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UNIVERSITY OF DELAWARE BRIDGE CENTER TO CONDUCT LONG-TERM MONITORING PROGRAM ON SIGNATURE BRIDGE

University of Delaware Bridge Center to Conduct Long-Term Monitoring Program on Signature Bridge

The Center for Innovative Bridge Engineering (CIBrE) at the University of Delaware has proposed to install a long-term structural health monitoring system on new the Indian River Inlet Bridge in Sussex County, Delaware. Designed by the Figg Engineering Group for the Delaware Department of Transportation (DelDOT), the 1,000-foot single-rib concrete arch bridge will replace an aging structure, which continues to experience serious scour at the base of the piers due to the high-velocity tidal currents in the waterway.

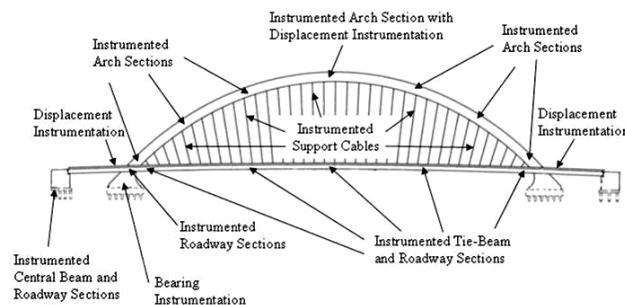
The monitoring system will include 240 sensors, a networked/distributed data-acquisition system, and a central computer system with high-speed internet access. Sensors will be installed in the concrete rib arch, tie-beam, deck, and support cables. These will include accelerometers, load cells, vibrating and foil strain gages, GPS transceivers, and displacement transducers.

Sensors will be installed and brought "on-line" as the bridge is being built, such that construction loads and deformations can be monitored. Once the bridge is completed, the monitoring system will periodically

read all sensors several times a day and will be triggered to record at higher sampling rates during high wind events. The data collected will become part of the bridge's permanent maintenance and inspection record.

The UD team plans to monitor the bridge from the time of construction through the first bi-annual inspection and periodically thereafter. "The intended service life of the bridge is over 75 years," said Michael J. Chajes, Chair of UD's Department of Civil and Environmental Engineering. "The inspection and maintenance during that time will require a substantial investment in time and resources. By installing a monitoring system, we will be able to monitor the bridge during construction to ensure safety, understand the initial bridge condition, and monitor changes in condition over time to aid in ongoing management. Finally, some of the monitoring information will be made available for public display at an information kiosk."

For more information on the Indian River Inlet Bridge monitoring program, contact Prof. Michael Chajes, chajes@ce.udel.edu or 302-831-2442. For more information on CIBrE, visit www.ce.udel.edu/CIBrE.



Above left, artist's rendering of the Indian River Inlet Bridge to be built in Sussex County, Delaware. Above right, a cross-section of the concrete arch showing the instrumentation plan for long-term health monitoring.

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MESSAGE FROM THE DIRECTOR



Ardeshir Faghri, Director

The most significant events of the last few months affecting the operations of the Delaware Center for Transportation have been the hiring of Sue McNeil as a new professor in Civil/Transportation Engineering and the departure of Professor Shinya Kikuchi to Virginia Tech. After a long and sometimes tedious search, the department of Civil and Environmental Engineering was successful in hiring Professor McNeil as the new addition to our existing Civil/Transportation Engineering faculty. Professor McNeil comes from the University of Illinois in Chicago where she was a professor in both Civil Engineering and Urban Planning while at the same time served as the director of their transportation research institute. More about Professor

McNeil is written in this newsletter in the upcoming pages. Professor Kikuchi leaves the department after serving approximately twenty two years as a faculty of Civil and Environmental Engineering and as the first director of the Delaware Center for Transportation. Professor Kikuchi conducted research in the newly established Intelligent Transportation Systems Laboratory and taught courses in fundamentals of transportation and traffic engineering, transportation planning, and public transportation and mass transit. Efforts are currently underway to reorganize the transportation program so that our main missions of research, education and training will continue without any interruption.

Another important event being currently planned for either 2006 or 2007 is the International Conference in Transportation Security. We mailed all of our readers a survey to be completed and returned to the center regarding their preferences of the time, place and different events contained in this conference. If you have not already done so, please return your answers to us as soon as possible. The results of this survey will help us in more accurately estimating the number of participants as well as a better coordination of the programs and speakers in the conference.

Please look for many other exciting events including courses, training workshops, research projects, distinguished guest speakers and others which are sponsored by the center in the upcoming months. Please either contact the center by e-mail, or phone, or visit our web page at www.ce.udel.edu/dct.

JOE TOOLE PRESENTS DISTINGUISHED SPEAKER LECTURE



Joseph S. Toole

Joseph S. Toole, Associate Administrator of the Federal Highway Administration's Office of Professional and Corporate Development, presented a Distinguished Speaker Lecture at the University of Delaware on March 4, 2005. His theme was developing workable plans for transportation agencies to recruit and retain professional and technical workers. Students, faculty, and DelDOT managers comprised the

audience.

Transportation agencies have many difficulties in attracting and keeping employees. They include:

- ◆ Expanding agency missions require new skills
- ◆ Program growth is coinciding with decreasing staffing due to budget cuts
- ◆ More than 50 percent of transportation agency workers will be eligible to retire in the next 10 years

- ◆ Pay scales are higher in the private sector
- ◆ Workforce training expenditures are insufficient

These obstacles must be overcome. Mr. Toole is a federal employee, but he enthusiastically shares his research, strategies, and commitment with state and local governments through the national network of FHWA offices, T² Centers, and state universities.

Some of the approaches he recommends are:

- ◆ Transportation agencies should devote more funds and time for training
- ◆ More federal funds should be eligible for use by states and localities for training and education activities
- ◆ Transportation agencies should more actively partner with universities, community colleges, training institutes, and T² Centers to meet workforce needs
- ◆ Organizations should develop strategic plans for the development of human capital.

PROFESSOR McNEIL JOINS THE DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Sue McNeil will be joining the Department of Civil and Environmental Engineering as a new professor in the area of Transportation and Infrastructure, starting August 15, 2005. Professor McNeil is currently the director of the Urban Transportation Center and Professor in the College of Urban Planning and Public Affairs at the University of Illinois at Chicago (UIC). Prior to joining UIC, she was a Professor of Civil and Environmental Engineering and Public Policy at



Carnegie Mellon University. Her research and teaching interests focus on transportation infrastructure management with emphasis on the application of advanced technologies, economic analysis, analytical methods, and computer applications. Other projects relate to brownfield development. She has also developed a graduate course titled Infrastructure Management. Dr. McNeil initiated and chaired (1988-1993) the ASCE Urban Transportation Division Committee on Transportation Facilities Management. She is an Associate Editor for the ASCE Journal of Infrastructure Systems. She is also a member of the TRB's Executive Committee. Professor McNeil was a Presidential Young Investigator from 1987 to 1992 awarded by the National Science Foundation (NSF). In 1994 she was awarded the Benjamin Teare teaching award. She is a registered professional engineer.

Professor McNeil obtained a BSc and BE from University of New Castle, Australia, as well as a MS and Ph.D. from Carnegie Mellon University in 1983.

DCT TO HELP SET SCRAP TIRE AGENDA

By Diane Kukich



Our Co-Project Investigators for the Scrap Tire Project take a minute to pose for a picture. Pictured above left to right: Dr. Victor Kaliakin, Dr. Nii Attoh-Okine and Dr. Paul Imhoff.

With support from DelDOT, DCT researchers are launching an effort to develop an agenda for handling scrap tires in Delaware. Professors Nii Attoh-Okine, Paul Imhoff, and Victor Kaliakin are leading the project.

According to Imhoff, estimates of the number of scrap tires in stockpiles throughout the U.S. range from 500 million to 3 billion. An additional 270 million tires become scrap every year. The State of Delaware generates 780,000 scrap tires annually and currently has 38 known tire piles.

Illegal or improper dumping and stockpiling of scrap tires pose serious problems, including clogging landfills; providing breeding grounds for rats, snakes, ticks, mosquitoes, and other pests; posing a potential fire hazard; and emitting dangerous oils and

soot into the air and water when burned illegally. "These problems require an effective scrap tire management program in the State of Delaware," says Attoh-Okine, who specializes in the area of infrastructure management.

The plan is to develop a Scrap Tire Center at the University of Delaware, which will help set the stage for the State to take immediate action to

- ◆ regulate Delaware businesses that collect, store, recycle, and process scrap tires;
- ◆ perform compliance and enforcement activities to reduce and eliminate hazards associated with scrap tire stockpiling and management;
- ◆ develop and establish ongoing systems to accommodate scrap tires;
- ◆ provide the public with information necessary to properly manage scrap tires in ways that protect and enhance the environment;
- ◆ continue to clean up existing illegal scrap tire stockpiles; and
- ◆ develop proper quality control/quality assurance in scrap tire application.

Possible approaches include reduction, retreading, recycling, and recovery through tire derived fuel. However, these approaches need to be well organized and an appropriate scrap tire management plan must be adopted for effective results.

The proposed center in Delaware will work with State agencies, the Delaware legislature, and scrap tire companies and operators in Delaware to achieve its goals. Potential uses of the tires include substitute aggregate in septic tanks, landfill leachate collection systems, fences in agricultural areas, embankment projects, and pavement systems.

"A number of states have strong scrap tire management programs," says Kaliakin. "Delaware is a small state, but we have the opportunity to make a significant impact through the development of working principles, specifications, and educational outreach programs for scrap tires."

Research

The Center has several new and exciting projects for the FY'06 Annual Research Program. In January 2005 we met with DelDOT's Research Committee to identify and prioritize the most important transportation problems facing DelDOT. In May 2005, the DCT Policy Council approved the following projects for the start of our fiscal year on July 1, 2005:

Application of Speed Tables in Delaware

Problems for emergency vehicles with speed reducing strategies.

Principal Investigator: Shinya Kikuchi, Virginia Tech.

Problem proposed by: Ralph Reeb, Division of Planning

Investigating the Cost, Liability and Reliability of Anti-Idling Equipment for Trucks

Investigating the cost, liability and reliability of anti-idling equipment for trucks.

Principal Investigator: Young-Doo Wang and John Byrne, Center for Energy and Environmental Policy

Problem proposed by: Ralph Reeb, Division of Planning

Succession Planning – Phase II

Continuation of Succession Planning Project. Phase II would be the implementation of the current project. There are a high number of retirements coming up this summer; a high number of leadership people will be leaving.

Principal Investigator: James Flynn, Institute for Public Administration

Problem proposed by: Denise Beaston, Department of Human Resources

Rating of 4-way Stop Intersections for Conversion to Roundabouts

Continuation of Roundabouts Project. Roundabouts are safer, cleaner and improve traffic flow. Phase II would be the rating of 4-way stop sign intersections for switching to roundabouts.

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

Problem proposed by: Dan LaCombe, Division of Planning

Scrap Tire Research

Determine the environmental and engineering properties that should be monitored during the construction of shredded tire embankments. Include instrumentation, installation, monitoring and an analysis plan. Implement the monitoring. What instruments are needed and how to construct and monitor them. The issue in Delaware is that the temperature is much higher in the summer than it is in New England.

Principal Investigator: Nii Attah-Okine, Paul Imhoff, Victor Kaliakin Department of Civil and

Environmental Engineering

Problem proposed by: Wayne Kling, Division of Materials and Research

Historic Bridges Study

What constitutes a historic bridge? How to designate between old and historic. How are other states handling this? Life cycle cost strategies. Mobility and congestion issues involved in keeping the older structures. Re-evaluate the current State historic bridge list.

Principal Investigator: David Ames, Center for Historical Architecture and Design

Problem proposed by: Rosemary Samick, FHWA

Hot Mix Asphalt Specification Research

A continuation of analysis of DelDOT's Hot Mix Asphalt Quality Assurance Specifications. Include an updated comparison to other states, particularly Pennsylvania and Maryland.

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

Problem proposed by: Wayne Kling, Division of Materials and Research

Laboratory Determination of Resilient Modulus of Unbound Materials and Hot Mix Asphalt

Review of Resilient Modulus Project and check for any gaps between products from that project and the recently released pavement design procedure.

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

Problem proposed by: Wayne Kling, Division of Materials and Research

A Practical Application/Implementation of the ADA Eligibility Model for DART First State Paratransit

This would be a practical application/implementation of the project "ADA Eligibility Model for DART First State Paratransit."

Principal Investigator: Michael Gamel-McCormick, Center for Disability Studies

Problem proposed by: Cathy Dennis, Delaware Transit Corporation

NEW PROJECTS FOR THE CENTER FOR INNOVATIVE BRIDGE ENGINEERING FOR FY'06:

Moment Redistribution and Service II Limit State

Principal Investigator: Jennifer Righman, Department of Civil and Environmental Engineering

Bridge Management Using In-Service Data

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

THE CURRENT ACTIVE RESEARCH PROJECTS INCLUDE:

As each project is completed, an abstract will be available on the DCT website: <http://www.ce.udel.edu/dct>.

Active Adult (55+) Community/Trip Generation Rates

What are the trip generation characteristics of "active adult" (55+) communities?

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

Problem proposed by: Ralph Reeb, Division of Planning

Environmental Evaluation of Roundabouts vs. Unsignalized and Signalized Intersections in Delaware

Many fully-controlled (signalized) intersections, causing vehicles to stop and start, result in greater emissions (decreased air quality) than would be the case if the intersections were a roundabout instead. Which intersections would be appropriate for roundabouts? What impact would roundabouts have in DE? Need a model to identify intersections for roundabouts.

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

Problem proposed by: Dan Lacombe, Division of Planning

Characterization of SR-1 Concrete Test

Prioritization of concrete used for SR-1 pavement (shrinkage & modulus evaluations).

Principal Investigator: Danny Richardson, Department of Civil and Environmental Engineering

Problem proposed by: Wayne Kling, Division of Materials and Research

Hot Mix – Skid and Noise

Evaluation of skid and noise, (another surface texture characteristic) of DelDOT superpave HMA mixtures (and possibly compare to DelDOT SMA and open-graded HMA mixtures). Conducting tests for Delaware using our materials vs. other states.

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

Problem proposed by: Wayne Kling, Division of Materials and Research

Transit Accident Study

Correlation of work hours and accident rates and existing resources. Determine if there are more accidents as a result of progressive hours of operator drive time.

Principal Investigator: Douglas Tuttle, Institute of Public Policy
Problem proposed by: Ray Miller, Delaware Transit Corporation

Bike Path Adjacent To Residential Areas – Property Value/Desirability

Quantify that bike paths can increase real estate values. Economic benefits of bike paths/trails adjacent to residential properties.

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

Problem proposed by: Dan LaCombe, Division of Planning

Succession Planning

Transfer of institutional knowledge to the next generation of DelDOT professionals: Retirement/Succession planning; evaluate pros/cons of increased use of consultants vs. in house expertise; work force assessment (present & future); what are other state DOT's doing to address this issue? Develop aggressive plan.

Principal Investigator: James Flynn, School of Urban Affairs

Problem proposed by: Rosemary Samick, FHWA

Durability of Thin Overlays

What do you replace it with on a new structure? Compare to more traditional ways.

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

Problem proposed by: Larry Klepner, DCT T² Program, University of Delaware

A Study of the Traffic Monitoring and Data Program in Delaware

This project will review the traffic monitoring and data program of the Delaware Department of Transportation. Specific recommendations and subsequent monitoring of the implementation of those recommendations will follow this review.

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

Project Manager: Tyrone Crittenden, Division of Planning

Evaluation of the Potential of Retention Ponds and Sand Filters to Produce Nuisance Mosquitoes and West Nile Virus Vectors

Principal Investigator: Jack Gingrich, Department of Entomology and Wildlife Ecology

Project Manager: Maryanne Walsh, Division of Field Services

Letting Scenic and Historic Roads in Delaware Tell Their Story

A web-based manual to facilitate the identification, designation and management of scenic and historic highways

Principal Investigator: David Ames, Center for Historical Architecture and Design

Project Manager: David Petrosky, DelDOT, Division of Planning

2003-2004 GPS Travel Time and Delay Data Collection and Analysis

This project uses the state-of-the-art equipment in receiving satellite position information for collecting real-time state-wide traffic data. The data is then analyzed and displayed by Geographic Information Systems software.

Principal Investigator: Ardeshir Faghri, Dept. of Civil and Environmental Engineering

Project Manager: Dan Lacombe, Division of Planning

HMA Specification Research

Evaluate quality assurance program of DelDOT's hot mix asphalt acceptance program. Statistical evaluation of test results.

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

Project Manager: Wayne Kling, Division of Materials and Research

Surface Treated Roads

DelDOT maintains 1800 lane miles of surface treated pavement. It is along many of these roads that major new development is occurring. Is there a better surface treatment method or inexpensive technology that DelDOT could be using to address this issue?

Principal Investigator: Danny Richardson, Department of Civil and Environmental Engineering

Project Manager: Jennifer Cajthaml, Division of Preconstruction

Subdivision Inter-Connectivity

Various researchers have claimed that providing road connections between large sub-divisions results in fewer and shorter automobile trips and less congestion on the adjacent road system. We need to know how much difference inter-connectivity can/could or does make.

Principal Investigator: Ed O'Donnell, Institute of Public Policy

Project Manager: Ralph Reeb, Division of Planning

GPS/AVL System Evaluation

Determine benefits and productivity improvements of our Automated Vehicle Locator (AVL) System. (A GPS system that identifies location of buses).

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

Project Manager: Bill Hickox, Delaware Transit Corporation

Estimating Current Modal Splits

This project will produce a new, more reliable estimate of travel mode choice in Delaware to be used for planning and evaluation of services and assist in the establishment of systems to better judge the consequences of alternative solutions to transportation problems.

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

Project Manager: Michael DuRoss, Division of Planning

Data for Trip Generation Models: Trip Attraction Rates for Delaware Condition

Two types of developments create special trip generation circumstances: large commercial shopping complexes, and very compact multi-use developments. The purpose of this project is to have Delaware-specific trip generation rates for these land-uses.

Principal Investigator: Shinya Kikuchi, Dept. of Civil and Environmental Engineering

Project Manager: William Brockenbrough, Division of Project Development

Enhancing Delaware's Highways: A Natural Vegetation Project

The project will investigate vegetation models conceived to restore Delaware's roadside landscapes to a more natural state reflecting the regional flora.

Principal Investigator: Sue Barton, Department of Plant and Soil Sciences

Project Manager: Chip Rosan, Roadside Environment

Transforming Data into Information: The Development and Demonstration of a Data Model to Support Planning

This project will demonstrate how information can be structured for integration into Oracle Enterprise databases, and how it can be accessed and used to support DelDOT's needs.

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

Project Manager: Gene Donaldson, Traffic Management Center

Travel Time Measurement & Analysis Using Automated Vehicle Locator (AVL) on Dart Buses

This project will devise a system that provides the travel time in the network using AVL on the DART buses. This will include measuring and analyzing the accuracy of travel time, developing a set of algorithms to translate the measurements to information useful to auto users as well as transit users, and evaluating the effects of this system with respect to the overall performance of DelTrac.

Principal Investigator: Shinya Kikuchi, Department of Civil and Environmental Engineering

Project Manager: Gene Donaldson, Traffic Management Center

Treatment of Data for Transit Operations and Planning Decisions

Principal Investigator: Shinya Kikuchi, Department of Civil and Environmental Engineering

Project Manager: Dave Gula, Delaware Transit Corporation

ITS Lab Operations and Maintenance

Principal Investigator: Shinya Kikuchi, Department of Civil and Environmental Engineering

Project Manager: Gene Donaldson, Traffic Management Center

Toward New Transit Services in Newark: Transit Center-Circulation Service Survey of Existing & Potential Riders

Principal Investigator: Shinya Kikuchi, Department of Civil and Environmental Engineering

Project Manager: Dave Gula, Delaware Transit Corporation

CURRENT ACTIVE PROJECTS FOR THE CENTER FOR INNOVATIVE BRIDGE ENGINEERING:

Development of State-Specific Truck Weights

Principal Investigator: Dennis Mertz and Baidurya Bhattacharya, Department of Civil and Environmental Engineering

Assessing the Fatigue Life of Delaware's Steel Bridges

Principal Investigator: Dennis Mertz and Baidurya Bhattacharya, Department of Civil and Environmental Engineering

TECHNICAL ASSISTANCE

The Delaware Center for Transportation also does short-term projects, which include, but not limited to, a literature search on a topic that a full-fledge research is not required, or did not receive high enough priority to be funded. During the 2004-2005 fiscal year the Center did literature searches on the topics listed below. A report of the findings was given to the project manager to look over and decide if that is enough information for their needs, or if they would like the Center to do more research.

- ◆ Succession Planning
- ◆ Truck Anti-idling
- ◆ Off-Peak Signal Timing
- ◆ Scrap Tires
- ◆ Speed Reduction Techniques

Most of these literature searches have become FY'06 projects.

SECOND ANNUAL TRANSPORTATION RESEARCH SHOWCASE

The Second Annual Transportation Research Showcase sponsored by DCT was held Monday, May 16th at the Paradee Center in Dover. Project Investigators and graduate student(s) offered poster sessions for each of his/her current research project. The posters were divided into six categories: Environmental, Planning, Pavement and Materials, Structures and Bridge, Traffic and ITS, and Transit. Over 100 guests attended the showcase with visitors from DelDOT, the University of Delaware, Delaware Legislature and private industry. Each had the opportunity to view the poster, and discuss the project with each of the Principal Investigators.



Susan Barton from the University of Delaware's Dept. of Plant and Soil Sciences tells about her project, *Enhancing Delaware Highways: A Natural Vegetation Project*



Gary Wenczel, Senior Research Tech. explains the Bridge Center projects to Wayne Kling of DelDOT

RESEARCH PAYS OFF

RUMBLE STRIPS

FINDING A DESIGN FOR BICYCLES AND MOTOR VEHICLES

Dave Bachman

The Pennsylvania Department of Transportation (PENNDOT) researched milled rumble strip patterns that are safe and effective for bicyclists as well as motorists on nonfreeway roads—a difficult task, since the needs of each group differ. Although bicyclists want to cross the rumble strip safely and comfortably with minimal vibration, motorists want sufficient vibration and sound to warn that the vehicle is drifting from the travel lane.

Problem

Roads that are open to bicycles—the majority of the highway network—need rumble strips designed to meet the conflicting needs of motorists and bicyclists. Used mainly on urban and rural freeways, rumble strips have reduced crashes and fatalities by 20 to 50 percent.

One reason rumble strips have not been implemented on nonfreeway roads is that they can be uncomfortable for bicyclists to ride over and can cause loss of control of the bicycle—a serious safety issue. Although bicyclists usually travel on the shoulder outside of the rumble strip, they occasionally need to cross it, for example, to make a left turn or to avoid debris.

Solution

Developing a Model

After an assessment of PENNDOT's rumble strip pattern, 25 alternatives were developed and evaluated, and a simulation model was devised and validated. The simulation model indicated that 4-inch-wide (102-mm) grooves would provide the smoothest ride for bicyclists. However, the cutting head on the milling machine used by PENNDOT is a fixed diameter, which means that there is a linear relationship between width and depth of cut. Four-inch cuts would have meant an unacceptably shallow cut. Therefore, 4-inch (102-mm) grooves were not considered further. All of the patterns used the same groove length, between 16 and 17 inches (406 and 432 mm).

Testing the Rumble Strips

The five highest ranked test patterns and PENNDOT's current standard were installed at a test facility for field experiments. Volunteers rode four different bicycle models—mountain, touring, hybrid, and tandem—over the test rumble strip patterns at various speeds and angles. Vertical acceleration (up and down movement by the bicyclist) and pitch angular acceleration (before and after rocking experienced by the bicyclist) data were collected and compared for each pattern. The bicyclists rode on an 8-inch (203mm) white line over each pattern to measure the effect of the grooves on handling and control, and the researchers recorded the percentage of time spent off the line. The bicyclists rated the comfort and control for each pattern by marking a graphical scale from very uncomfortable to very comfortable.

Rating the Test Patterns

The researchers normalized the scores for each experiment to a scale of 0 (best) to 1 (worst) and averaged the scores to obtain composite scores. Test Pattern 1 was clearly the worst from the bicyclist's perspective; conversely, Patterns 6 and 3 were the best and second best.

Patterns 2 and 5 had the same composite score, with Pattern 2 doing better on the acceleration tests, and Pattern 5 doing better on the subjective ratings. Pattern 4 did well on the white line test but poorly on the others.

To assess each rumble strip pattern's auditory effect on inattentive or drowsy motorists, the maximum sound level in a vehicle was measured when the vehicle drove over the patterns. The difference between the maximum sound level and the ambient sound level when driving on a smooth pavement was determined.

Vertical and pitch angular accelerations also were measured, but were not found useful. Previous research had found that rumble strips producing 4 dB(A) increases above the ambient noise can be readily detected by motorists who are awake (1), but there are no data indicating the sound level difference necessary to alert a drowsy motorist.

For higher speed roads, near 55 mph (88 km/h), Pattern 3 was the best balance between the competing needs of motorists and bicyclists. It was the second-best pattern for bicyclists and the third-best for motorists. Pattern 6, the best for bicyclists, was not chosen because it provided the least sound difference to motorists.

For lower speed roads, near 45 mph (72 km/h), Pattern 5—the third-best pattern for both bicyclists and motorists—was recommended. The two best patterns for bicyclists generated less than 7 dB(A) sound above the ambient level, which was not deemed to be sufficient to rouse drowsy motorists.

Application

PENNDOT will install pilot rumble strips designed from Patterns 3 and 5 on nonfreeway routes across Pennsylvania this year. Installation is only on roadways with shoulders at least 6 feet wide, so that there is sufficient room for bicyclists to travel outside of the rumble strip. If these pilot installations are well received by the bicycle community, additional installations will follow.

Benefits

PENNDOT's goal is to reduce crashes and fatalities by 10 percent. Run-off-the-road motor vehicle crashes on nonfreeway facilities make up a significant portion of crashes and fatalities. Although data are not yet available to estimate the reduction in crashes and fatalities due to nonfreeway rumble strips, the success of rumble strips on freeways is a good prediction of performance.

Effectively designed rumble strips also may improve bicyclist safety by providing a buffer between motor vehicles and bicycles and by reducing the number of motor vehicles infringing on the bicyclists' part of the shoulder.

Reference

1. Watts, G. R. The Development of Rumble Areas as a Driver-Alerting Device. In Supplementary Report 291, Transportation and Road Research Laboratory, 1977.

For more information contact Michael Bonini, Research Division, Pennsylvania Department of Transportation, 400 North Street, 6th Floor, Harrisburg, PA 17120-3789 (telephone 717-772-4664, email mbonini@dot.state.pa.us).

EDITOR'S NOTE: Appreciation is expressed to Ray Derr, Transportation Research Board, for his efforts in developing this article.

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FALL 2005 OPPORTUNITIES

DelDOT relies on the DCT to manage and sponsor much of its educational and training needs. This is particularly true for the "hard skills" otherwise labeled technology. The list below shows the names of the hard skills courses that the University will offer during the Fall 2005 semester.

This list is provided as a guide. For more information about a particular course, see the Fall 2005 Educational Opportunities for the Transportation Community, a DCT booklet mailed to all newsletter recipients. Also refer to the Fall '05 Undergraduate and Graduate Registration Booklet and the Fall 2005 Professional and Continuing Studies Bulletin available in print or at www.udel.edu.

Construction

- Introduction to Land Surveying
- Earth Retaining Structures
- Deep Foundations
- Mechanically Stabilized Earth Walls & Reinforced Soil Slopes

Environmental Engineering

- Introduction to Environmental Engineering
- Environmental Engineering Processes
- Fluid Mechanics
- Solid Waste Management
- Water Resources Engineering
- Chemical Aspects of Environmental Engineering
- Contaminant Transport & Separation in Environmental Systems
- Fate & Effects of Metals in the Environment
- Land and Water Management
- Storm Water Management
- Waste Water Treatment Systems
- Admiralty and Maritime Law
- Politics and the Environment
- Regional Watershed Management
- Energy Policy and Administration
- Political Economy of the Environment

Geotechnical Engineering

- Soil Mechanics
- Soil Mechanics Lab
- Deep Foundations
- Earth Retaining Structures
- Mechanically Stabilized Earth Walls & Reinforced Soil Slopes

Government Policy

- Solid Waste Management
- Public Administration
- Local Economic Development: Policy & Practice
- Regional Watershed Management
- Planning Theory and Urban Policy
- Energy Policy and Administration
- GIS in Public Policy
- Case Studies in State & Local Management
- Admiralty and Maritime Law
- Environmental Values, Movements and Policy
- Seminar in Public Administration
- Political Economy of the Environment
- Taxation and Fiscal Policies
- Economics in Public and Nonprofit Sectors
- Organization and Management in Public & Nonprofit Sectors

Licensing Review Courses

- Fundamentals of Engineering (FE) Review Course
- Professional Engineer (PE) Licensing Review Course

Management & Leadership

- Finance Reporting and Analysis
- Data Analysis & Quality Management
- Understanding People in Organizations
- Marketing Management
- Introduction to Public Relations
- Public Relations Writing
- Financial Management
- Public Administration
- Conflict Resolution
- Case Studies in State and Local Management
- Seminar in Public Administration
- Public Management Statistics
- Economics in Public and Nonprofit Sectors
- Organization & Management in Public and Nonprofit Sectors

Roadway Capacity & Design

- Traffic Engineering & Modeling

Structural Engineering

- Statics
- Structural Analysis
- Building Design
- Earth Retaining Structures
- Deep Foundations
- Technology & Computer-aided Drafting
- Statics & Structure of Materials
- Composite Materials Structures
- Theory & Practice of Historic Preservation Planning
- Mechanically Stabilized Earth Walls & Reinforced Soil Slopes

Traffic Engineering

- Traffic Engineering & Modeling

Transportation & Land Use Planning

- Traffic Engineering & Modeling
- Land and Water Management
- Intro to Land Surveying
- Storm Water Management
- Regional Watershed Management
- Planning Theory and Urban Policy
- Theory and Practice of Historic Preservation Planning

Other

- Elementary Statistics
- Urban Communities
- Introduction to GIS
- Documentation of Historic Structures
- Research Methods and Data Analysis

Certificate Programs

- Graduate Certificate in Composite Materials
- Geotechnical Engineering
- Maintenance Engineering

VISITING PROFESSOR POLUS IS INTERVIEWED BY THE WALL STREET JOURNAL

Dr. Avi Polus, visiting Professor with the Delaware Center for Transportation, was recently interviewed by Sharon Begley of the *Wall Street Journal*. The article appeared in the July 1 issue. Because of the importance of the subject matter, we have provided a copy of the article for our readers:

If you plan to hit the roads like the zillions of other drivers this holiday weekend, Avi Polus has a word of advice: patience.

A transportation engineer at Technion-Israel Institute of Technology in Haifa, Prof. Polus's concern isn't drivers' collective blood pressure but traffic flow. Like the growing number of other engineers and physicists who are hubcap-deep in the science of traffic, he is determined to explain infuriating mysteries such as phantom traffic jams (There's no bottleneck or accident at the front of this jam, so why weren't we moving?) and why a brief drop in volume can, paradoxically, trigger a long-lasting traffic jam.

Impatience on two-lane roads actually improves traffic flow, as antsy drivers pass slowpokes rather than letting a convoy form. On highways, however, "passing, aggressive behavior and lane changing is greatly detrimental to the flow," says Prof. Polus.

The reason is that chronic lane changing simulates the "weaving section" of a highway. If an off-ramp lies just beyond an on-ramp, entering drivers merge left (assuming ramps are on the right) and exiting drivers merge right, causing traffic to crisscross like mobile braids. When, in heavy traffic, many drivers change lanes again and again, trying to find the one that is moving faster, the same weaving effect kicks in, reducing the capacity of that section of road.

"Weaving is the worst condition for traffic flow," says Prof. Polus. Because drivers in heavy traffic brake when a car pulls into their lane, and because it takes time to get back up to speed, there are larger and constantly-changing gaps between vehicles. That invites yet more cars to change lanes, propagating a wave of stop-and-go traffic that cuts the number of cars in a stretch of road by about 10%, calculates Prof. Polus, who will present his work at the 16th International Symposium on Transportation and Traffic Theory at the University of Maryland this month. That may not sound so dire, but in rush hour the result is a five-mile backup, his calculations show. In congestion, be content with the lane you're in.

More and more scientists are modeling traffic with equations from the branch of math called nonlinear dynamics, which describes systems that suddenly jump from one state to another. Like water that suddenly freezes, flowing traffic can spontaneously seize up, beginning at a single point of crystallization (the idiots who braked to rubberneck) and causing a wave of high density to spread backward.

Lane closures, on ramps, uphill, chronic lane changing and other "inhomogeneities" in traffic flow can all trigger a density wave, Martin Treiber of Dresden University of Technology has shown in mesmerizing simulations (www.traffic-simulation.de/). One result can be "phantom" jams, which occur so far upstream of the bottleneck that the congestion there has long cleared by the time drivers at the back of the pack reach it. As a result, they never see the snafu that flipped smooth flow into a stop-and-go mess. By one estimate, three-quarters of traffic jams are phantoms.

Carlos Daganzo of the University of California, Berkeley, was puzzled by what highway sensors showed: When congested traffic forms upstream of a bottleneck, the rate at which cars at the front leave the congested area decreases. "It's as if, when a line forms at the popcorn stand, the server slows down, so people leave with their popcorn at a slower rate just because there are more people waiting," he says.

Yet the counterintuitive effect is seen time and again, and in a recent study he and colleagues figured out why. The congestion causes cars to jockey across lanes, ever on the lookout for the faster one. Lane changing increases the gaps between cars, as drivers slow down when someone barges in front of them. Bigger gaps mean fewer cars per second leaving the front of the jam.

If that seems counterintuitive, consider that briefly reducing volume can trigger a stop-and-go wave. Within the region with suddenly fewer cars, perhaps because a long funeral cortege just exited, the emptier road entices drivers to speed up ("Open road — yes!"). But sooner or later, Prof. Treiber notes, these drivers catch up to a denser, slower-moving region. The ensuing braking can trigger the dreaded density wave.

Most jams occur way before a road reaches its capacity, and the culprits are all around you. Even in heavy but moving traffic, inhomogeneities would have much less effect if drivers had faster reaction times. When merging traffic causes the driver in front of you to brake, you do so as well, unless you enjoy fender benders. But because braking takes time, the gap between you and the car ahead shrinks, explains Prof. Treiber. You slow even further until the gap reaches a size you are comfortable with. Result: You are now traveling even more slowly than the car whose braking triggered the stop-and-go wave in the first place. The car behind you does the same, and the effect propagates backward, often for miles.

You can lessen this effect, however. Prof. Treiber suggests looking a few cars ahead so you know when and how much to brake. "If you brake just in time, you can usually safely brake less," he says, "which improves the flow." Consider it a good deed.

U.S. DEPARTMENT OF ENERGY- ENERGY EFFICIENCY AND RENEWABLE ENERGY CLEAN CITIES – ADVANCED TECHNOLOGY VEHICLES

Fuel Cell Vehicles

In response to growing concern over air pollution and our nation's reliance on imported oil, the U.S. Department of Energy has been working with automakers and industry partners to develop vehicle technologies that are virtually pollution free and powered by abundant, renewable, domestic resources. One such promising transportation technology is the fuel cell vehicle.

What Is a Fuel Cell?

A fuel cell produces electricity directly from the reaction between hydrogen (derived from a hydrogen-containing fuel or produced from the electrolysis of water) and oxygen from the air. Like an internal combustion engine in a conventional car, it turns fuel into power by causing it to release energy. In an internal combustion engine, the fuel burns in tiny explosions that push the pistons up and down. When the fuel burns, it is being oxidized. In other words, the fuel combines with oxygen and, as a result, produces energy in the form of heat and mechanical motion. In a fuel cell, the fuel is also oxidized, but the resulting energy takes the form of electricity. What's more, when powered by pure hydrogen, the only by-products of the reaction are heat and water.

A fuel cell power system has many components, but its heart is the fuel cell stack, which is made of many thin, flat cells layered together. (Although the term fuel cell is often used to describe the entire stack, strictly speaking, it refers only to the individual cells.) Each cell produces electricity, and the output of all the cells is combined to power the vehicle.

Fuel Cell Vehicle Availability

There are currently no fuel cell vehicles available for sale in the United States. There are, however, many types of fuel cell vehicles in demonstration. These include light-duty vehicles by most major auto manufacturers, medium-duty vehicles, and buses.

Cost

It is too early to estimate the cost of the first retail fuel cell vehicles. Incentives and rebates may be necessary to help reduce the initial purchase price of these vehicles.

Operational Performance

Fuel cell vehicles are being developed to meet the performance expectations of today's consumers. These vehicles are expected to

be extremely quiet and have very little vibration.

Maintenance Considerations

Because fuel cell vehicles are still in the prototype stage, maintenance and reliability data are unavailable.

Safety

The goal is to develop fuel cell vehicles with levels of safety and comfort that are comparable to those of conventional vehicles. If used, high-pressure hydrogen tanks will be designed for maximum safety to avoid rupture. Additionally, manufacturers are perfecting sensors that will immediately detect impact in the case of collision and additional sensors that will detect any leakage from the hydrogen tanks. In both cases, the sensors will instantly shut the valves on the tanks.

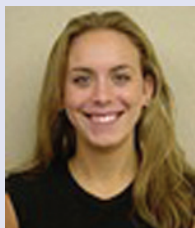
Benefits

Using pure hydrogen to power fuel cell vehicles offers the distinct advantage of zero emissions, but only on the vehicle, not at the hydrogen production source. However, emissions created at a single point of production are often easier to control than those produced by a moving vehicle. A fuel cell vehicle that runs on pure hydrogen produces only water vapor—using any other fuel will produce some carbon dioxide and other emissions, but far less than what is produced by a conventional vehicle.

Fuel cell vehicles are expected to achieve overall energy conversion throughput efficiencies around twice that of today's typical gasoline internal combustion engines. The fuel cell system is being targeted by DOE to achieve 60% efficiency by 2010. Fuel cell vehicles can run on any hydrogen-rich liquid or gas, as long as it is suitably processed. Gasoline is one possibility, but in addition to pure hydrogen, alternative fuels such as ethanol, methanol, natural gas, and propane can also be used.

Hydrogen is the most abundant element in the universe and can be found on Earth in virtually unlimited quantities. Using hydrogen or other domestically produced alternative fuels to power fuel cell vehicles will help reduce our nation's dependence on imported oil.

2005 SUMMER INTERNS GET VALUABLE JOB EXPERIENCES



Lisa Karwoski

Each summer the University of Delaware and the Delaware Department of Transportation cooperate in a symbiotic summer intern program. The University ensures that its students have career related work experiences. DelDOT uses the interns to perform needed work and assesses them as potential full-time employees after they graduate.

This summer 19 summer civil engineering interns (18 from the University of Delaware) are working in many DelDOT offices throughout the state. Some are working on construction and maintenance projects, others are helping to design roads and bridges, and others are dealing with safety and traffic management issues.

One intern, Lisa Karwoski (Class of '06), of Phoenixville, PA, is spending her summer at the Traffic Management Center in Smyrna. Previously, Lisa has worked as an intern for two summers at PennDOT where she helped to analyze unsafe road conditions identified by drivers and local residents. She also learned how proper pavement designs, both concrete and asphalt, can reduce accidents.

Presently, Lisa is working for Randy Grunden who heads up DelDOT's safety studies section. We asked Lisa to describe her duties at DelDOT:

My duty at DelDOT is to learn as much as I can in the few months I have. I am going around to the different sections of traffic, i.e., signs and pavement markings, or the ITS (Intelligent Transportation Systems) Center. I spend roughly 5 days in each section to learn about their contributions to help move the traffic as safely as possible. I have also spent some time with traffic studies which are very important to understanding a problem and what solution would bring the most significant results while still being cost efficient.

We also asked Lisa if her internship was augmenting her coursework with "real life" experiences that help her to prepare for a transportation career:

In the classroom there is always a solution to every problem and you never really have to think outside the box. However, the more time I am spending with DelDOT, I am realizing how much there is never one specific way to solve a given problem. I do see how the equations that I learned in class are used as a starting point, but then you also have to check everything with the MUTCD (Manual of Uniform Traffic Control Devices) to make sure you are in compliance. I believe that when I start my senior year in the fall I will have much more hands on, real life experience than my classmates will have gotten. I am just very grateful for this opportunity that DelDOT has given me for such a detailed insight into transportation and all my experiences here will help me get far in the rest of my career.

Conversations with other interns and their end-of-summer evaluations from past years show that Ms. Karwoski is not alone in her opinions. Most interns report similar learning experiences. Thanks to Ms. Denise Beaston, DelDOT's summer intern coordinator, who also contributed to this article.

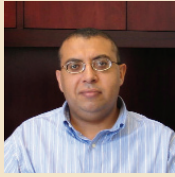
DELAWARE T² CENTER HOSTS REGIONAL MEETING

Clayton Hall on the University campus was the site of the 2005 Region 3 T² Directors' Meeting on June 2-3. Region 3 includes the centers in Delaware, Maryland, Pennsylvania, Virginia, and West Virginia. Guests from the Federal Highway Administration, DelDOT, and local governments also were in attendance.

The directors get together periodically to share ideas and best practices. For example, Delaware discussed its new partnership with the National Highway Institute. Pennsylvania displayed its updated web site which is much more user friendly than its predecessor. FHWA described how it is getting improved data from all 58 centers across the country regarding the training they provide and how state and local transportation agencies are using what they learn.

WHAT ARE OUR FORMER GRADUATE STUDENTS DOING TODAY?

We have contacted four of our graduate students who graduated this year to see what they are doing today and how their studies may have helped with their current position.



KHALED HAMAD received his Ph.D. in Civil/Transportation Engineering in January 2005. He is currently employed as an Assistant Research Scientist with the Texas Transportation Institute – Texas A & M University in San Antonio, Texas. He con-

ducts research in different transportation engineering areas, mainly in intelligent transportation systems. When asked about his studies at the University of Delaware, he replied, "My graduate studies equipped me with the tools that I need to perform the duties of my job. The research I conducted at DCT has helped my learning the basic research skills to conduct my current job duties." For future plans, Dr. Hamad wants to maintain and develop research resources and to obtain his professional engineering licensure.



SHILPA MALLEM received her Masters in Civil Engineering in May 2005. She is currently employed as a Transportation Engineer with Rummel, Klepper & Kahl, LLP, in Dover, Delaware. In her job, she deals with the different transportation aspects of data collection, preparation of traffic studies, preparation of highway engineering designs, using engineering reference guides such as AASHTO and MUTCD, and preparation of cost estimates and design specifications. When asked about her studies at the University of Delaware, she replied, "the graduate program offered in the University of Delaware not only allowed me to build a strong foundation in the various fields of transportation engineering but also helped in honing my presentation and communication skills which are critical in a career which deals with public works."



LAURA BERZINA received her Masters of Applied Sciences in Civil Engineering in May 2005. She is currently employed as a Highway Designer with McCormick Taylor,

Inc., in Newark, Delaware. In her position, she performs highway design calculations and prepares highway construction plans. She prepares specifications related to the development of highway construction projects. She is developing and designing drawings for both new construction and rehabilitation projects, as well as calculating quantities and cost estimates for clients. When asked about her studies at the University of Delaware, she replied, "I was interning in this company a few summers ago. With this experience and my new Master's Degree, it was not a difficult search to get this position. The projects that were done during my graduate studies have helped me to get a better understanding of what is 'out there' and have introduced me to the various sections of the civil engineering field (transportation, planning, design, etc.), making it easier to choose what I would like to do most." For future plans, Miss Berzina would like to obtain her P.E. and become a better engineer in this field.



DAVID MARIO CAPPARUCCINI received his Masters in Civil Engineering in May 2005. He is currently employed as a Traffic Analyst with McCormick Taylor, Inc. in Newark, Delaware. In his job, he is working on various Traffic Engineering

Assignments including capacity analysis, signal design, speed studies and conceptual design. Primarily, he is working on the Traffic Impact Studies (TIS) Review Contract that McCormick Taylor, Inc., has with the Delaware Department of Transportation (DelDOT). When asked about his studies at the University of Delaware, he replied, "my graduate studies helped me by providing me with excellent technical skills (statistical and analytical), and also being able to work well with computers. These skills are essential for the field of transportation engineering. For future plans, Mr. Capparuccini hopes to become more of a technical expert in certain aspects of traffic engineering, while also learning more in the general field of transportation engineering. He hopes to become licensed as a professional engineer in the next few years, and eventually take on managerial responsibilities.

JENNIFER RIGHMAN TO JOIN BRIDGE CENTER



Dr. Jennifer Righman

Dr. Jennifer Righman, who earned her Ph.D. at West Virginia University, is joining the CEE Department faculty and will be affiliated with the Department's Center for Innovative Bridge Engineering. Her Ph.D. dissertation focused on rotation-based moment redistribution design and rating specifications for highway bridges. She also holds bachelor's and master's degrees from WVU, with her master's thesis focusing on the development of an innovative connection for FRP bridge decks to steel girders. Dr. Righman has already published several papers on her work and given a number of presentations at conferences and symposia. "We're very happy to have Jennifer joining us," said Bridge Center Director Dennis Mertz. "Her expertise complements that of our other faculty members, and she will strengthen our research and education programs in bridge engineering."

RESEARCH AND TECHNOLOGY TRANSFER

WHAT CAN WE DO FOR YOU?

The Federal Highway Administration (FHWA) created the Local Technical Assistance Program (LTAP) in 1982 to provide assistance to more than 38,000 local communities across the United States. We continue that effort today through the national network of LTAP centers. The FHWA and State Departments of Transportation provide limited funds each year to support LTAP centers, and the challenge to stretch taxpayer dollars is constant.

From a national perspective, the FHWA *Highways for LIFE* initiative is looking at ways to best utilize resources, lessen congestion, accelerate construction, improve safety, and increase the longevity of our infrastructure. Two components of *Highways for LIFE* deal with the advancement of proven innovations into routine practice, and extensive technology transfer. FHWA Research and Technology professionals and the American Association of State Highway and Transportation Officials (AASHTO) are working together to identify high payoff, ready-to-use technologies. Focus is on deployment of select technologies, products, or processes that are likely to yield significant economic or qualitative benefits. LTAP centers around the country are partnering with AASHTO to solicit new technologies for consideration.

Let's work together to bring this to the local level by identifying Delaware's needs and finding mutual resolutions.

Taking the time to carefully consider implementation of proven technologies and innovations to improve transportation in Delaware is simply the right thing to do. We encourage you to share your ideas with the Delaware LTAP Center Program Coordinator, the Delaware Department of Transportation Research Coordinator, or our local FHWA Division Office Transportation Specialist. For more information on the FHWA and AASHTO list of market-ready technologies and innovations as well as the *Highways for LIFE* initiative, see <http://www.fhwa.dot.gov/rnt4u>

We're very proud of Delaware's LTAP Center and the important role it fulfills. Located at the Delaware Center for Transportation on the campus of the University of Delaware, the LTAP Center staff strives to enable counties, cities, towns, and municipalities to improve their roads and bridges by providing training, sharing information on new and existing technology updates, and by delivering personalized technical assistance. We work in close partnership with DelDOT and the LTAP Center in our quest to provide excellent customer service. Please let us know what we can do for you.

For more information about FHWA, refer to our agency website at <http://www.fhwa.dot.gov>

Rosemary Samick

Transportation Specialist

FHWA Delaware

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DELAWARE CENTER FOR TRANSPORTATION'S NEW VAN ARRIVES



Wanda Taylor, Assistant to the Director of DCT, (left) stands along side of the new 2006 Ford 8-passenger van purchased by the Center. The additional van will be an asset for meetings, trips to DelDOT, projects and data collection performed by our graduate students.

Mid-Atlantic Pedestrian Safety Forum



at
The University of Delaware
September 7, 2005

Join us for an exciting day to share best practices to help improve pedestrian safety. You will be involved in valuable pedestrian discussions and issues that can help improve your pedestrian programs and enhance your current efforts to reduce pedestrian injuries and fatalities. This is open to all individuals interested in improving pedestrian safety.

Place: The University of Delaware, Newark, Delaware

Agenda

- 8:30 - 9:15** Welcome and Opening Remarks
- 9:15 - 9:30** Break
- 9:30 - 11:30** Breakout Sessions
 - Development of Statewide and Local Pedestrian Safety Plans
 - Pedestrian Issues and Crash Reduction Programs in Large Cities
- 11:30 - 12:30** Lunch (Provided)
- 12:30 - 2:00** Breakout Sessions
 - Accessibility/ADA Issues
 - Pedestrian Data Needs and Issues
- 2:00 - 2:30** Break
- 2:30 - 4:00** Breakout Sessions
 - Working with Local Advocacy Groups
 - Incorporation of Pedestrian Needs in Highway Design Standards
- 4:00 - 4:15** Closing Session



Registration

You can register online by accessing:
www.engr.udel.edu/outreach/DelawareT2courses.html
 Or by calling: **302-831-8302**
 Registration Fee: \$50

Accommodations

A block of rooms has been reserved through August 17th at the Marriott Courtyard Newark - University of Delaware. The standard room rate is \$129 plus tax. A government room rate of \$108 plus tax is available. You can access their web site at: www.marriott.com
 Or contact the Marriott Courtyard Newark directly at (302) 737-0900.
 (When reserving a room, be sure to mention the Mid-Atlantic Pedestrian Safety Forum.)

For additional information about the forum, contact Mr. Patrick Kennedy at (302) 734-5326 or send him an e-mail at Patrick.Kennedy@FHWA.DOT.GOV

Sponsored By

**Federal Highway Administration
 National Highway Traffic Safety Administration
 Delaware Office of Highway Safety
 Delaware Department of Transportation
 University of Delaware**

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The mission of the Delaware Center for Transportation is to improve the movement of people, goods, and ideas within, to, and through the State of Delaware, the mid-Atlantic region, the nation, and the world through research, development, and education.