

TranSearch

DELAWARE CENTER FOR TRANSPORTATION

YOUR MAIN RESOURCE FOR TRANSPORTATION EDUCATION,
RESEARCH & TECHNOLOGY TRANSFER

FALL 2014 VOL. 14, NO. 2

Dare to be first.



**Delaware Center
for Transportation**

**Department of Civil and
Environmental Engineering**

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University of Delaware Transportation Program

Before the establishment of the Delaware Center for Transportation (DCT) 25 years ago, the University of Delaware's Department of Civil and Environmental Engineering did not offer a concentration for undergraduate students interested in Transportation Engineering. The department had one full time faculty member whose main responsibility was to offer a course in transportation at the introductory level, along with one or two graduate courses. The need for civil engineers who possessed advanced knowledge in the field of transportation and traffic engineering, as well as the existence and need for different projects that professional staff at DelDOT thought were conducive to an academic type approach, were the two main reasons for the establishment of DCT.

Today, many State of Delaware legislators as well as some new employees at DelDOT think of DCT as an organization that only conducts research projects. They are simply not aware of the educational contributions that our Center has made in conjunction with the Civil & Environmental Engineering Department's Transportation program. In addition to conducting major local, state and regional related transportation research, DCT-affiliated faculty and professional staff also train and educate between 30 to 40 engineering, planning and policy students on an annual basis who find jobs and rewarding careers in different transportation organizations. We also have a Technology Transfer program that offers short courses free of charge to DelDOT employees on all

topics related to transportation.

Other than the 4 full-time faculty members in transportation and infrastructure in the Department of Civil and Environmental Engineering, UD also has transportation experts and professional staff across campus such as the School of Public Policy & Administration, College of Business & Economics, Department of Sociology and College of Agriculture. Students who graduate in transportation-related fields find rewarding jobs in academic settings, private companies, consulting firms and government organizations at all levels.

Several UD Transportation graduates have worked for numerous years at DelDOT and many new graduates seek employment with the organization.

Following are statements from select DelDOT employees who have passed through our CEE department:

The UD / DCT Perspective

Monroe C. Hite, III, P.E. '96BCE

I truly appreciate my UD education in the Department of Civil and Environmental Engineering especially the huge impact it had in my life. It was the late Dr. Shinya Kikuchi and Dr. Ardeshir Faghri that inspired me to seek a profession in the transportation field when I was a civil engineering student at UD. While the Delaware Center for Transportation (DCT) was in its infancy during my tenure at UD, the curriculum laid the foundation and framework in preparing me for a future in transportation. Since graduation, I have been fortunate to participate in

the Technology Transfer program to broaden my knowledge in topics related to transportation while employed at DelDOT for the past 18 years. Today, DCT allows my colleagues and me an opportunity to network with other professionals in the transportation field and strategize on how we can strengthen the transportation field and infrastructure by exploring local and global issues as well as new technologies in transportation. The impact was so great that it inspired my sister, Dr. Monique Hite Head, to also seek an education at UD in the Department of Civil and Environmental Engineering. My career in engineering has provided opportunities for me to encourage and share information with many high school students to pursue civil engineering as a lifelong career as well as serving as a mentor/tutor to undergraduates and graduates completing course requirements for graduation. It is without doubt that the impact of my education and experiences from my professors and faculty had a major impact to the Hite Family.

**Adam Weiser, P.E., PTOE
Safety Programs Manager
Delaware Department of
Transportation**

I graduated from the University of Delaware's Civil & Environmental Engineering (CEE) program in 2003 with a BSCE with a concentration in Transportation Engineering. UD's CEE program really crafted me as a Transportation Engineer. When I first started at UD, I didn't really know much about transportation engineering. I

figured I would go into structural engineering, just like everyone else in my freshman class. In my sophomore year, I interned with a construction company that specialized in heavy highway construction. This was my first exposure to roadway design and highway construction and I really enjoyed it. I was then lucky enough in my junior year to take the introductory transportation engineering course taught by the late Dr. Kikuchi. Dr. Kikuchi was really able to open my eyes to transportation engineering and the numerous possibilities that existed. He became my advisor and helped to craft the rest of my education in the transportation field. He was able to put me into contact with several industry representatives, who included other UD graduates and through those interactions I was able to secure a summer internship with a local consulting firm. I think the biggest impact on my choice to continue with transportation engineering was during my senior year being able to take classes such as Geometric Design and Highway Capacity Manual taught by two off-campus

faculty members. Both of these opportunities allowed me to gain additional insight into transportation engineering and really opened my eyes to the numerous possibilities that were available in a career in transportation. Having off-campus faculty teaching these types of courses brought real-world experience and helped to explain the more theoretical side of the education that I had experienced previously. These classes and my internships also gave me a "leg-up" on other transportation engineering students that didn't have similar experiences and allowed me to start my career with some job related experience. UD's CEE program in Transportation Engineering was extremely helpful in jump starting my career and continues to be an important factor in my career today. Without the undergraduate level classes that I attended prior to graduation and some graduate level classes taken after graduation, I would not have been able to generate the knowledge to increase my experience that allowed me to be where I am today as manager of statewide

highway safety programs at the Delaware Department of Transportation. Without the dedication of the faculty at UD, I would not have been able to find my niche.

UD's Transportation Program still impacts my career, even now that I've been out of school for over 10 years. I work with UD faculty on an almost daily basis dealing with Delaware related safety problems, recommending and reviewing research related to state specific safety issues and developing and testing new tools that are being made available to our industry. Most recently, I have had the wonderful opportunity to also be a member of the UD off-campus faculty, teaching a senior level undergraduate/graduate level course in traffic safety. This opportunity has been very important to me as it has given me the opportunity to mold future traffic engineers and prepare them for real-world experiences, similar to the opportunities that I received while a student in the UD CEE Transportation Program.

There's an App for That!

BY MARCIA SCOTT, IPA POLICY SCIENTIST

Motorists in Delaware have a great weapon to fight traffic snarls, weather-related travel delays, and travel restrictions and closures. It's the DeIDOT App. Unfortunately, because most motorists are unaware of the app, they battle on as road warriors through areas impacted by construction, accidents, and congestion.

Last fall, the Institute for Public Administration (IPA) at the University of Delaware was enlisted by the Delaware Department of Transportation's Transportation Management Center (DeIDOT TMC) to conduct a branding and marketing study for its real-time traveler information system. While the November 2012 launch of the DeIDOT App was promoted via the DeIDOT website and press releases, the agency expressed concern that the traveling public lacked sufficient awareness of the app.

DeIDOT TMC developed its real-time traveler system to help motorists make informed decisions about choosing and planning the best trip routes in Delaware. Real-time traffic information and traveler alerts are provided through this system via DeIDOT's website,

traveler advisory radio system, and social media sites. The app features DeIDOT news, events, streaming traffic cameras, live traffic advisories, and real-time interactive traveler information.

The intent of the branding and marketing study was to assist DeIDOT TMC better align the marketing of its real-time traveler information system, along with its priorities for future enhancements, with needs of the traveling public. IPA conducted an extensive literature review and a market/competitive analysis to compare how the DeIDOT App stacked up to apps developed by other state departments of transportation (DOTs) as well as private-industry competitors like Waze, INRIX, Beat the Traffic, and Google Maps. To assess the degree to which targeted customers were aware of and utilized the app, IPA conducted surveys and facilitated several focus groups.

IPA's June 2014 report, Research to Assess Branding and Marketing Needs for DeIDOT TMC's Real-Time Traveler Information System, provides several recommendations, including the need for DeIDOT TMC to move forward with planned app improvements such as voice-guided

navigation, hands-free voice commands, and real-time incident reporting or "crowd-sourced" information. The marketing plan developed by IPA reinforces the need to utilize both traditional and digital marketing tools to attract, retain, and capture new target audience users. Also advised was the need to identify and prioritize DeIDOT TMC staffing support and resource needs. The report is available online at www.ipa.udel.edu/publications/delidot-app-report-2014-06-06-web.pdf.

The IPA research team included Assistant Policy Scientist William (B.J.) DeCoursey, Policy Scientist Marcia Scott, Policy Specialist Sarah Pragg, and Public Administration Fellows Neil Kirschling (MPA '15), Geoffrey Heath (MPA '16), and Rebekah Inman Perry (MPA '14). In addition to her role as a researcher, Ms. Pragg also prepared a promotional flyer (www.deldot.gov/information/pubs_forms/brochures/pdf/DeIDOT-App-Flyer-06-16-2014.pdf) and a large poster now on display at the I-95 Welcome Center in Delaware. IPA plans to continue to work with DeIDOT TMC on app marketing strategies and the implementation of an enhanced customer preference and research strategy.

Driving in Delaware?

Access real-time traveler information at your fingertips with the DeIDOT App.



The **DeIDOT App** provides up-to-the-minute, reliable traffic data that comes directly from DeIDOT's Traffic Management Center (TMC).

Use the **interactive traffic map** to view

-  Live video from over a 100 traffic cameras
-  Round-the-clock travel advisories (incidents)
-  Travel times for the heaviest-traveled roadways
-  Travel restrictions and closures
-  Delay-at-a-glance traffic
-  Roadway weather



Stay informed and avoid delays.

Download the free **DeIDOT App**, for Android and iOS devices.



Events

Detailed travel information about road closures, beach traffic, and special events in Delaware like Firefly Music Festival, NASCAR races, and the Delaware State Fair.



News

Direct connection to DeIDOT press releases and traffic alerts.

Report Traffic Issues

Please contact DeIDOT's TMC 24/7 to report any issues with Delaware's transportation system:

Tap the  icon to contact DeIDOT through the App;

Dial #77 from any cell phone;

Call (302) 659-4600 or (800) 324-8379; or

Email DeIDOTTMC@state.de.us

For emergencies, contact 911.



Social Media

Engage with DeIDOT on Twitter, Facebook, YouTube, and Flickr, as well as DeIDOT's blog.



Radio Station

With one touch, activate a live stream of DeIDOT's traveler advisory radio, WTMC 1380 AM. Perfect for hands-free access to traffic information.



Stay connected.

Like us on Facebook.
[/DelawareDOT](https://www.facebook.com/DelawareDOT)



Follow us on Twitter.
[@DelawareDOT](https://twitter.com/DelawareDOT)

Without your phone?

Access the same real-time traveler information from DeIDOT's website (www.map.deldot.gov) and radio station (WTMC 1380 AM).



www.deldot.gov

produced with assistance from the Institute for Public Administration, University of Delaware | www.ipa.udel.edu

Message from the Director

August 2014



Ardeshir Faghri,
Director

Two events that took place since the publication of our last newsletter make me incredibly proud and honored to have been

affiliated with the transportation program and the Delaware

Center for Transportation at the University of Delaware for nearly 25 years. First, before the end of the last fiscal year, when the State of Delaware legislature held meetings to approve the budget, the line items that pertained to the continuation of research, technical education and other services by the University of Delaware and other academic institutions in the state received unanimous approval. And secondly, a highly competitive national proposal for providing transportation research, education and public service in the mid-Atlantic region by the Delaware Center for Transportation and five other regional universities was awarded by the U.S. Department of Transportation. It is so reassuring that in these times of economic challenge, our representatives and decision-makers both at the state and the national levels appreciate the value of what we provide for the society. It is always affirming to get a pat on the back from organizations that monitor, review and use our products and ultimately pay our bills.

At the State level, our 25 year partnership with the Delaware Department of Transportation and the State of Delaware has secured what we cherish the most – their trust – trust in our research-driven results, in our educating the transportation leaders of our state and trust in knowing that UD thrives on providing the most up-to-date and comprehensive transportation programs so that the constituents of the state can enjoy the safest,

the most efficient and the most environmentally sound transportation services. I send my warmest gratitude to DeDOT, to Governor Markell and to the State legislature for their invaluable support in continuing our programs.

At the federal level through a competitive process, Delaware Center for Transportation received a University Transportation Center (UTC) grant as part of a regional consortium of universities. The grant provides the center with funding to conduct research and technology transfer in the area of environmental sustainability applied to various aspects of transportation engineering and planning in the mid-Atlantic region.

Awarded by the U.S. Department of Transportation (USDOT) the grant funds the research agenda of the newly formed Mid-Atlantic Transportation Sustainability Center (MATS UTC) that is led by the University of Virginia. In addition to UD, consortium members include Virginia Tech, Old Dominion University, Marshall University, and Morgan State University.

The awarding of this proposal is significant in two ways: First, we were able to compete successfully against some of the much larger institutions in the mid-Atlantic region. Second, I can't think of a more important and relevant issue in civil infrastructure engineering than environmental sustainability.

The MATS UTC research program will focus on US DOT's strategic goal of environmental sustainability and focus on five major areas: 1) SUSTAINABLE FREIGHT MOVEMENT-Due to the fact that freight movement is particularly critical in the mid-Atlantic region given the large port facilities, critical trucking routes, extensive rail network and inland waterways, this area is highlighted for emphasis. While the movement of freight plays a key economic role, the impact of freight movement on the environment in the region is significant and must be directly addressed. 2) COASTAL INFRASTRUCTURE RESILIENCE -This area of research was chosen since the majority of the population in the mid-Atlantic region lives

in coastal areas that are directly impacted by the effects of climate change – particularly sea level rise and extreme weather events. Research in understanding the risks and innovative adaptations is necessary. 3) ENERGY EFFICIENT URBAN TRANSPORTATION – The I-95 urban corridor in the mid-Atlantic region experiences extreme congestion. The Washington D.C. and Philadelphia metropolitan areas are among the most congested corridors in the nation. Research will focus on energy efficient, environmentally sound methods to address this urban congestion problem. 4) ENHANCED WATER QUALITY MANAGEMENT-Given the mid-Atlantic's coastal location and important inland waterways, the management of stormwater on transportation facilities is particularly important to protect watersheds. Regional transportation agencies are particularly interested in looking beyond meeting minimum regulations to developing sustainable water quality management practices. 5) SUSTAINABLE LAND-USE PRACTICES -since the mid-Atlantic region is made up of an incredibly diverse mix of densely populated urban areas sparsely populated forested regions, brownfield sites, and others, one-size-fits-all land use policies and practices simply will not work. The center will investigate practices that promote environmental sustainability.

For the first year of the multi-year research agenda, several UD faculty, professional staff members graduate and undergraduate students will conduct research on a variety of core projects. Topics include research on alternative fuels, multimodal transportation facility resilience, mode choice among commuters, land use planning and environmental sustainability, and infrastructure and development patterns to support reduced driving.

We continue sponsoring many more interesting and useful programs at the center. Please refer to our web site at <http://www.ce.udel.edu/dct> for all DCT-related information and inform me if you have any questions. ■

New Project for the Center for Innovative Bridge Engineering

In late March, Dr. Harry "Tripp" Shenton, Chair of the Department of Civil and Environmental Engineering, received notice that his National Cooperative Highway Research Program proposal had been selected for funding. Funded under project NCHRP 12-100, the objective of this research is to develop proposed guidelines with commentary for evaluating and maintaining small movement (4" or less) bridge joints to support the decisions of bridge owners. The proposed guidelines will be presented to the American Association of State Highway and Transportation Officials (AASHTO). AASHTO is a standards setting body that publishes specifications, test protocols

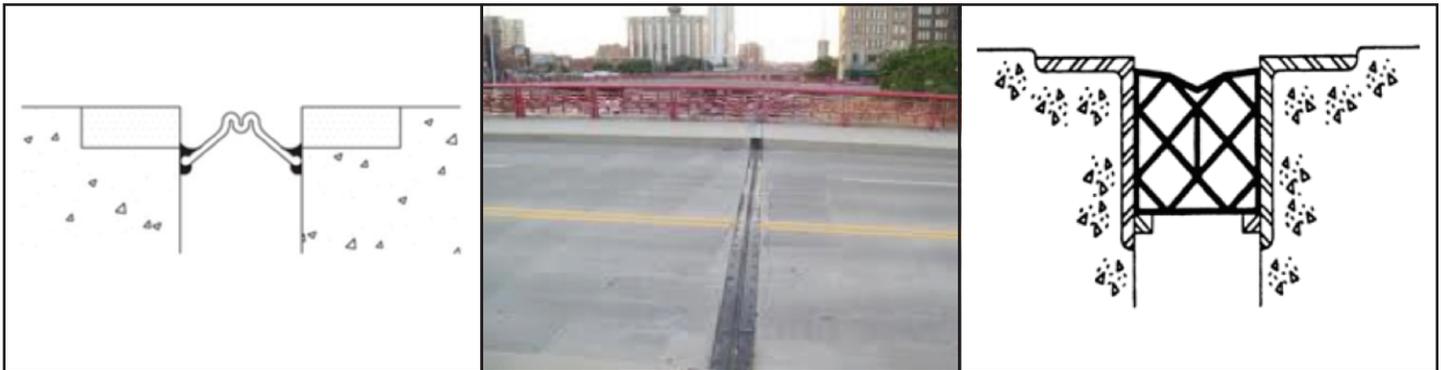
and guidelines that are used in highway design and construction throughout the United States.

Dr. Shenton will be working on the project with Dr. Dennis Mertz, Director of the Center for Innovative Bridge Engineering at UD and Peter Weykamp, formerly the Bridge Maintenance Program Engineer for the New York State Department of Transportation, and now of Greenman-Pedersen, Inc. Each of these individuals has complimentary expertise in the areas of health monitoring of bridges, bridge performance, and current bridge engineering practice.

The principal investigator is looking forward to getting

the research project underway. "We are very excited about the project. For a long time small movement joints have been neglected by the engineering community and have not received the attention they deserve. We look forward to developing guidelines that bridge owners can rely on to provide a higher level of service with their joints."

Throughout the course of the 18 months of the project, the team will address typical modes of failure, performance metrics to select the best performing bridge joints, and procedures for maintenance, repair and replacement of small movement joints.



University Team Examines Track Conditions

As part of a Delaware Department of Transportation (DelDOT) sponsored project which investigates the ability of Delaware short line railroads to handle heavy axle load freight cars, a University of Delaware team under the direction of Professor Allan M. Zarembski, Director of the Railroad Engineering and Safety program in the Department of Civil and Environmental Engineering, conducted an inspection on June 24th of several miles of track on the Snow Hill line of the Maryland and Delaware Railroad in the vicinity of Selbyville. The team included Professor Nii Attoh-Okine, and graduate students John Cronin, Dan Einbinder and Dewan Hossain. The team was accompanied by Eric Calloway, President of the Maryland and Delaware RR and Scott Harris, Assistant General Manager of the railroad.

The purpose of the inspection was to examine the track condition to include the rails, ties, ballast and track geometry and to assess what the impact of heavy freight cars are on the line. A portion of the line is built with a heavy rail section and currently allows these heavy freight cars which weigh 286,000 lbs. The remainder of the line has a light rail section and as such does not permit operation of these heavy cars but rather limit car weight to 263,000 lbs.



From left: John Cronin, Dewan Hossain, Prof. Nii Attoh-Okine, Dan Einbinder and Prof. Allan Zarembski

DeIDOT Publishes ADA Transition Plan

The Americans with Disabilities Act (ADA), through its Title II enabling regulations (28 CFR Part 35), requires that public entities complete a self-evaluation of its services, policies, and practices to identify elements that do not comply with ADA and initiate a program to correct deficiencies. This, of course, includes any buildings, pedestrian pathways, sidewalks, crosswalks, and so on. For entities employing 50 or more employees, a transition plan is required to set forth the steps necessary to complete such remedies. Transition plans must (pursuant to 28 CFR Part 35 Sec. 35.150):

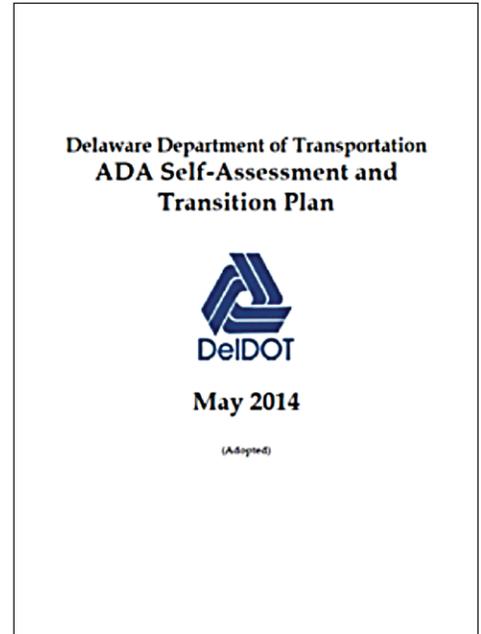
- i. Identify physical obstacles in the public entity's facilities that limit the accessibility of its programs or activities to individuals with disabilities;
- ii. Describe in detail the methods that will be used to make the facilities accessible;
- iii. Specify the schedule for taking the steps necessary to achieve compliance with this section and, if the time period of the transition plan is longer than one year, identify steps that will be taken during each year of the transition period; and
- iv. Indicate the official responsible for implementation

of the plan.

The Delaware Department of Transportation (DeIDOT) has recently prepared and published its Transition Plan, which can be viewed at DeIDOT's website at <http://ada.deldot.gov>. The Transition Plan includes DeIDOT's self-evaluation of buildings, pedestrian corridors, transit facilities, rest facilities, and toll plazas under its maintenance authority. The plan then goes on to discuss how DeIDOT will remediate barriers and other deficiencies over time.

Many local and state agencies across the country are far behind schedule in completing self-evaluations and transition plans (which were to be prepared by July 1992 and updated regularly). The Department of Justice has increased pressure for state agencies to complete transition plans and the Federal Highway Administration has increased its outreach and education campaign as well.

All public agencies should complete a self-evaluation as soon as possible, including those sidewalks along DeIDOT maintained streets, as the maintenance for those facilities generally falls to the municipality. For many municipalities, this can be a time consuming



activity with few existing staff available for its completion. The Delaware T²/LTAP Center has worked with several Delaware municipalities to provide technical oversight to engineering interns hired by the municipality. Any local agency needing assistance should contact Matt Carter, our Municipal Engineering Circuit Rider, at (302) 831-7236 or matheu@udel.edu.

Delaware and New Jersey LTAPs Team to Present ADA Training in Newark (Delaware)

The Delaware T²/LTAP Center's Matt Carter teamed up with the New Jersey LTAP's Ted Green to teach "Designing Pedestrian Facilities for Accessibility (DPFA)," a two-day training course on the Americans with Disabilities Act (ADA) focused on many of the design elements in the standards that support the Act. Matt and Ted are among a handful of nationwide trainers certified to teach the Federal Highway Administration developed course and have taught the course together twice before at Rutgers University, where the New Jersey LTAP is located. Finally, Matt and Ted were able to bring the course to the University of Delaware, and thirty-eight representatives of municipal and state transportation agencies, the Federal Highway Administration, and several design consultants participated in the course on the Newark campus.

The training accomplishes several goals. To be sure, it goes into some depth regarding technical specifications necessary for complying with ADA

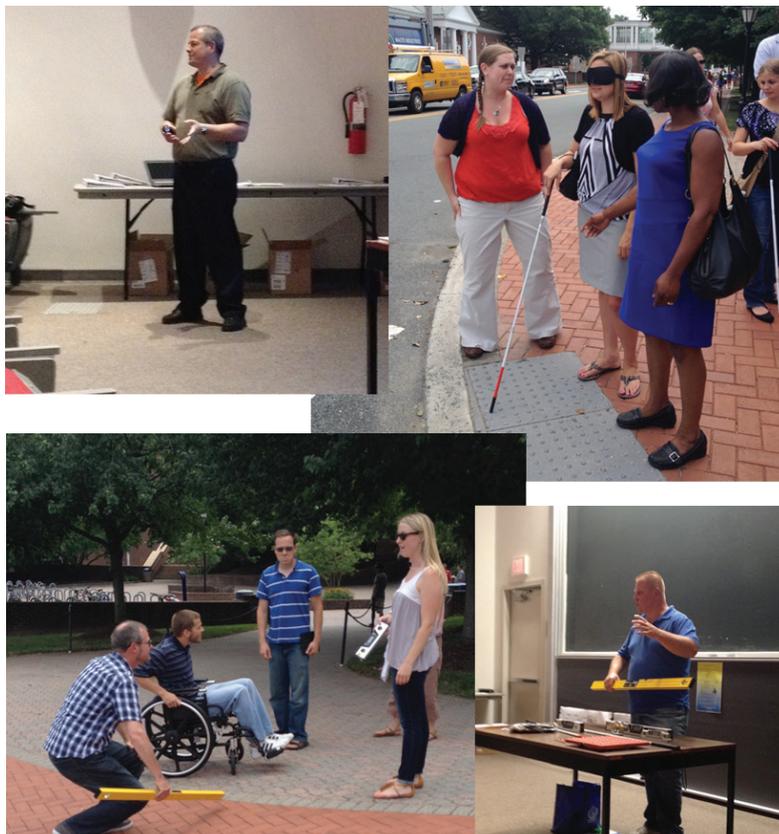
in the public right of way. However, the course has many elements that help raise a designer's awareness of the varied disabilities they must have in mind, the occasional conflicts in needs between those disabilities, and how the nuances of the various standards and guidelines can move the disabled community to a more similar accessibility as that experienced by other pedestrians.

A significant tool to accomplish this is the outdoor exercise. Training participants were taken outside to the pedestrian mall areas adjacent to Kirkbride Hall and the Trabant Student Center. There, participants took turns in several wheelchairs while others donned blindfolds and picked up white walking canes. Accompanied by one or more spotters, these participants received a small insight into the physical demands, dangers, frustrations, and disorientation that are encountered by just these two disabilities. With traffic buzzing by, they courageously navigated crosswalks and attempted

to follow the sidewalks without stepping into the travel lane. There was lots of laughter and good hearted ribbing of each other, but there were also many "aha" moments where participants "got it."

That participants were engaged in the material also became evident when a challenge from the instructors to find interesting examples of good, bad, and unusual accommodation practices in their travels for coffee, pastries, and lunch resulted in more than two dozen examples brought in after lunch on the second day.

We thank Ted Green for visiting Delaware to co-teach the course and also the training participants themselves, who brought experience and questions with them that proved instrumental in a better understanding of the challenge and the creative solutions we can use to better accommodate all pedestrians.



Local Governments Continue to Gain Handle on Traffic Sign Compliance

Again this summer, the Delaware T²/LTAP Center is providing engineering and technical oversight for local agencies as they employ engineering interns to gain a handle on their traffic sign inventory and compliance with such elements as retroreflectivity, sign size, mounting height, offset from roadway, and the use of breakaway or yielding posts.

In the City of Newark, Brigid Deely and Aaron Campbell are collecting a host of sign data using the City's

retroreflectometer and a GPS data collector from the Delaware T²/LTAP Center. Their data will be compiled into a single set that will be reflected as a shape file in the City's GIS system and will enable the Department of Public Works to evaluate priorities for sign and sign assembly replacement.

In Cecil County, Maryland, Ben Fisher is completing a second tour of duty with the Department of Public Works, having started to collect sign data for the

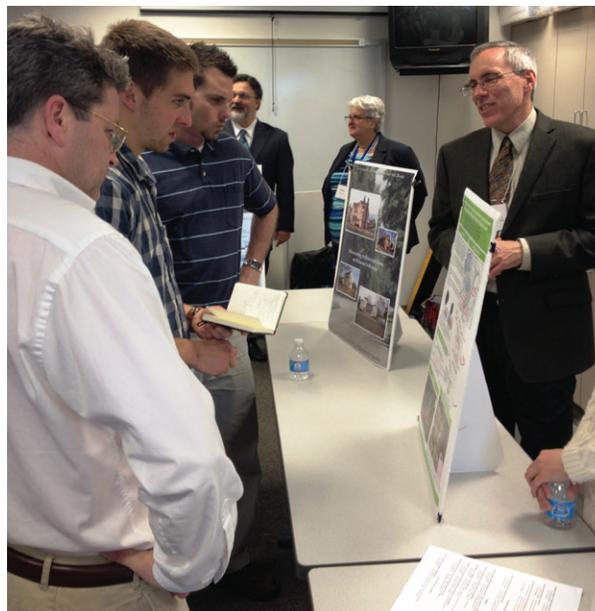
Roads Division last summer. Ben is using the County's retroreflectometer and a GPS data collector from the Delaware T²/LTAP Center. Again, his data will be reflected as a shape file in the County's GIS system.

In both instances, the Delaware T²/LTAP Center is providing training, technical oversight, and equipment to support these local agency efforts to better understand their transportation assets and manage them more effectively in the future.



11th Annual Research Showcase

Over 100 guests attended the Delaware Center for Transportation (DCT) Research Showcase held on May 7th at the University of Delaware's Paradee Center. The annual showcase, in its 11th year, highlighted the current research projects funded by the Delaware Department of Transportation and the US Department of Transportation. Featuring 22 poster displays on DCT projects in the areas of environment, pavement & materials, planning, policy, soils, bridges and structures, traffic and intelligent transportation systems (ITS), as well as projects from the University Transportation Center (UTC) program. Hosting this event provides the opportunity for researchers and interested parties to meet and discuss current projects in civil and environmental engineering, public administration and extension. Guests included representatives from DeIDOT; Delaware Transit Corporation; Federal Highway Administration, local government; University of Delaware undergraduate students; as well as representatives from Advanced Infrastructure Design, RK&K, Davis Bowen & Friedel, H4 Design, Hardesty & Hanover and JMT. As an added bonus, guests were offered a scoop of UDairy Creamery ice cream while viewing the presentations. We extend our thanks to the Federal Highway Administration, US Department of Transportation and the Delaware Department of Transportation for supporting our Center's research and outreach activities.



RESEARCH

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

1687-A LIGHTING-URBAN DESIGN

Principal Investigator: Ardeshir Faghri

1687-B PAVEMENT-STORMWATER

Principal Investigator: Ardeshir Faghri

1687-C SURVEYING-STATISTICS

Principal Investigator: Tibor Toth

1687-D STORMWATER-NUTRIENT REMOVAL

Principal Investigator: Paul Imhoff

1687-E BRIDGE-ENGINEERING SPECIFICATIONS

Principal Investigator: Harry Shenton

1687-G PAVEMENT-INSPECTION

Principal Investigator: Sue McNeil

1687-H TRAFFIC-SAFETY

Principal Investigator: Mingxin Li

1687-J MULTI-MODAL TRAVEL MODELING

Principal Investigator: David Racca

1687-K TRAFFIC-SAFETY

Principal Investigator: Mingxin Li

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

DEVELOPMENT OF A STATEWIDE TRAVEL SPEED SURVEY

This research seeks to substantially improve statewide travel speed and travel time monitoring by considering a range of data sources while also creating a statewide data set to meet immediate performance measure needs, respond to concerns, support policy decisions, and evaluate impacts of growth and effects of remedial actions. Ending 8/31/14

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

Project Manager: Mark Eastburn, Division of Planning

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS – PILE DOWNDRAG DESIGN PROVISIONS

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

RESEARCH TO INTEGRATE MASTER PLANS WITH THE LOCAL DEVELOPMENT APPROVAL PROCESS

This project will research best practices and set forth strategies to integrate local government master plans with local government processes to attract developers to “market-ready” sites. Research outcomes will be summarized in a downloadable and user-friendly “how-to guide” for Delaware local governments. Ending 10/31/14

Principal Investigator: Marcia Scott, Institute for Public Administration

Project Manager: Ralph Reeb, Division of Planning

DELAWARE TRANSPORTATION LIGHTING INVENTORY AND ASSESSMENT

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

INTEGRATING ZERO-VALENT IRON AND BIOCHAR AMENDMENTS IN GREEN STORMWATER MANAGEMENT SYSTEMS FOR ENHANCED TREATMENT OF ROADWAY RUNOFF – PHASE II

This continuing project will evaluate two technologies involving the addition of biochar and/or zero-valent

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>.

iron to existing and new stormwater facilities which will reduce nutrients from DelDOT stormwater discharges.

This phase will be the field demonstration. Ending 12/31/14

Principal Investigators: Dan Cha and Paul Imhoff, Department of Civil and Environmental Engineering

Project Manager: Marianne Walch, Maintenance and Operations

FY14 GPS TRAVEL TIME AND DELAY DATA COLLECTION AND ANALYSIS

This project entails data collection during peak travel times on roadway segments throughout the state. Each segment will be traveled at least four times for maximum accuracy. Once data collection is completed, data will be transformed into the GIS database and transported to the ARCGIS software. Ending 12/31/14

Principal Investigator: Arde Faghri, Department of Civil and Environmental Engineering

Project Manager: Mark Eastburn, 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

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

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

FY14 LAB BASELINE SERVICE

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

INCREMENTAL PARK AND RIDE DEMAND MODEL

The objectives of this research project are to develop a model to estimate the number of incremental parking spaces required as a result of proposed residential or commercial development for railway and bus-based park & rides. Ending 8/31/14

Principal Investigator: Bintong Chen, Lerner College of Business and Economics

Project Manager: Cathy Smith, Delaware Transit Corporation

REVIEW OF EXISTING PAVEMENT CONDITION RATING SYSTEM

This project will analyze the accepted level of variation among the various measurement methods. This would allow the agency to switch between methods (and vendors) with more confidence that the results are valid. Ending 8/31/14

Principal Investigator: Nii Attoh-Okine, Department of Civil and Environmental Engineering

Project Manager: Jennifer Pinkerton, Materials and Research

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

DELMARVA FREIGHT STUDY

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

EVALUATION OF SMART GROWTH DEVELOPMENT PATTERNS AND EFFECTS ON TRANSPORTATION

This project will identify and evaluate the effects of: 1) alternate locations in Delaware for hypothetical residential and mixed-use communities, and 2) alternate street forms and interconnectivity levels for these hypothetical communities in Delaware. Ending 8/31/14

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

Project Manager: Mike DuRoss, Division of Planning

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

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

ABANDON, REPAIR OR IMPROVE ROADS IN THE FACE OF CLIMATE CHANGE?

The objective of this research is to provide DelDOT

with a defensible strategy for determining whether to maintain road repeatedly damaged by flooding and to develop decision trees to quantify systematically the impacts of the decision to abandon, repair or improve a road given the uncertainty associated with climate change. Ending 8/31/14

Principal Investigator: Sue McNeil, Civil and Environmental Engineering

Project Manager: Rob McCleary, Chief Engineer

CAPACITY OF REINFORCED CONCRETE MOMENT FRAME CULVERTS

This research project will assess the latest bridge analysis procedures and conduct full-scale laboratory experiments to develop a new evaluation methodology specifically for concrete moment frame culverts. Ending 8/31/14

Principal Investigator: Thomas Schumacher, Department of Civil and Environmental Engineering

Project Manager: Ping Jiang, Bridge Management

FY13 LAB BASELINE SERVICE

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 DeIDOT; 2) training for DeIDOT and support classroom instruction; and 3) research for faculty and students. Ending 8/31/14

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

Project Manager: Gene Donaldson, Transportation Management Center

FY13 TRAVEL DEMAND MODELING SUPPORT

Support for this project will assist DeIDOT with the development, maintenance, application and evaluation of a travel demand forecasting model. The model supports planning studies for Delaware's MPOs and various DeIDOT sections on an as-needed basis. Ending 8/31/14

Principal Investigator: Rusty Lee, Department of Civil

and Environmental Engineering

Project Manager: Mike DuRoss, Division of Planning

BASELINE MONITORING AND TESTING OF THE INDIAN RIVER INLET BRIDGE (IRIB)

This project is phase 2 of the long-term structural health monitoring (SHM) system on the Indian River Inlet Bridge. These funds will be used to conduct various baseline tests, studies, and analyses to characterize the baseline performance of the bridge as a permanent record for the future. DeIDOT will be able to understand how the as-built bridge is functioning and through long-term monitoring, will be in a better position to efficiently and effectively manage this significant resource. Ending 12/31/2014

Principal Investigators: Tripp Shenton and Michael Chajes, Department of Civil and Environmental Engineering and College of Engineering

Project Manager: Barry Benton, Bridge Management

Research Pays Off: Cost–Benefit Analysis of Added Cycling Facilities

MINGXIN LI AND ARDESHIR FAGHRI

MINGXIN LI, *Research Associate II, Department of Civil and Environmental Engineering, University of Delaware*

ARDESHIR FAGHRI, *Professor, Department of Civil and Environmental Engineering, University of Delaware.*

It is well acknowledged that cycling is one of the most energy efficient and healthy transport modes followed closely by walking. A wide range of approaches and models have been devoted to finding ways to increase the proportion of cycle trips. However, there exists significant uncertainty regarding the level and effectiveness of added cycling facilities. Few studies have been carried out in the detailed cost-benefit analysis (CBAs) for added cycling facilities. The aim of this research is to fill this knowledge gap by proposing a comprehensive methodology to estimate the most important benefit components and expenses associated with the installation of bicycle facilities and gain a better understanding of the strategies used to identify their effect.

PROBLEM

The majority of the research interests in the field of CBAs were concentrated on assessing the impacts of road investment projects in USA and many other countries. Since transportation planners have been faced with considerable challenges in trying to estimate the benefits of bicycle facilities, a favored approach to estimate the cost of various bicycle facilities involves cost–benefit analysis of cycling policy options incorporating estimation of both direct benefits to the users of the facilities and indirect benefits to the community. In addition, many significant questions remain to be addressed, particularly regarding the costs that should be monitored and recorded and quantitative and qualitative benefits which can be attained through investments in policies and initiatives, in particular those related to the implementation of sustainable transport policies, such as cycling. For example, one of critical challenges concerning the economic appraisal of health effects related to cycling is the relationship between observed cycling and total physical activity. In other words, how cycling might influence total physical activity? Also, many consider spending public monies on cycling facility a luxury due to lack of identified and quantified benefits in the current literatures. How to evaluate the benefit of new bicycle facilities and justify these investments? And how long does it take for an investment to pay for itself?

SOLUTION

One of the most widely used economic evaluation method in transportation investment is cost benefit analysis which yields estimates of costs and benefit of different types of transportation facilities. It is worth noting that cost-benefit analysis determines the most cost-effective solution, not simply the least cost solution. In this research, a general framework for identifying the effects of adding cycling facilities into an existing road infrastructure was provided to quantify or value the costs and benefits relative to bicycle facilities. This research seeks 1) to establish a standard analytical approach for analysis and documentation 2) to analyze cycling investment from an economic framework with cost-benefit setting, and 3) to provide planners, transportation specialists and health advocates with detailed economic analysis worksheets to determine the full costs and benefits of promoting bicycling in urban and suburban areas.

METHODOLOGY

Investment projects such as adding new cycling facilities to increase levels of walking and bicycling may affect a wide range of parameters relating to economics, the mobility, environment and health. In order to identify outputs, for example, the cost and monetary benefits for society, it is necessary to enter the characteristics about the size and type of a proposed facility as input before conducting a complete and comprehensive CBA. This would have to cover all relevant aspects, including those on population, mode share rate, demand, human health and the environment. The planners and other transportation specialists might input minimal specifications to receive a simplified approximate estimate or enter highly detailed information that will allow for a more complete and accurate analysis

(Figure 1). Valuation techniques and the cost of the cycling project and health effects in a CBA of development of infrastructures for cyclists are provided.

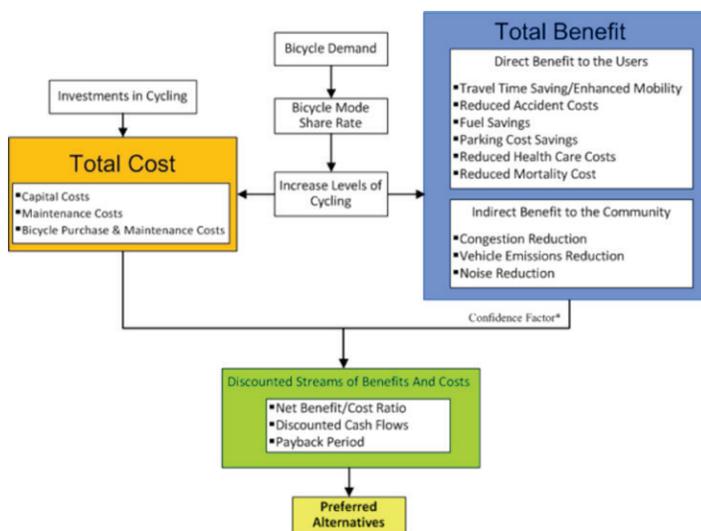


Figure 1. Conceptual framework of the cost-benefit analysis.

To reasonably identify, apply, and project the costs for each alternative, the cost analysis provides a comprehensive estimate of the costs for cycling projects, which are typically broken into two major categories: capital costs and maintenance/operating costs including pavement, drainage, traffic controls, and landscape maintenance. The construction cost level depends on categories of bicycle facilities: on-street, off-street, and equipment. Cycling facility maintenance costs depend on numerous factors such as location, volume of use, types of use, pavement type, and level of voluntary participation.

Once the cost categories have been developed, the transportation specialists must identify the profiles of benefits that apply to each feasible alternative over the systems life. The main categories of quantifiable benefits of the cycling project are: direct benefit to the cyclists themselves and indirect benefits to the community. Direct benefit include enhanced mobility, increase in physical activity, reduced health care, reduced mortality, fuel savings and decreased crashes. Indirect benefits to the community include decreased congestion, reduced pollution, improved livability, and increased economic activity.

APPLICATION

The cost-benefit analysis tool provides urban planners, transportation specialists and public health advocates with the information necessary to evaluate investments in bicycling. The analysis provides the estimated costs of different bicycle investment options and the benefits to be derived from each feasible alternative.

A case study in the State of Delaware is presented to demonstrate how the approaches can be employed to assess the impacts of road investment projects. The Wilmington to New Castle Greenway (Figure 2) is the transformation of an abandoned railroad right-of-way into the Whittier Greenway Trail, a 6-mile recreational and commuter bikeway and pedestrian path. It will connect two major cities almost entirely by off-road trail facilities. The Trail begins from SR 273 in the City of New Castle and travels through the Christina River north of Interstate 495, linking schools, homes, transit stops, parks, and shopping areas. The trail has very few at-grade road crossings, providing a lush greenbelt for walking and bicycling.

In order to compare the effects of different variables on economic results, sensitivity analysis (or “what

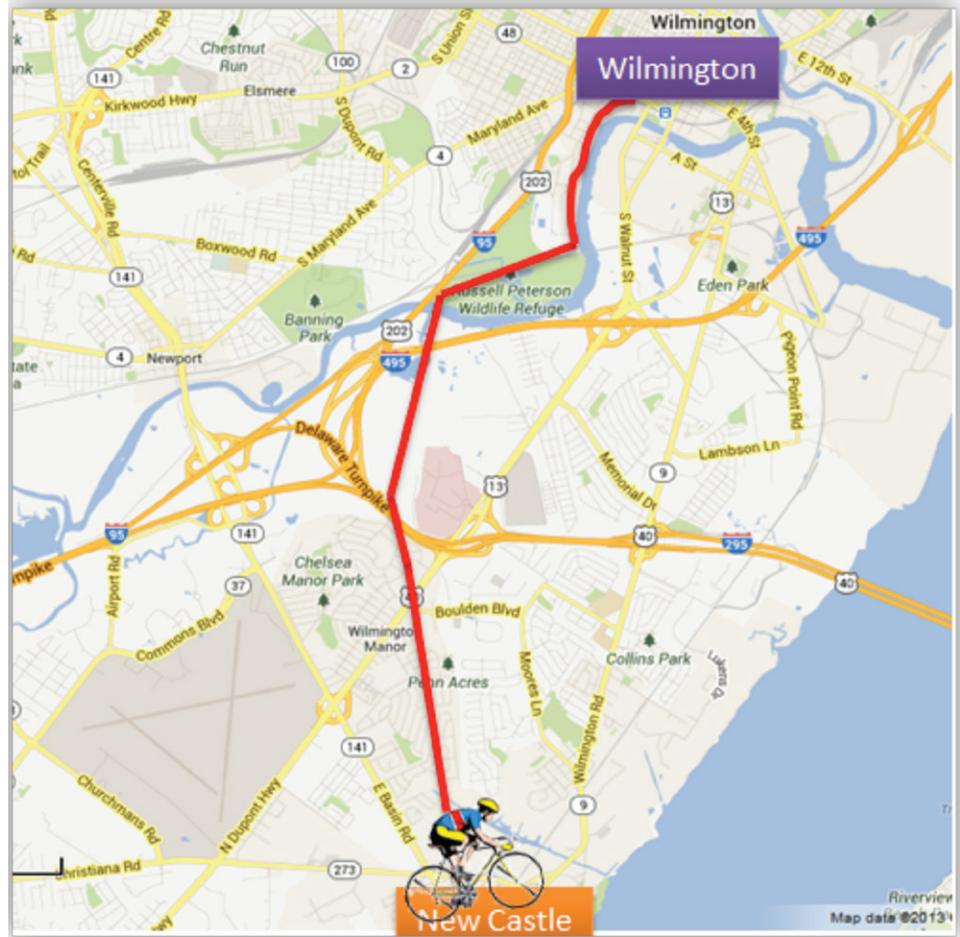


Figure 2. Wilmington to New Castle Greenway.

if” analysis) was used to emphasize areas where improvements to cycling facility may have the greatest economic impacts and performance. Sensitivity analysis highlighted that the greatest gains to be

realized in improving both direct and indirect benefit were those associated with increasing the capacity of facility, increasing the mode share rate of cycling, and decreasing the capital cost of cycling facility.

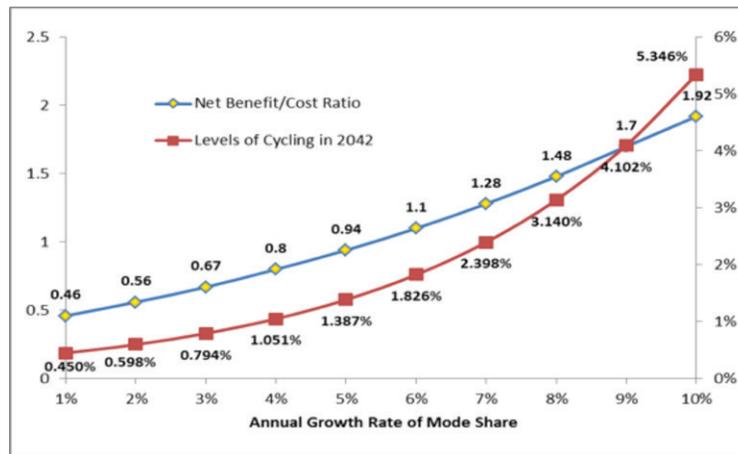


Figure 3. Net benefit/cost ratios and levels of cycling at different annual growth rate.

Within the scope of this research, the effect of annual growth rate on the net benefit/cost ratios and levels of cycling was studied by means of a sensitivity analysis of cycling projects. The results indicated strong economic viability with positive benefit/cost ratios. Moreover, an increase of up to 10% in the mode share

increases the net benefit/cost ratio to 1.92 and the first conclusion that can therefore be drawn is cost-benefit analyses of cycling infrastructure generally produce positive net benefit/cost ratios (Figure 3). However, the question that emerges is how long it takes for an investment to pay for itself, in other words, how

rapidly the decision maker can expect confirmation that he or she has made a good choice. Hence, a second sensitivity analysis is further discussed concerning discounted payback period.

Discounted Payback

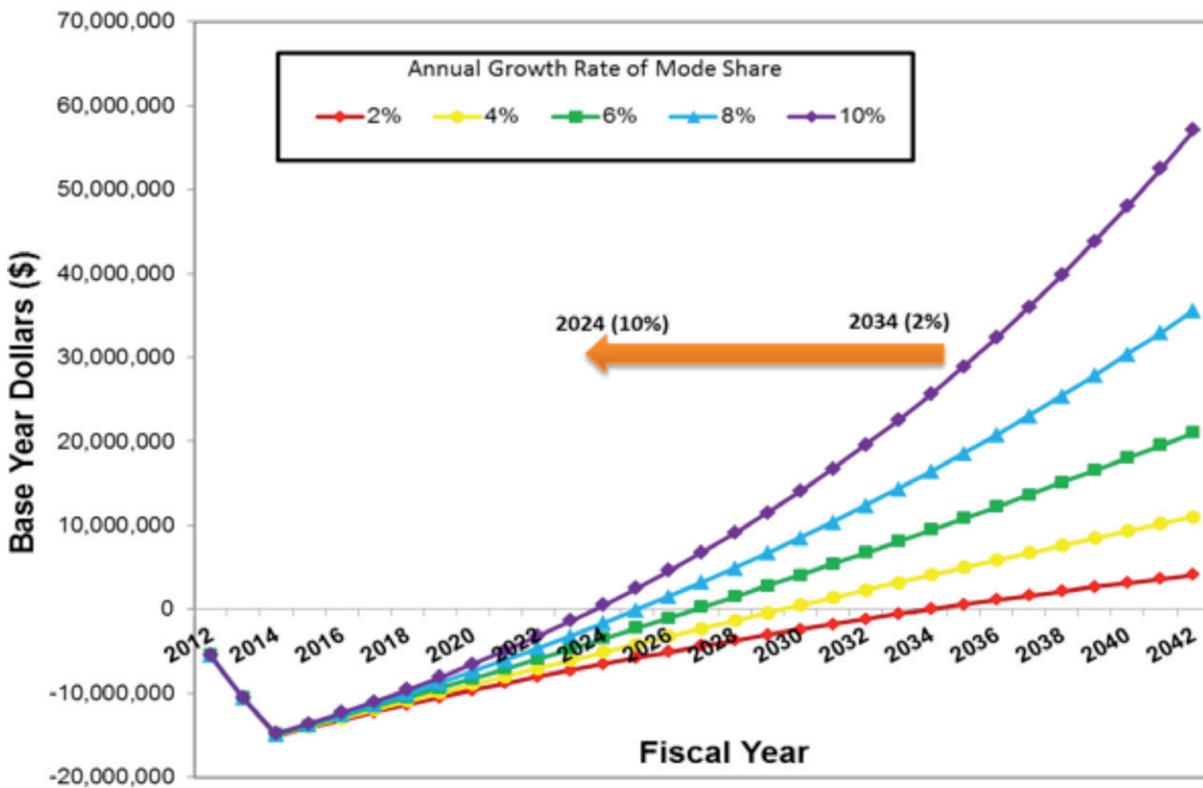


Figure 4. Estimated discounted payback period.

As a supplement to profitability measurements, the discounted payback period, where savings are discounted to their present worth before equating to the initial expenditure, is reached during the study period (Figure 4). The longer a project's payback period the greater the uncertainty or risk of future returns. As shown in Figure 4, the discounted payback year lies between 2024 and 2034, i.e., the project has been fully paid back in 2034 when the mode share of cycling increase 2% per year or 2024 if the mode share increase 10% per year. These findings justify the use of the

framework in bicycle facility selection or analysis of the characteristics of the existing bicycle facility.

TECHNICAL BENEFITS

The research provides quantitative techniques for transportation planners to understand and interpret many of the interrelated processes, the healthy and environmental benefit from improved cycling facility, and the economic constraints faced by transportation decision makers. The cost benefit analysis spreadsheet can be used as part of the compendium of supporting

materials. This research focuses primarily on cycling, but its findings may also be easily applied to other active modes, such as walking, skateboarding, and manual wheelchairs.

(Note: This paper has been identified as the only practice-ready paper of cycling policy and facility evaluation session at the 2014 TRB Annual Meeting. A practice-ready paper is defined as "a paper which should make a major contribution to the solution of current or future problems or issues.")

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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UTC NEWS
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RESILIENCY OF TRANSPORTATION CORRIDORS

PUBLISHED BY THE UD UNIVERSITY TRANSPORTATION CENTER

FALL 2014

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Director's Message

Congratulations to Delaware Center for Transportation (DCT) Director Professor Arde Faghri! Professor Faghri spearheaded UD's participation in the consortium that was awarded a regional UTC known as the Mid-Atlantic Transportation Sustainability (MATS) Center. Led by University of Virginia, in addition to UD, consortium members include Marshall University, Morgan State University, Old Dominion University and Virginia Tech. With a strong connection to the Institute of Public Administration (IPA) at UD and a focus on the environment, MATS-UTC complements our research, education and outreach funded through CAIT as a National UTC focused on state-of-good-repair. We look forward to working with MATS-UTC and a continued relationship with DCT and IPA.

Meanwhile, participants in CAIT at UD continue to work on research and communicate the outcomes of our research, both in the classroom and to the professional community. This newsletter describes some of these

activities including providing a synopsis of the four reports published this spring and new projects starting this fall, and an overview of the activities our students have been engaged in including participation in the WTS Annual Meeting, the Infrastructure Management "Bootcamp", the Annual Interuniversity Symposium on Infrastructure Management, and the ENO Leadership Development Conference. We also list some of the recent events related to and products of our work.

Our UD-UTC Tier 2 grant has now ended. Our theme was "Resiliency of Transportation Corridors" with a summary included below. We are proud of our accomplishments (especially our graduates) and are pleased that we can continue to contribute to transportation research and education through the UTC program, first as a Tier 1 UTC as part of the CAIT consortium and now as both a National UTC continuing as part of the CAIT consortium and as participants in the new Regional UTC - MATS-UTC

Sue McNeil

Professor, Department of
Civil & Environmental Engineering

Director and Managing Editor
Sue McNeil

Design
University of Delaware College of
Engineering communications team

UD-UTC: Resiliency of Transportation Corridors (2006-2013)

Over the course of the grant, UD-UTC received 50 proposals and funded 27 projects. These projects involved five different colleges at UD. In 2010, a project to develop a Transportation Performance Index was funded by the US Chamber of Commerce Foundation. This project was completed in 2012. These projects, supported by UTC funds or matching funds have resulted in 55 reports, dissertations and theses that are listed on the UTC website. Ninety three graduate students who worked on UTC related projects completed their degrees. We are very proud of our graduates. They have taken on faculty positions in transportation; they are working for consultants and government agencies in states as far afield as Mississippi and Vermont; and some are pursuing higher degrees.

In addition several companion projects were funded by DelDOT including:

- Infrastructure Security and Emergency Preparedness: Selecting Asset Protection Strategies
- Abandon, Repair or Improve Roads in the Face of Climate Change?
- Pavement Performance Models for Delaware

Reports from these projects can be found on the Delaware Center for Transportation website (<http://www.ce.udel.edu/dct/Publications.html>)

Other accomplishments include:

- Seventy conference presentations stemming from UTC related projects were made and sixteen papers have been published or are scheduled to appear in archival journals.
- Sixteen graduate student fellowships were awarded over the course of the grant. We also supported six undergraduate summer research fellowships.
- A new course, CIEG 650 Urban Transportation Systems was initiated in fall 2007. It was co-taught by Professors McNeil and Lee. The course provides an introduction to transportation systems. The objective is to provide an overview of transportation issues, both freight and passenger, and qualitative and quantitative tools for addressing these issues. The class engaged several guest lecturers.

Our community came together with other transportation professionals in the Delaware region and beyond to listen to Distinguished Lectures, participate in brown bag discussions and engage in workshops and conferences. The transportation courses offered as part of our UTC emphasize the multi-disciplinary nature of transportation and we have encouraged our students and faculty to think beyond their traditional disciplines.

Our researchers shared the products of their research at conferences and meetings and also initiated and enhanced collaborations with Delaware Department of Transportation, Federal Highway Administration and the Maritime Administration drawing on knowledge gained as part of UTC funded projects.

As we transition from UD-UTC to CAIT at UD we continue to build on the legacy of the UD-UTC. This is an exciting opportunity to strengthen our work through further collaboration, and to bring our breadth of expertise to the rigorous engineering projects that CAIT at Rutgers have developed to support state of good repair. Working together this partnership will continue to improve the resilience of transportation corridors through reliable, efficient and cost effective infrastructure that is safe and supports economic development.

Recently Completed CAIT at UD Projects

The first round of projects funded through the CAIT collaboration have been completed and final reports posted to the CAIT website. The following are brief synopses of the projects.

QUANTITATIVE ACOUSTIC EMISSION MONITORING OF FATIGUE CRACKS IN FRACTURE CRITICAL STEEL BRIDGES

Principal Investigators: Thomas Schumacher and Jennifer McConnell (Civil and Environmental Engineering)

Graduate Student: Andrew Chen

Despite decades of active research on the topic of fatigue cracks in steel bridges, this remains a common problem. With the increasing use of skewed and curved bridges, and the aging of the existing population of this bridge type, distortion-induced fatigue in particular is a growing problem. Similarly, there are ongoing concerns regarding fatigue cracks in fracture critical bridge members, which can have disastrous consequences to the infrastructure and public safety. One common solution to stop a detected crack is to drill a so-called crack-stop hole at the end of a crack. However, the optimum size for this hole has not been entirely certain, as the minimal size to ensure a crack is indeed locked was recently re-evaluated. Furthermore, detecting fatigue cracks can be difficult because of their small size and tendency to develop in locations that are difficult to inspect such as gusset plate connections or web gaps.

Because detecting fatigue cracks can be difficult, methods for stopping fatigue cracks can be uncertain, and questions remain in understanding the micromechanics of fatigue crack propagation, there is the potential for these situations to be better understood and remedied through the application of a promising technique that has been applied for a variety of applications: Acoustic Emission (AE) monitoring. AEs are the result of sudden strain releases within a body and directly related to energy release due to fracture processes. The method is thus especially well-suited to monitor crack initiation and progression and can provide quantitative real-time feedback of fracture critical details, for example, on steel bridges.

For detection of fatigue cracks, typically qualitative AE methods have been employed that attempt to establish empirical relationships between AE parameters and crack growth based on measurements from a few sensors. These methods may work for a specific tested geometry but may not be transferable to a real bridge. Also, noise discrimination can be a problem since these methods are not event-based, i.e. they do not attempt to locate the source. Additionally, resonant sensors are typically used resulting in recorded signals that are heavily distorted by the sensor characteristics, that is, the real source characteristics are lost. Quantitative AE methods attempt to explain the source mechanisms (or fracture mode) employing a sensor network with at least eight sensors. The analysis method proposed for this project is called moment tensor inversion and was originally developed in the geosciences. This method is capable of inferring on the source mechanism and give estimates of the source magnitude similarly to earthquake magnitude. With the recent availability of true high-fidelity AE sensors, quantitative AE analysis methods are finally becoming a feasible means for monitoring and characterizing of fracture processes. These quantitative AE methods for monitoring and characterization of fatigue cracks in steel bridges have tremendous potential for addressing problems such as detecting fatigue cracks in fracture critical steel bridges, assessing the effectiveness of distortion-induced fatigue retrofits, and understanding the micromechanics leading to crack propagation in structures subjected to variable multi-axial loadings.

Products:

Final Report: <http://cait.rutgers.edu/cait/research/quantitative-acoustic-emission-monitoring-fatigue-cracks-fracture-critical-steel-bridg>

BETTER STATE-OF-GOOD-REPAIR INDICATORS FOR THE TRANSPORTATION PERFORMANCE INDEX

Principal Investigator: Sue McNeil (Civil and Environmental Engineering)

Graduate Students: Farzana Atique and Ryan Burke

The Transportation Performance Index was developed for the US Chamber of Commerce to track the performance of transportation infrastructure over time and explore the connection between economic health and infrastructure performance (see <http://>

www.uschamber.com/sites/default/files/lra/files/LRA_Transp_Index_Technical_Report_100919.pdf). The index has been computed for the period 1990 to 2009 and shown to influence economic health. In constructing the index, our objective was to develop a transparent process that uses publicly available data to capture infrastructure performance. State of good repair and safety are important elements of transportation performance. In the current version of the index, state of good repair is directly represented by 2 of the 21 performance indicators and indirectly represented by another seven indicators, or 10% and 37% of the performance index based on weight. Three indicators capture safety. These indicators represent 22% by weight. This project revisits performance indicators related to state of good repair and safety, and their relative weights to be sure that state of good repair is adequately captured in the transportation performance index (TPI). This includes evaluating the TPI for 2010 and 2011 using both the original method and the new method, and understanding the relationship among the estimates, as well as the relationship with economic health.

Products:

Final Report: <http://cait.rutgers.edu/cait/research/better-state-good-repair-indicators-transportation-performance-index>

MULTI-RESOLUTION INFORMATION MINING AND A COMPUTER VISION APPROACH TO PAVEMENT CONDITION DISTRESSES

Principal Investigator: Nii Attoh-Okine (Civil and Environmental Engineering)

Graduate Student: Yaw Okyere Adu-Gyamfi

This research outlines three primary goals. First, develop a robust vision system addressing three key challenges of traditional pavement distress detection systems. Second, perform the integration of the vision system on to a GIS platform for crack classification and quantification. GIS will be used to generate real time road condition maps and provide recommendations regarding maintenance actions. Third, establish a real-time implementation of the system through parallel processing on current generation of multi-core CPUs.

Products:

Final Report: <http://cait.rutgers.edu/cait/research/>

multi-resolution-information-mining-and-computer-vision-approach-pavement-condition-di

MATHEMATICAL AND EXPERIMENTAL INVESTIGATIONS OF MODELING, SIMULATION AND EXPERIMENT TO PROMOTE THE LIFE-CYCLE OF POLYMER MODIFIED ASPHALT

Principal Investigator: Nii Attoh-Okine (Civil and Environmental Engineering) and Pam Cook (Mathematics)

Graduate Student: Yun Zeng

The formulation of constitutive equations for asphaltic pavement is based on rheological models which include the asphalt mixture, additives, and the bitumen. In terms of the asphalt, the rheology addresses the flow and permanent deformation in time, under different temperatures, and under different loading conditions. Currently, there are various laboratory methods used to determine the rheological parameters of the asphalt. Unfortunately, most of these tests are conducted in the linear viscoelastic region, therefore the true

picture of asphalt during in-service has not been fully investigated. Furthermore there are quite few polymer-modified asphalts that have been used. The mathematical models needed to formulate and model these materials are limited. This study attempts to develop a mathematical approach to modeling of polymer modified asphalt which is applicable in pavement design. The next step is to calibrate the models with laboratory data.

Products:

Final Report: <http://cait.rutgers.edu/cait/research/mathematical-and-experimental-investigations-modeling-simulation-and-experiment-promot>

New CAIT at UD Projects

Two new CAIT at UD projects have been approved for funding. These projects are briefly described below.

USING INFORMATION AT DIFFERENT SPATIAL SCALES TO ESTIMATE DEMAND TO SUPPORT ASSET MANAGEMENT DECISION MAKING.

Principal Investigators: Sue McNeil and Joseph Trainor

An important component of the asset management framework is demand estimation and other external influences. To date little attention has been paid to this component as it has been assumed that demand is either constant or steadily growing. In areas where events (for example, Hurricane Sandy) have disrupted daily life as well as the improvement, renewal and maintenance of infrastructure, understanding these relationships is more important. Furthermore, there are many rich sources of this data but much of the data occurs at disparate spatial scales and is collected at different points in time. Building on two ongoing CAIT projects, in this project we explore how this large volume of data fits into the asset management process for a community.

Our goal is to better understand how diverse, large data sets support asset management decision making and explore tools to facilitate this process. In particular the focus is on integrating sensor, survey, demographic, vulnerability and condition data. The specific objectives are to:

1. Identify new and emerging data that can be used to support the decision making process.
2. Characterize the spatial scale, temporal frequency of data collection, and trends in the data to support strategies for aggregating and updating data for use in asset management.
3. Explore role of tools including "big data" tools, and GIS.
4. Develop a case study
5. Identify lessons learned.

SATELLITE ASSESSMENT AND MONITORING FOR PAVEMENT MANAGEMENT

Principal Investigators: Arde Faghri and Mingxin Li

Environmental conditions, such as temperature, frost-thaw, rainfall, moisture, have significant impact on pavement response. For example, one unwelcome result of the recent snowstorms in the United States left in their wake more problems with dangerous surface distresses, such as rutting, cracking, pot holes, and other significant pavement surface defects.

Traditional pavement inspection techniques, e.g., manual distress surveys or automated condition surveys using specially equipped vehicles, offer a method of determining pavement condition through observing and recording, which causes this pavement survey work to be cumbersome and inefficient. To minimize obstruction to the traffic, this project aims to carry out investigation of the capability of remote sensing satellite data, including Synthetic Aperture Radar (SAR) satellite data for use in advanced infrastructure monitoring, which is a tangible breakthrough in sensing technology allowing to assess pavement deformations with millimetric accuracy on single specific points. Synthetic Aperture Radar (SAR) is an efficient tool for evaluation of traffic and environmental impact on pavements and is based on the use of a time series of satellite radar images. By bringing the SAR dataset into a GIS database, the research team is able to correlate average displacement velocities of SAR data points with respect to their proximity to mapped surface distresses, such as rutting, cracking, potholes and eventually replace the cumbersome and inefficient periodic inspection-based infrastructure monitoring system with continuous SAR-based system.

Advanced Infrastructure Management Bootcamp

The third Advanced Infrastructure Management “Bootcamp” was held at Virginia Tech from June 16 to June 27. The bootcamp brought together 14 students and 9 instructors. The students and instructors came from Georgia Tech, Purdue University, Texas A & M, Virginia Tech, University of Texas El Paso, University of Delaware, University of Iowa, and University of Waterloo as well as three international students from Chile, Japan and Portugal. The course covered performance and asset management, sensors and

instrumentation, deterioration modeling, data management, sustainability, risk and reliability, asset valuation, public private partnership, optimization, and research methods. Students participated in lectures, completed homework and a final project. The objective of Bootcamp is to provide an opportunity for students to gain in-depth knowledge, acquire advanced infrastructure management skills, and develop a mini-project and network with others with similar interests in Civil Infrastructure Management.

Three UD PhD students, Hadi Al-Khateeb, Omar Ghonima, and Silvia Galvan Nunez, participated in the bootcamp. Sue McNeil served as class coordinator and instructor for two modules. Professor Gerardo Flintsch of Virginia Tech with assistance from James Bryce, a PhD student, organized and led the class. Financial assistance from the UD students came from CAIT at UD. Support for the bootcamp came from the Connected Vehicle/Infrastructure UTC at Virginia Tech Transportation Institute.

AISIM10

The 10th Annual Interuniversity Symposium on Infrastructure Management (AISIM) was held at Virginia Tech in June. Hadi Al-Khateeb and Omar Ghonima, both PhD students in structures, and Mosi London, a PhD student in transportation, presented papers. Offei Adarkwa also attended.

Hadi’s paper, “Bridge Evaluation Based on Structural Health Monitoring,” was selected as one of the five best presentations from the Symposium. As such he is invited to present a poster at the Transportation Research Board Annual Meeting in Washington DC in January 2015. Congratulations to Hadi and his advisor Professor Michael Chajes.

AISIM10 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.



UD Participants in AISIM10 Visit Virginia Tech Transportation Institute Smart Road.



Hadi Al-Khateeb (far right) with other “Best Presentation” Awardees

Women's Transportation Seminar (WTS) Annual Meeting

The annual WTS Conference provides opportunities for networking and professional development. With assistance from CAIT at UD, Delaware Center for Transportation and the College of Engineering, Women in Engineering program, four students were able to

attend the conference. This year's conference was held in Portland, Oregon in May. The attendees were Rachel Beer, Sarah Doggett, Kelly Fearon, and Rachel Schott. All are students in Civil and Environmental Engineering. Rachel, Kelly and Rachel are graduating seniors. Kelly

is attending graduate school in transportation at the University of Washington. Rachel Beer and Rachel Schott are both working in transportation related positions. Sarah is a rising junior.



Sarah Doggett (first on left), Rachel Schott (third from left), Kelly Fearon (fourth from left) and Rachel Beer (fifth from left) network with members of the Philadelphia section at the WTS Annual Conference.

Brown Bag Seminars

The spring semester provided an opportunity for students and faculty to provide updates on the CAIT at UD projects. Five brown bag seminar were presented:

- **"Enhancing Nitrogen Removal in Stormwater Facilities for Transportation,"** Paul Imhoff, Pei Chu and Jing Tian, March 11th, 2014
- **"Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy,"** Alex Greer, Joseph Trainor and Sue McNeil, March 24th, 2014
- **"Defining and Quantifying State of Good Repair (SGR) for the Pedestrian Network,"** BJ DeCoursey and Jeremy Rothwell, April 22nd, 2014
- **"Guidelines for embedment length of carbon fiber reinforced polymer (CFRP) strips in near surface mount (NSM) retrofitted concrete structures,"** Nakul Ramanna, May 6th, 2014
- **"Rheology and strengthening through polymer binders,"** Pam Cook and Nii Attoh-Okine, May 13th, 2014

ENO Leadership Development Conference

PhD student Mosi London was selected as one of twenty graduate students to participate in the 22nd annual Leadership Development Conference (LDC). The weeklong program—which provides “Eno Fellows” the opportunity to learn about policy formulation, decision-making and executive responsibilities facing industry leaders - was held June 1-5 in Washington, DC.



Mosi London (back row, far right) with other attendees at the 22nd annual ENO Leadership Development Conference

Spring and Summer “Fun” for Undergrads and High School Students

Sarah Doggett a rising junior received the Helen Pattison Scholarship as a Summer Scholar in UD’s undergraduate research program. Sarah is interested in what makes cities transit friendly and has worked on a project titled “Characteristics of Transit Friendly Cities.” Sarah presented a poster describing her research at the Undergraduate Research and Service Celebratory Symposium on August 14.

Multiple students have participated or are participating in the project “Enhancing Nitrogen Removal in Stormwater Treatment Facilities for Transportation.” Working with Professors Imhoff and Pei the following students have largely been funded by partner organizations:

- Robert Rose, UD Environmental Engineering, Summer 2014, funded by CAIT at UD & NSF EPSCoR
- Naomi Chang, UD Environmental Engineering, Spring 2014, funded by DWRC fellowship
- Chris Youngquist, UD Environmental Engineering, Summer 2014, funded by DWRC fellowship
- Jing Jin, UD Environmental Engineering, Spring 2014, volunteer
- Jillian Allen, UD Environmental Engineering, Spring 2014, funded by DENIN scholarship
- Lyndsay Fagan, UD Environmental Engineering, Spring 2014, funded by DENIN scholarship
- Sangwon Jeon, UD Biology/Chemistry, Spring 2014, independent study
- Zelin Zhang, DTCC Chemistry/Mathematics, Summer 2014, funded by NSF EPSCoR
- Jared Saquing, Wilmington Charter, summer 2014, funded by UD CoE HS internship
- Sriram Cyr, Wilmington Charter, summer 2014,

funded by UD CoE HS internship

RECENT PRODUCTS

Posters:

- Greer, A., and I. Jahan, (2014). “Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy.” Poster, DRC 50th Anniversary, May.
- Greer, A., and I. Jahan, (2014). “Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy.” Delaware Center for Transportation PI/PM Research Showcase. Dover, DE. May 7
- Shariati, A., T. Schumacher and N. Ramanna, (2014). Video-Based Structural Health Monitoring. Delaware Center for Transportation PI/PM Showcase. Dover, DE. May 7.
- Ramanna, N., (2014). Innovative NSM-CFRP Retrofitting of Concrete Beams and Slabs under Static and Impact Loads. Delaware Center for Transportation PI/PM Research Showcase. Dover, DE. May 7
- Imhoff, P. and P. Chu, (2014). “Integrating Zero-Valent Iron and Biochar Amendments in Green Stormwater Management Systems for Enhanced Treatment of Roadway Runoff” Delaware Center for Transportation PI/PM Research Showcase. Dover, DE. May 7.
- Greer, A., (2014) “Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy” Poster Natural Hazards Workshop, Colorado, June.

CONFERENCE PAPERS

- McNeil, Sue, Farzana Atique, Ryan Burke and Susanne Trimbath, “Using the Transportation Performance Index to Understand the Impact of Regional Plans,” Proceedings of the ASCE TD&I Congress, Orlando, June 2014.
- Tian, J., S. Yi, P.T. Imhoff, P. Chiu, M. Guo, J.A. Maresca, A., V. Beneski and S.H. Cooskey, “Biochar-Amended Media for Enhanced Nutrient

Removal in Stormwater Facilities,” Conference paper for the ASCE EWRI World Environmental & Water Resources Congress 2014, Portland, Oregon June 1-5, 2014.

PRESENTATIONS

- Zeng, Y., (2014). “Stochastic modeling and simulations of transient networks: Soft materials, gels and concentrated surfactants,” mini symposium talk at the Society of Rheology meeting in Pasadena, CA. February.
- Schumacher, T. and A. Shariati, (2014). Video-Based Structural Health Monitoring. University of Delaware University Transportation Center (UD-UTC) Brown Bag Discussion. Newark, DE. March.
- Greer, A., J. Trainor and S. McNeil, (2014). “Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy,” CAIT at UD Brown Bag, March.
- Tian, Jing, (2014) “Enhancing Nitrogen Removal in Stormwater Facilities for Transportation,” CAIT at UD Brown Bag, March.
- DeCoursey, B.J., and J. Rothwell, (2014). “Defining and Quantifying State of Good Repair (SGR) for the Pedestrian Network,” CAIT at UD Brown Bag, April.
- Ramanna, N., (2014) “Guidelines for embedment length of carbon fiber reinforced polymer (CFRP) strips in near surface mount (NSM) retrofitted concrete structures,” CAIT at UD Brown Bag, May.
- Attoh-Okine, N. and P. Cook, (2014). “Asphalt: Rheology and strengthening through polymer binders” CAIT at UD Brown Bag, May.
- Greer, Alex, (2014). “Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy” Presented at the IRCD/Natural Hazard Center Researchers Meeting, Colorado, June.

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