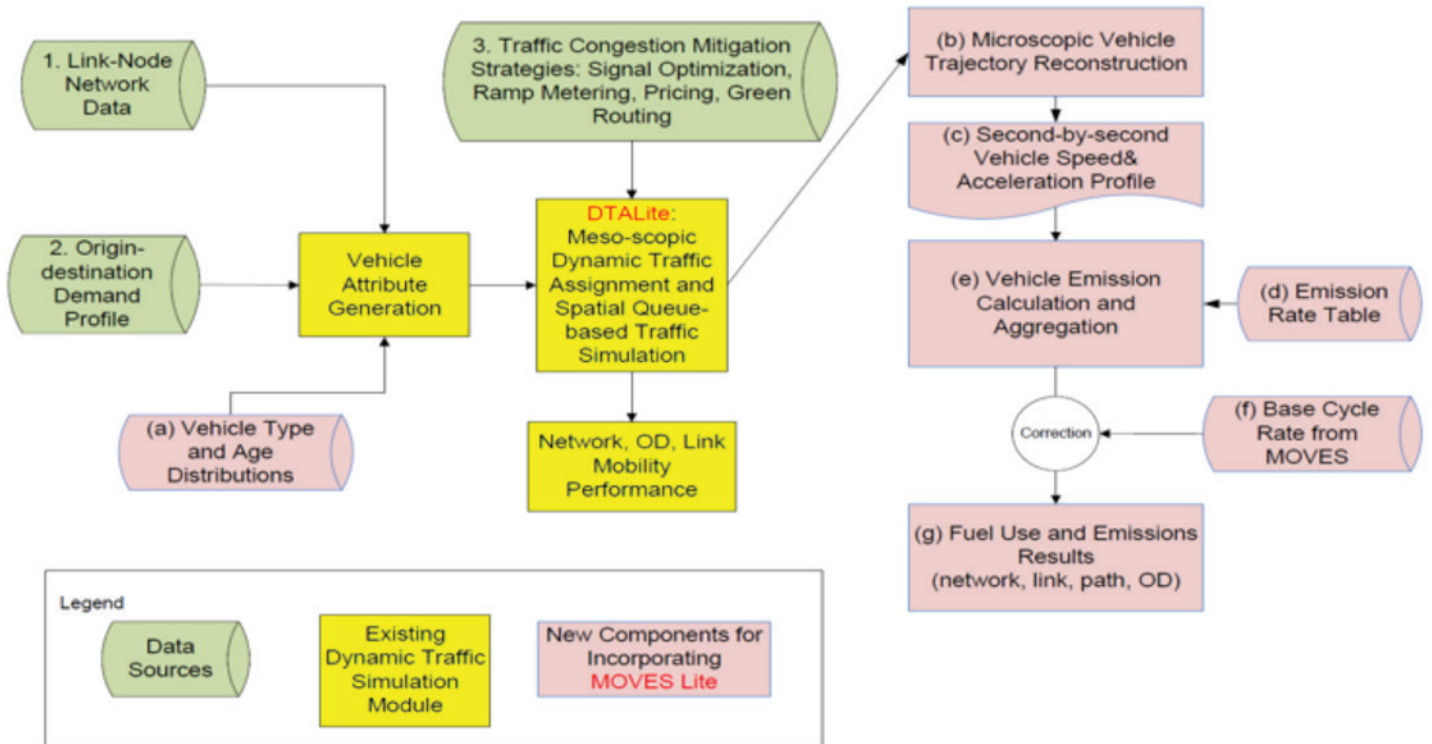
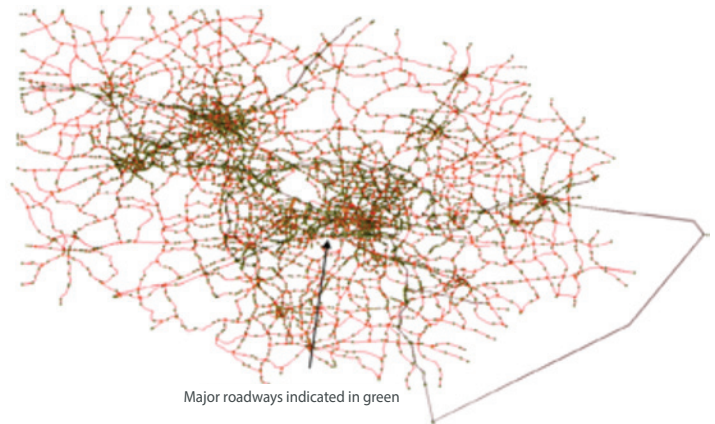


Figure 3. System framework of DTALite with the microscopic emission estimation model.



Figure 4 shows Phoenix subarea network volume and bottlenecks in Google Earth. This network clearly demonstrated the usefulness of the procedure in a real-world environment and featured the analytic elements of network diagnosis; identification

and evaluation of alternative treatment options; and interpretation of the results. Figure 5 indicates the dynamic density contour generated from DTALite simulation results.

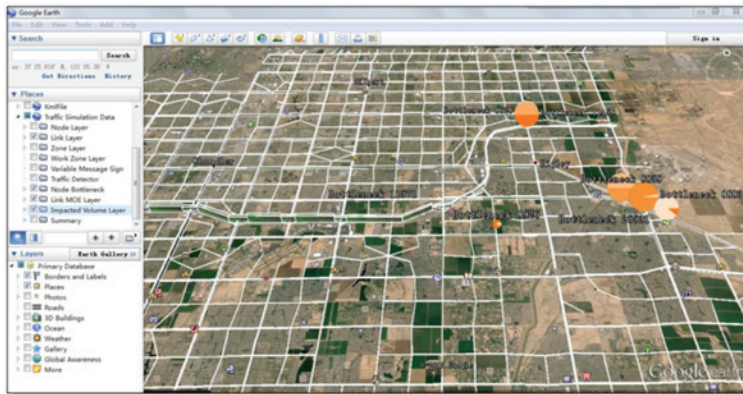


Figure 4. Network volume and bottlenecks in Google Earth.

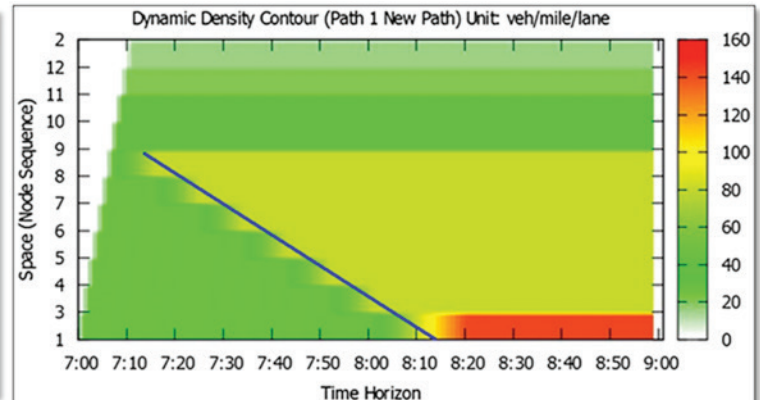


Figure 5. Dynamic density contour on a hypothetical corridor with a lane drop bottleneck.

## TECHNICAL BENEFITS

One of the highlights of DTALite is its support for multi-threaded processing, which significantly reduces model run-times. This could allow users to evaluate more alternative strategies to solve a problem within a limited amount of time, providing more information to help decision-makers find better solutions to difficult problems.

In general, the software suite of DTALite is able to:

1. Adopt a new software architecture and algorithm design to facilitate the most efficient use of emergent parallel (multi-core) processing techniques and exploit the unprecedented parallel computing power newly available on both laptops and desktops;
2. Provide an open-source code base to enable transportation researchers and software developers to expand its range of capabilities to various traffic management applications;
3. Present results to other users by visualizing time-varying traffic flow dynamics and traveler route choice behavior in an integrated 2D/3D environment;
4. Provide a free, educational tool for students to understand the complex

decision-making process in transportation planning and optimization processes.

Additionally, DTALite has the ability of importing networks created in macroscopic simulation tools (such as Cube, VISUM, TransCAD) through a set of general information system data and demand matrices. Signal control, which can be represented in different ways in these tools, is re-estimated through quick estimation method (QEM) and outputted in a UDF format, which is used by the majority of microsimulation tools. In that way, the starting macroscopic network can be converted to a microscopic network with detailed geometry, demand and signal control data.

In summary, main technical benefits of DTALite package include:

1. Seamless connection with existing static assignment through GIS connection.
2. Incremental approach for traffic flow modeling/simulation.
3. Rich interface in the new generation of graphical user interface (GUI).
4. Data-driven OD calibration built in DTALite
5. Sub-area results can be easily exported to Synchro and VISSIM.

## Delaware T<sup>2</sup>/LTAP Center Invited to Teach Winter Maintenance in Oklahoma

The success of winter maintenance training in Delaware caught the attention of our colleagues at the Oklahoma LTAP and TTAP. Matt Carter was asked to bring his training to Oklahoma for the benefit of local municipalities and tribal governments. In December, hosted by the Chickasaw Nation and the Oklahoma State University LTAP, Matt presented the full day snow and ice control training to approximately 160 local government personnel at the Pontotoc County Agri-Plex in Ada, Oklahoma.

Like other, more southern states, Oklahoma

experienced unusual storms the last couple winters, and is particularly afflicted with ice storms. Combined with a large number of unpaved, gravel roads, they have some unusual challenges. "We just came today to learn how to be a little bit better prepared. That storm last year, the ice storm kind of caught us off guard and I'd rather be pro-active than re-active," Marshall County Commissioner Erin Lemons said.

The LTAP Centers across the country often work collaboratively, sharing ideas, experiences, training materials, and trainers, and our Delaware Center is

happy to participate when we can. Even though he was the trainer, Matt said he, "gained great insight from the Oklahoma folks that I can use to reinforce and improve the training materials; they have challenges there that we don't and they also employ some creative solutions, prompted by the fact that their winters are in some ways even more unpredictable than ours."

Matt remarked on his Oklahoma hosts, saying "I couldn't have felt more welcome and appreciated."





## Delaware T<sup>2</sup>/LTAP Center Holds ADA Briefings

The Delaware T<sup>2</sup>/LTAP Center held four 2-hour briefings for local government decision-makers this past fall. The four sessions, held across the state, were attended by more than 40 representatives from 21 local governments. The briefings were specific to the urgent need for government agencies of all sizes to conduct a Self-Assessment for compliance with the Americans with Disabilities Act (ADA) and, where appropriate, the development of a Transition Plan.

The statutory requirements of ADA required that all government agencies to complete these more than twenty years ago and many have not. With the 25-year anniversary of ADA approaching this summer, it is essential that local agencies address these, if they have not already. The good news, as discussed in

these briefings, is that the Self-Assessment (and even the Transition Plan) need not be overly burdensome for most agencies and the benefit of completing them can be substantial in light of the legal liabilities involved.

Our Municipal Engineering Circuit Rider, Matt Carter, prepared and presented the briefings, aided particularly by Patrick Kennedy (FHWA DelMar Division, Delaware Office) and John McNeal (DelDOT's ADA Title II/Section 504 Coordinator), who were present at all the briefings as well and helped field questions.

Subsequent to the fall briefings, several municipalities have begun their Self-Assessments and Matt has met with some to help them get started. Several more have indicated their intent to begin their efforts

this spring. In these meetings, Matt has talked with relevant personnel about ways to go about their inventory, taken them out to look at some examples and how to handle them, and left them with some Excel tools to help gather the information. Where municipalities have hired an engineering intern to collect their inventory, we have also assisted with locating candidates and then provided technical oversight.

Local agencies that are not working on this important requirement are urged to get started. For more information, see our more detailed newsletter articles at <http://sites.udel.edu/dct/t2-center/newsletter/> (Winter 2014/2015, pages 1 and 3) or contact Matt at [matheu@udel.edu](mailto:matheu@udel.edu) or (302) 831-7236.





The mission of the Delaware Center for Transportation is to improve the movement of people, goods, and ideas, and be viewed as a valuable resource for transportation-related issues and challenges within the state, the mid-Atlantic region and beyond.

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The word "TranSearch" in a stylized font where "Tran" is blue and "Search" is green, set against a background of a city skyline and a bridge.

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**RESILIENCY OF TRANSPORTATION CORRIDORS**  
PUBLISHED BY THE UD UNIVERSITY TRANSPORTATION CENTER

Winter 2015

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## Director's Message

Summer and fall 2014 were a time for researchers to focus on our CAIT at UD projects, and students to take classes and work on their research. The end result is that our projects are making progress, products are being developed, collaborations with industry, government and other institutions are being formed and enhanced, and our work is being presented at conferences and workshops, and shared with practitioners. This edition of our CAIT at UD UTC newsletter serves to highlight some of the projects, review other activities and remind everyone of some upcoming opportunities.

This spring the opportunities include a request for pre-proposals for new research projects, a graduate student fellowship for the 2015-2016 academic year, undergraduate summer internships, graduate student participation in the Annual Interuniversity Symposium on Infrastructure Management (AISIM) and student (grad and undergrad) participation in the WTS Annual Conference. Each opportunity has a deadline, so please make note of the deadline and consider applying!

### Sue McNeil

Professor, Department of  
Civil & Environmental Engineering

**Director and Managing Editor**  
Sue McNeil

**Design**  
University Printing

## Highlights from Selected Recent and Ongoing CAIT at UD Tier 1 UTC Projects

*CAIT at UD researchers are working on wrapping up the collaborative projects and the projects funded in the second year of the Tier 1 UTC program.*

Investigators Professors Paul Imhoff and Pei Chu have completed the project “Enhancing Removal in Stormwater Treatment Facilities for Transportation.” The final report is in the review process. This study provides empirical data that support the proposed enhancement mechanism as well as knowledge that can guide future design and implementation of field-scale stormwater treatment systems. The results suggest that, in a bioretention cell, biochar-promoted microbial nitrate reduction would be particularly pronounced if a significant saturated (anaerobic) region is included in the cell design, and if a reducing agent is present/provided as an electron source.

This project has engaged many students (including graduate students, undergraduates and high school students) as well as the following collaborators:

- Dr. Quizhong (George) Guo, Department of Civil and Environmental Engineering, Rutgers, The State University of New Jersey
- Delaware Environmental Institute (DENIN), University of Delaware
- Charles H. Hegberg, reGenesis Consulting Services, LLC
- The Biochar Company (<http://thebiocharcompany.com/>)
- Dr. Marianne Walch, Environmental Scientist, formerly of the Delaware Department of Transportation (DelDOT), Stormwater Quality Program

The project “**Big Data: Opportunities and Challenges in Asset Management**” has involved a collaboration between Professor Sue McNeil, Professor Jie Gong from

Rutgers and Professor Kevin Heaslip from Virginia Tech (formerly from Utah State University). A workshop was held at Rutgers on Friday December 5. The workshop examined the role of big data and analytics in transportation infrastructure management. Leaders from the R+D, practitioner, and end-user communities examined and proposed solutions to economic, legal, and technical barriers which currently hinder big data and analytics to be effectively used by transportation agencies. The workshop also looked at the future of the big data technology and potential future applications.

The final report authored by Professor Thomas Schumacher and graduate student Ali Shariati documents the project “**Exploration of Video-Based Structural Health Monitoring Techniques**” is available at:

<http://cait.rutgers.edu/cait/research/exploration-video-based-structural-health-monitoring-techniques>

The research introduced and promoted a novel approach to video-based monitoring, using so-called Eulerian-based virtual visual sensors. This is different than traditional approaches such as digital image correlation (DIC). Advantages include: simplicity, robustness, and speed. The researchers have shown that they can very accurately measure frequencies of vibration using standard off-the-shelf digital cameras with the same accuracy achieved with expensive monitoring systems.

### In addition:

- Some new data analysis methods have been evaluated to process the digital video data.
- Presentations were made at the TRB Annual Meetings in 2014 and 2015, as well as a meeting with the external project manager at HNTB, New York. These meetings provided an opportunity to solicit direct industry feedback.
- The research is at a stage where it could be applied to real bridges. The researchers have successfully performed a test on a real bridge in Princeton, NJ, and shown the accuracy of the method.
- The method is capable of distributed sensing, i.e. it can measure a large number of points

simultaneously. As a result it is much more effective in capturing potential areas of damage.

Dr Nakul Rammanna has been working with students on the project “**Guidelines for Embedment Length of Carbon Fiber Reinforced Polymer (CFRP) Strips in near Surface Mount (NSM) Retrofitted Concrete Structures.**” Several mid-size concrete specimens with varying CFRP lengths, steel to CFRP ratio, have been tested under quasi-static loads to evaluate the bond performance, flexural behavior, moment curvature relationship and ductility. Undergraduate students enrolled in courses CIEG 212 - Solid Mechanics and CIEG 213 - Materials Testing Lab, participated in the testing of control and retrofitted specimens. As part of their class assignments they compared theoretical capacity of the beams to the experimental results. It was observed that while some specimens far exceeded the theoretical capacity some came short due to premature debonding. This exercise exposed students to the importance of development length provisions in RC specimens, be it for steel or CFRP reinforcement.

Large size normal and high strength concrete RC specimens are now being tested and their performance evaluated. The test beams have been analyzed in the Response 2000 program (section analysis software) and theoretically per ACI 440 code provisions. A Matlab program is under development to improve the prediction of the experimental behavior.

The project “**Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy**” has surveyed residents of Oakwood Beach, New York and Sea Bright, New Jersey to better understand household decisions related to rebuilding versus relocating. Disaster Science and Management program PhD candidate Alex Greer, working with Professor Joe Trainor and Professor Sue McNeil, and assisted by MS candidate Israt Jahan and undergraduate research assistant Kelsey Burke, has been analyzing the 357 responses and supplementing the survey responses with in-person and telephone interviews. The project attempts to understand how transportation infrastructure influences these decisions and provides a preliminary assessment of how data can be used for transportation decision making.

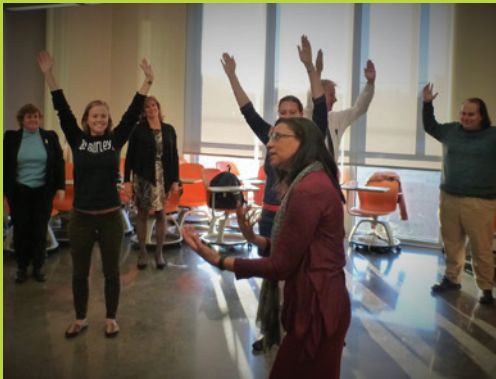


## Transportation and Dance

The outreach initiative "Transportation and Dance" has been part of the UTC at UD for some time. The goals are to create, implement and assess arts integrated lessons

with elementary school age students. Transportation Scholars, UD undergraduates, worked with 5th grade students in Cecil County, Maryland to teach them about transportation concepts through creative movement. Analysis of assessment data and outcomes demonstrates that the integrated lessons enhance learning.

For the third time, faculty, researchers and graduate students were treated to this learning experience through a brown bag seminar run by Professor Lynnette Overby and Transportation Scholar Megan LaMotte. Despite initial skepticism on the part of the graduate student participants the smiles on everyone's faces indicate that a good time was had by all!



*Lynnette Overby instructs brown bag participants on connecting dance moves to transportation concepts*



*UTC Fellow John Cronin*

## UTC Fellow

John Cronin, a first year PhD student in Civil Engineering at UD was awarded the CAIT at UD National UTC Fellowship for 2014-2015. The fellowship provides a year of support including stipend, tuition and modest support for travel and computing. John completed an MCE at UD in 2014 working under the direction of Professor Allan Zarembski. His thesis investigated the relationship between volume of missing ballast

and the number and type of reported defect(s). His research interests center around railroads and range from safety and performance to new technologies for data collection and analysis. He is continuing to work with Professor Zarembski. In December, John presented some of his research at the mini conference on Emerging Techniques in Track Maintenance Planning in the Era of "Big Data" sponsored by the Railroad Engineering & Safety Program at the University of Delaware.

## New CAIT at UD National UTC Project

One new CAIT at UD project has been approved for funding.

**BRIDGE RETROFIT OR REPLACEMENT DECISIONS: TOOLS TO ASSESS SUSTAINABILITY AND AID DECISION MAKING**

**Principal Investigators: Abigail Clarke-Sather and Thomas Schumacher**

Several sustainability rating, scorecard, and quantitative and/or qualitative performance metrics tools exist to assist in the assessment of sustainability of bridge projects e.g. the Sustainable Transportation Analysis and Rating System (STARS) and INVEST. These tools are mostly applied after a project is completed or late in the design when most of the retrofit details have been decided. What is needed are tools to help in the early stages of decision-making about whether to repair or reconstruct bridges when there are more choices open and hence a greater ability to radically reduce environmental and societal impacts. What is missing is the life cycle inventory data to

allow comparison of construction and maintenance techniques for sustainability objectives, such as worker safety and increased ozone emissions from slowed and stopped car traffic, in addition to cost. This research will set up the framework for a life cycle inventory database of bridge repair and construction techniques including social and environmental sustainability concerns. Bridge experts and practitioners will be recruited to upload their information about the service life of bridges and sustainability impacts to this database. This research will also modify existing early-stage commercial product design decision-making tools to create an applicable tool for bridge retrofit decisions utilizing sustainability information available in the life cycle inventory database.

## Brown Bag Seminars and Webinars

The fall semester again provided an opportunity for students and faculty to provide project updates for the CAIT at UD projects. Three brown bag seminars were presented:

**“Satellite Assessment and Monitoring for Pavement Management.”** Arde Faghri, Mingxin Li and Kadir Ozden, November 19, 2015

**“Transportation and Dance,”** Megan LaMotte, and Lynnette Overby, November 12, 2014.

**“Understanding the Relationships between Household Decisions**

**and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy, An Update,”** Alex Greer, Sue McNeil, and Joseph Trainor, December 1, 2014.

A webinar **“Sustainability Assessment of Pavement Systems”** was presented by the Transportation Research Board and sponsored by CAIT at UD September 18.

## Recent CAIT at UD Related Presentations

**Boccardi, A. and M. LaMotte,** “An Interdisciplinary Approach: Integrating Dance and Music in the Elementary Classroom,” NDEO National Conference, Chicago, Illinois, November 6, 2014.

**Chu, Pei,** “Microbial Nitrate Removal Promoted by Zero-Valent Iron and Black Carbon (Biochar)” Environmental Frontier Seminar Series, University of Delaware. December 8, 2014.

**LaMotte, Megan, Lynnette Overby and Ali Zimmerman,** “The Integrated Approach vs. the Traditional Approach: Analyzing the Benefits of a Dance Integrated Curriculum in Teaching Transportation Concepts,” University of Delaware Undergraduate Research Summer Scholars Symposium, University of Delaware, August 9th, 2014

**Ramanna, Nakul,** “Static and Impact Load Response of Reinforced Concrete Beams and Slabs with NSM-CFRP Retrofitting”, Invited Plenary Session Speaker, International Conference on Recent Advances in Engineering Sciences (ICRAES 2014), Sep 4-5 2014, MSRT Bangalore, India.

**Ramanna, Nakul, Richard Zabel,** Embedment length provisions in ACI 440 2008 for carbon fiber reinforced polymer (CFRP) strips in near surface mount (NSM) retrofitted concrete structures, 2014 PCI Convention & National Bridge Conference, Washington DC, September 6-9, 2014.

**Schumacher, T.** (2014). Novel Sensing Methodologies for Non-Destructive Testing and Structural Health Monitoring. Structural Engineering Seminar. Portland State University, Portland, OR. October 20. (Invited)

**Shariati, A. and Schumacher, T.** (2013). Video-Based Techniques in Structural



Health Monitoring. Review of Progress in Nondestructive Evaluation (QNDE). Baltimore, MD. July 21-26.

Shariati, A. and Schumacher, T. (2014). Oversampling in VVS as a Means to Recover

Higher Modes of Vibration. Review of Progress in Nondestructive Evaluation (QNDE). Boise, ID. July 20-25.

Shariati, A. and Schumacher, T. Video-Based Structural Health Monitoring: A

Review. Special symposium session entitled Structural Health Monitoring of Concrete Structures (Serviceability) at the ACI Fall 2014 Convention. Washington, D.C. October 26-30.

## UD Presentations at the TRB Annual Meeting

Several UD faculty, researchers, graduate students, and former students made presentations or presented posters at the 2015 Annual Meeting of the Transportation Research Board. These included:

### Workshop 187

#### TRACK INSPECTION PRACTICES AND DEVELOPMENTS IN THE INSPECTION OF SPECIAL TRACKWORK.

Analysis of Rail Turnout Profile Data, Allan M. Zarembski, University of Delaware

### Workshop 866

#### STATUS OF LONG-TERM BRIDGE PERFORMANCE PROGRAM

Weathering Steel Study, Jennifer Righman McConnell, University of Delaware; Dennis R. Mertz, University of Delaware Bridge Preservation Committee Summary Of Past Experience And State-of-the-practice In The Design And Maintenance Of Small Movement Expansion Joints In The Northeast, Micah H Milner, Mulhern & Kulp; Harry Shenton, University of Delaware

#### CRUDE OIL TRANSPORTATION SUBCOMMITTEE, AT040(1)

Valuation Based Models and Networks to Determine Conditional Probability of Release of Hazardous Materials from Railroad Tank Cars During Accidents, Nii O Attoh-Okine, University of Delaware

### Session 246

#### TRB'S SAFETY IDEA PROGRAM: SPONSORING INNOVATION IN RAILROAD SAFETY AND PERFORMANCE

Safety Project 23: Reducing Wheel Climb at Switch Points to Reduce Derailments, Allan M. Zarembski, University of Delaware

### Session 250

#### RAILWAY TRACK STRUCTURE MAINTENANCE AND DESIGN

Relationship Between Missing Ballast and Development of Track Geometry Defects, Allan M. Zarembski, University of Delaware; Gregory T Grissom, Georgetown Rail Equipment Company; Todd L Euston, Georgetown Rail Equipment Company; John J Cronin, University of Delaware

### Session 294

#### LIQUEFIED NATURAL GAS AS A MARINE FUEL: OPERATIONS AND INFRASTRUCTURE

Vessel Operations, James J. Corbett, University of Delaware

### Session 299

#### INNOVATIONS IN ASSET MANAGEMENT - BEST PAPERS FROM AISIM

Bridge Evaluation Based on Structural Health Monitoring, Hadi Al-Khateeb, University of Delaware

### Session 503

#### ADVANCES IN AND CASE HISTORIES OF MECHANICALLY STABILIZED EARTH STRUCTURES

Instrumented MSE Wall Reinforced with Polyester Straps, Yushan Luo, Tongji University, China; Dov

Leshchinsky, University of Delaware; Pietro Rimoldi, Maccaferri, Italy; Giulia Lugli, Maccaferri, Italy; Chao Xu, Tongji University, China

### Session 505

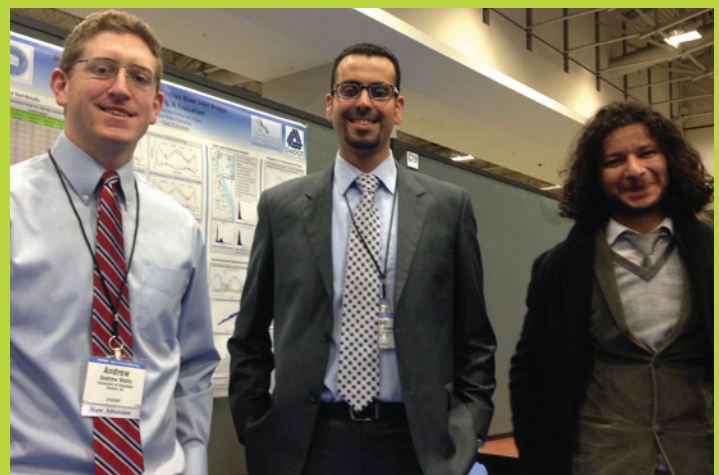
#### INNOVATIVE TEACHING OF HIGHWAY CAPACITY MANUAL PROCEDURES

Problem-Oriented And Project-Based Learning (POPBL) as An Innovative Approach for Teaching Highway Capacity Concepts, Mingxin Li, University of Delaware; Ardeshtir Faghri, University of Delaware

### Session 586

#### CURRENT ISSUES IN TRANSPORTATION ENERGY

Assessing Climate Change Adaptation Practices Across Transportation Planning Agencies: Case Study of Mid-Atlantic Region After Hurricane Sandy, Michelle Renee Oswald Beiler, Bucknell University; Leylin Marroquin, Bucknell University; Sue McNeil, University of Delaware



Hadi Al-Khateeb (center) with fellow students Andrew Wells and Lassaad Mhamdi.



## Opportunities

### FACULTY AND RESEARCHERS: 2015-2016 RESEARCH GRANTS

A call for pre-proposals for UTC research funding for 2015-2016 has been issued. Consistent with the focus of the National UTC the pre-proposals will address State of Good Repair in the following areas:

- Advanced Infrastructure Monitoring
- Innovative Materials
- Large Volume Data
- Construction Maintenance

For a pre-proposal template, please email [ud-utc@udel.edu](mailto:ud-utc@udel.edu).

Our base funding will support three projects. Subject to reviews being completed in a timely manner, the timeline is as follows:

- March 1, 2015: Pre-proposals due – submit to [ud-utc@udel.edu](mailto:ud-utc@udel.edu)
- March 15, 2015: Invitation to submit full proposals
- April 15, 2015: Full proposals due (by invitation only) – submit to [ud-utc@udel.edu](mailto:ud-utc@udel.edu)
- May 15, 2015: Project funding announced.
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### GRADUATE STUDENTS AND FACULTY: CAIT AT UD GRADUATE FELLOWSHIP

The CAIT at UD graduate fellowship is awarded to a student pursuing a master's and PhD degree in an area of relevance to the theme of our National UTC – state of good repair. Applicants may be either new students to the University of Delaware or continuing students. New students must be nominated by a faculty member willing to advise the student. Continuing students may be self-nominated or nominated by their advisors. Applicants must be U.S. citizens. Fellowships are awarded on the basis of academic qualifications, and relevance to the CAIT at UD theme and goals.

The fellowship may be used for the 12 months beginning in Fall 2015 or 12 months beginning Spring 2016.

Fellowships pay a stipend of \$2000 per month for 12 months, and include a \$500 allowance for travel and supplies and a \$1000 allowance for computing. Tuition will be covered assuming CAIT at UD is able to negotiate an arrangement with your college.

Fellowship recipients are required to participate in the activities of the center, including brown bag seminars, distinguished lectures and the research showcase, and conduct research in transportation; however, the fellowships do not directly support specific projects.

Applications consist of the following:

- Application form (attached)
- Transcript
- At least two recommendation letters.
- Statement of research interests, previous research experience (if any), particular interests and career plans, and how the fellowship will contribute to the student's academic and professional development. Statements are limited to two pages (double-spaced, 12-point font). New students may draw their statements from their graduate school applications.

**Application due date is March 1. Please send applications to [ud-utc@udel.edu](mailto:ud-utc@udel.edu)**

### GRADUATE AND UNDERGRADUATE STUDENTS: WTS ANNUAL CONFERENCE

The annual WTS Conference provides opportunities for networking and professional development. Each year CAIT at UD sends at least one student to the annual conference. That means registration, airfare and hotel are covered! In 2015 the conference will be held in Chicago from May 20-22. (See <https://www.wtsinternational.org/networking/annual-conference/>) If you are interested, contact Professor Sue McNeil ([smcneil@udel.edu](mailto:smcneil@udel.edu)), or simply send her a Resume and a one paragraph email indicating why you would like to attend the WTS Annual Conference by **March 9!**

### GRADUATE STUDENTS: AISIM11

The 11<sup>th</sup> Annual **Interuniversity Symposium on Infrastructure Management (AISIM)** will be held in conjunction with the 9<sup>th</sup> **International Conference on Managing Pavement Assets** in Arlington, Virginia on Friday May 22, 2015. University of Delaware graduate students will be hosting AISIM11.

AISIM is a student-run symposium to advance the infrastructure management body of knowledge and applications by providing a forum for information exchange and for professional conversations about ongoing research. Engineers, scientists, and administrators around the world continually analyze state-of-the-art and best practices in this field, seeking innovative solutions in managing assets. The exchange of information and knowledge in infrastructure management is critical to this search for more effective and efficient methods of retaining initial investment. If you are interested in participating in the organization of AISIM or presenting at the conference please contact Offei Adarkwa ([adarkwa@udel.edu](mailto:adarkwa@udel.edu))

### UNDERGRADUATE STUDENTS: SUMMER INTERNSHIP

CAIT at UD is supporting two interns at DelDOT or WILMAPCO for summer 2015. The internship would be for 10 weeks and is intended to provide a student with practical experience. The student would be paid through CAIT at UD, at an hourly rate of \$10 per hr. The placement within DelDOT or WILMAPCO and responsibilities will be based on the student's interests and skills, the organizations needs and the focus of CAIT.

***To apply for the internship, please send a brief cover email, names and contact information of two references, and a resume to [ud-utc@udel.edu](mailto:ud-utc@udel.edu) by 5pm Friday March 1, 2015.***

## Contact Us

Want to learn more about the UTC?

**Watch for our new website – there will be a link from: <http://www.ce.udel.edu/UTC/index.html>**

Want to be notified by email when UDUTC is sponsoring transportation related events? Want to be notified by about UDUTC funding opportunities or graduate fellowships?

**To be added to the email distribution list,  
send an email to Marikka Beach ([marikka@udel.edu](mailto:marikka@udel.edu)).**