

# TranSearch

## DELAWARE CENTER FOR TRANSPORTATION

Your main resource for transportation education and research

Summer 2003

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### DELDOT USES SATELLITE TECHNOLOGY TO MONITOR STATEWIDE TRAFFIC CONGESTION



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It is a well-known fact that the beaches of Delaware act as a main source of attraction to the tourists during summer from Delaware and beyond. This automatically results in an increase in the vehicular traffic. Also, studies show that the traffic is increasing in leaps and bounds with every passing year. In the year 2002 the vehicular traffic had increased by 1,899 vehicles in a single month, at a single beach in Delaware. This increase in traffic in turn leads to greater congestion, increased travel time and increased delays not only on the roads near the beaches but all those roads in Delaware which lead to the beaches directly or indirectly.

This scenario brings into view the necessity of travel time and delay studies. The solution for this problem demands accurate and timely traffic data. The analysis of the data collected from these studies is useful not only to ease the congestion by proper monitoring of traffic but also for the further planning and development of the roads.

Since 1997, a research team, led by Dr. Faghri of the Delaware Center for Transportation, has been collecting traffic data in Delaware. The project funded by the Delaware Department of Transportation, covers all the major routes in the State on a county by county basis. The data is collected on more than 25 major roads including

I-95, US 13, US 113, SR 1 and SR 896 covering more than 1300 miles. A considerable amount of research was put into the project before its initiation. The original idea was proposed by Mr. Ralph Reeb, the current director of Planning at DelDOT. The research satisfactorily established that the collection of data using a Satellite-based Global Positioning System (GPS) is far more superior, reliable, faster, efficient and accurate and almost 50% cheaper than the conventional manual methods which only covered a small fraction of the current total mileage. The data is automatically captured by the GPS instrument into a laptop while traversing the route. In this project, every major road is divided into segments and the data is collected for each and every segment separately. The data is collected on both sides of divided highways during the peak hours so as to seek a better insight into the congestion on the roads. This enables a macroscopic, as well as microscopic, analysis of the data.

The process is carried out twice every year – once during the summer and the other during the fall. The data collected during the summer clearly shows the congestion due to the attraction from the beaches whereas the data collected during fall shows the congestion, mostly in the Northern part of the State. This can be mainly attributed to the people from Delaware and the neighboring states commuting to and from their work places.



UD Students use satellite receiver to collect congestion data

Story continued on page 3

### In This Issue

DelDOT Uses Satellite Technology to Monitor Statewide Traffic Congestion	1	Opportunities	7
Message from the Director	2	DSWA Computerizes Routing of Recyclables	8
Distinguished Guest Speaker Series	2	Pavement, Materials & Construction	9
Research	4	I-95 Bridge Crack Repair	9
T <sup>2</sup> Program	6	Technical Assistance	10
Summer Interns	7	Transportation Education & Research Forum	11

## MESSAGE FROM THE DIRECTOR



Ardeshir Faghri, Director

First and foremost, let me thank all those who read our first newsletter, contacted our Center and expressed their interest in participating in the different activities that we offer. The participation of our constituents in our activities is a key to the overall success of the mission of the Center and for achieving of the goals that we have set for ourselves. Since our last newsletter, the Center staff has been hard at work, continuing with our original initiatives and supplementing them with many programs that have enhanced the cooperation between DelDOT and DCT and have greatly contributed to the Center's programs.

We kicked off our Distinguished Guest Speaker Series with an excellent presentation by Dr. Nigel Wilson of the Department of Civil and Environmental Engineering at MIT. An international authority on Public Transportation, Professor Wilson presented a talk on the differences between public transportation systems in Europe and America. His speech was attended by over sixty participants from DelDOT, Delaware Transit Corporation (DTC), WILMAPCO, and many students and faculty from the Colleges of Engineering and Human Services, Education and Public Policy.

Senator Thomas Carper is scheduled to be our second speaker in the Fall of 2003. Senator Carper is a member of the public works committee which has jurisdiction over AMTRAK and transportation security issues.

Our Technical Assistance initiative in the form of providing Literature Search reports on projects which did not get a high enough priority to be funded, was a big success. We provided seventeen reports to the Project Managers at DelDOT and DTC who had requested the projects. The reports documented some of the latest information available on the subject matter. For next year, we are working on supplementing our Technical Assistance program with verbal presentations, as well as providing one-on-one discussions and implementation for each project.

Our Industrial Collaboration/Private Partnership also saw many activities. Many companies called our Center and expressed their willingness to contribute in different ways to the different programs that we offer at the Center. Submitting joint proposals to the different government agencies, providing student scholarships, participating in our courses, workshops and seminars are just some of the examples of these different types of collaborations that we have been pursuing with our partners in the private sector. We have every intention to increase our level of cooperation with our private partners in the coming months.

Our most important mission of providing quality education and research is also going forward with full force. We have been offering more courses and have been trying to be even more responsive to the educational needs of the transportation community in Delaware and the surrounding region. Our last year's research program ended successfully and we started a group of new projects this year, all of which are described in the upcoming pages of this newsletter. Many efforts are currently underway by the Center staff to increase our federal research funding for the coming years.

As yet another sign of mutual and cooperative effort between DCT and DELDOT, the Center obtained a contract to conduct DelDOT's internship program this summer. Accordingly, we chose fifteen of our most talented students to participate in a three-month long internship program in different divisions and district offices within DelDOT. If successful, we will most likely continue this program into next year and possibly beyond.

Transportation Education and Research Forum, in which all the parties interested in the health and well-being of the transportation system in Delaware and the region participate to express their ideas, will take place on November 6, 2003 in Clayton Hall on the campus of the University of Delaware. Federal, State and local government agencies, private corporations, students and faculty, as well as public at large will participate in this important event to tell us and identify what they perceive to be as the most important and critical issues facing the transportation in Delaware and the surrounding region. After publishing the results of the forum and distributing the report to all the participants and others, we study the generated issues carefully, share them with the different government agencies involved with transportation and see how we can use those issues to generate research and education ideas.

Again, a big thanks to all those who have been working jointly with the Center and helping us realize our potential as a top transportation education and research Center in the world. We have many new and exciting programs coming up in the next few months. Please check our new web-site at <http://www.udel.edu/dct> for the latest information on our different programs.



Dr. Nigel Wilson  
Professor of Civil  
Engineering, MIT

### DISTINGUISHED SPEAKER SERIES

The Delaware Center for Transportation was privileged to have Dr. Nigel Wilson, Professor of Civil and Environmental Engineering at the Massachusetts Institute of Technology, as their distinguished guest speaker on March 25, 2003. He presented a seminar on "Public Transport: US versus Europe." The seminar was attended by students, faculty and staff of the University, employees of DelDOT and other government agencies and people from private industries.

Dr. Wilson is internationally known for his work in Public Transit. He is currently directing a major long-term joint research and education program between MIT and the University of Puerto Rico in support of the Tren Urbano project, the planning and construction of a new urban rail system in San Juan, Puerto Rico. Dr. Wilson also directs a major research program with the Chicago Transit Authority which is patterned on the Tren Urbano program. He has directed research activities in workforce planning in the transit industry, short-range transit planning methods, the role of private operators in public transportation and the potential for computers and communication systems to improve the performance of transit systems. He has written more than 75 articles and reports on the results of this research. During two leaves from MIT, he worked directly in two large transit agen-



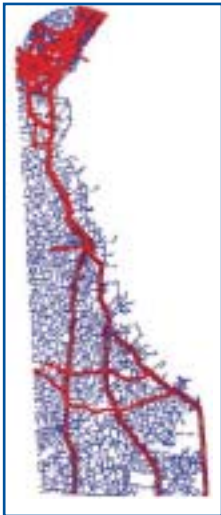
cies, the Massachusetts Bay Transportation Authority and London Transport, and has also consulted to a number of other North American transit authorities.

In the seminar, Dr. Wilson said that public transport plays a much greater role in Europe than in the US. He reviewed the differences in roles and some of the important reasons for these differences including major differences in government funding and policies towards the transit system as well as the auto/highway system, differences in urban structure and differences in the transit services provided. In both continents important changes are underway which may change the relative positions of transit and auto with the emphasis in Europe being on further auto restraints and restructuring of

the way transit service is delivered, while the emphasis in the US is increasing on finding ways to improve bus service quality through strategies falling broadly under the title of bus rapid transit. In both continents the challenge is to find ways to attract the increasingly large numbers of travelers who have the choice of using their own car or taking transit and the degree of effectiveness in answering this challenge will determine the future prospects for public transport.

This fall our distinguished guest speaker will be Senator Tom Carper. Senator Carper is very active with transportation security and Amtrak issues. For more details, check our website: [www.udel.edu/dct](http://www.udel.edu/dct).

*Story continued from cover*



Application of GIS technology enables the simplification of the data analysis. This image obtained from GIS in which the roads covered by the project are highlighted in red.

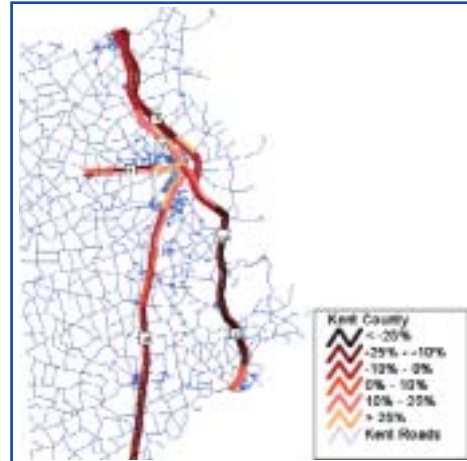
The data and the information derived from it are critical in analyzing the travel patterns and monitoring the congestion on the roads in Delaware. For better understanding and convenience in interpreting the data, it is converted into a format adaptable into a Geographic Information System (GIS). In simple terms, a GIS is a system which can give a visual depiction of the critical information of an event i.e., information about what has occurred and the place where it has occurred. This information has been interpreted on a map of Delaware. The information is stored in the form of layers which can be overlaid upon one another for the simplification of the analysis.

The data collected on the field is converted into a format adaptable into the GIS. Parameters such as the Mean Peak Travel Speed, Mean Peak Travel Time, Percentage time in Delay, etc., which are calculated from the raw data, can be graphically represented on a map of Delaware using GIS. They can be represented either individually or in a combination. The information depicted can be obtained at the click of a button. GIS also has the capacity to store a tremendous amount of

data which can be retrieved when necessary. This depiction makes the data simple to understand and analyze.

Every year, together with Dr. Faghri, a number of graduate and undergraduate students are involved in the collection and analysis of the data. The project has also served as a basis for a few Masters Theses. It thus serves as an excellent learning experience and exposes the students to the latest technologies in the field of Traffic Engineering. The Center also houses the software required to convert the data captured by the GPS instrument into a user-friendly format with minimum effort.

The DCT through this project has provided The Delaware



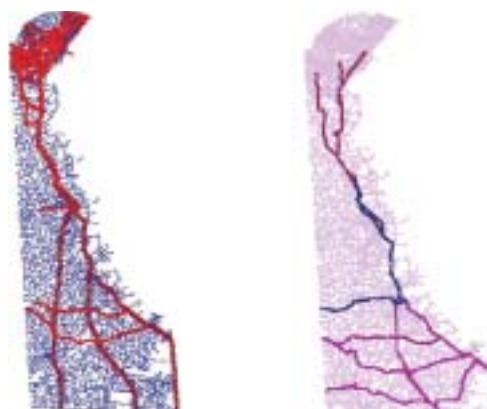
Percentage difference between average and posted speed is one of the important parameters which help in determining the conditions of the route. Above is an image showing the routes in Kent County which are color-coded according to the Percentage Difference between Average and Posted speed of the route.

Department of Transportation with the analyzed data, results and conclusions derived from the data and the relevant suggestions. These results are helping The Delaware Department of Transportation to undertake measures which would improve the road conditions in the State and would make the roads safe and convenient to drive upon.

In summer, due to the increase in traffic on roads leading to the beaches, it becomes absolutely necessary to concentrate on these roads while conducting travel time and delay studies. The below GIS image shows the roads covered by the project in summer. These routes can be compared with the image below which shows the routes covered in fall. In fall, stress is laid on the routes in North Delaware as the roads leading to the beaches do not have heavy traffic except in summer.



This picture shows one example where GIS can be used for analysis. The roads are color-coded according to their Level of Service (LOS). Images such as above obtained using GIS help in a better understanding of the data.



Fall Coverage

Summer Coverage

Article Submitted by: *Shilpa Mallem*  
Graduate Student, Civil Engineering

# Research

During the 2003-2004 fiscal year the Delaware Center for Transportation's project investigators have been busy doing research for specific needs for DelDOT. We have completed and published six project reports. Check our website for an abstract of each report.

- **Load Rating of Arch Bridges.** October 2002  
by Michael J. Chajes in cooperation with  
Project Manager, Dennis O'Shea, DelDOT.
- **Inspection Guidelines for Construction and Post-Construction of Mechanically Stabilized Earth Wall.** November 2002  
by Dov Leshchinsky in cooperation with  
Project Manager, Dennis O'Shea, DelDOT.
- **Creating Cooperative Transportation Agreements (CTAs).** March 2003  
by Carol R. Denson in cooperation with  
Project Manager, Stephen Kingsberry, DelDOT.
- **Standards for Transportation Related GIS Data.** March 2003  
by David P. Racca in cooperation with  
Project Manager, Mary Raley, DelDOT.
- **Jurisdictional Maintenance Project.** March 2003  
by David P. Racca in cooperation with  
Project Manager, William Brockenbrough, DelDOT.
- **Application of Global Positioning System (GPS) to Travel Time and Delay Measurements: 2001 Phase.** April 2003  
by Ardeshir Faghri in cooperation with  
Project Manager, Dan LaCombe, DelDOT.

Research is a very important component of the Delaware Center for Transportation. In January 2003 we met with DelDOT's Research Committee to identify and prioritize the most important transportation problems facing DelDOT. For the 2003-2004 fiscal year the Center will be doing research for DelDOT on the following projects:

## HMA Specification Research

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

Principal Investigator: Nii Attoh-Okine, Department of Civil and Environmental Engineering  
Project Manager: Wayne Kling, Division of Highway Operations

## 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 and Policy

## 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

## 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, Department of Civil and Environmental Engineering  
Program Manager: Dan Lacombe, Division of Planning and Policy

## The current active research projects include:

### 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, Department of Civil and Environmental Engineering  
Program Manager: William Brockenbrough, Division of Project Development

### 2002-2003 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, Department of Civil and Environmental Engineering  
Program Manager: Dan Lacombe, Division of Planning and Policy

### 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  
Program Manager: Chip Rosan, Roadside Environment

**Process Control ADA Eligibility Model for DART First State Paratransit**

This project will help transit providers to develop and implement eligibility methods as stated in the Americans with Disabilities Act of 1990, as well as to meet local demographic situations and local governmental needs for the State of Delaware.

Principal Investigator: Carol Denson, Department of Consumer Studies

Project Manager: Bonnie Hitch, Delaware Transit Corporation

**Resilient Modulus of Construction Materials**

This project will conduct a laboratory resilient modulus test on pavement materials from the State of Delaware to characterize their behavior under different traffic loadings and environmental conditions; and to provide input necessary for modeling the material with the mechanistic pavement design and evaluation.

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

Project Manager: Wayne Kling, Division of Highway Operations

**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: Mike DuRoss, Division of Planning and Policy

**Factors That Affect and/or Can Alter Mode Choice**

This project will investigate ways of developing better methods of estimating mode share in light of specific factors present in a given trip.

Principal Investigator: Edward Ratledge, Center for Applied Demography and Survey Research

Project Manager: Dan LaCombe, Division of Planning and Policy

**Analysis and Design of Multi-tier Mechanically Stabilized Earth Wall Systems**

This project will give a simplified design methodology for multi-tier MSE wall that is compatible with AASHTO.

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

Project Manager: Dennis O'Shea, Division of Preconstruction

**Application of Load Resistance Factor Rating Using Site Specific Data**

This project will develop a method for load rating bridges using site-specific response data and probabilistic methods which will enhance DelDOT's ability to ensure the safety of the traveling public, route permit vehicles through the state safely and efficiently, and better allocate limited funds for bridge repairs or replacement.

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

Project Manager: Dennis O'Shea, Division of Preconstruction

**Environmental Impact of Growth in Delaware**

This project will assess the environmental impacts of new single family residential land use, relative to older, established medium and high-density residential areas of northern Delaware. It will determine the relative expense of sprawling low density growth as compared to rejuvenating existing urban areas.

Principal Investigator: Edward Ratledge, Center for Applied Demography and Survey Research

Project Manager: Joseph Cantalupo, Division of Planning and Policy

**Selection of Appropriate Design Speed in the State of Delaware**

This project will research and provide DelDOT with the most up-to-date and accurate methods for selecting design speeds. It will allow engineers to easily and efficiently select the appropriate design speed for a roadway, based on the existing or proposed roadway, traffic, and environmental conditions.

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

Project Manager: Michael Balbierer, Division of Preconstruction

**High Performance Concrete for Bridge 8F in Frederica, Delaware**

This project is for gaining an understanding of the actual post-construction performance of HPC bridge structures from both a materials- and a structural-behavior perspective.

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

Project Manager: Muhammad Chaudhri, Division of Preconstruction

**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

**Examination and Application TRANSIMS**

This project will examine TRANSIMS and how it will match the needs for travel demand analysis in Delaware. It will produce a preliminary user's manual for DelDOT's use.

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

Project Manager: Mike DuRoss, Division of Planning and Policy

**Structural Health Monitoring of Delaware's Transportation Infrastructure**

The project will enhance the prototype ISBMS to allow for near real-time remote access of the recorded data via a cellular modem and development of a web based interface for data display and retrieval by DelDOT engineers. Also, to review and evaluate Delaware's ITMS as a potential network for structural health monitoring of the State's transportation infrastructure.

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

Project Manager: Joe Vogel, Division of Preconstruction

For more information related to bridge research, contact Diane Kukich at the Center for Innovative Bridge Engineering, 302-831-1721, or email: dkukich@udel.edu.



# EDUCATION T<sup>2</sup> PROGRAM

The previous issue of TranSearch offered a short history of the T<sup>2</sup> Program nationally and in the State of Delaware. In this issue we will look at some of our accomplishments during 2002, the year we relocated to the University of Delaware.

Every year each of the 58 T<sup>2</sup> Center summarizes its activities in a report to the Federal Highway Administration. The information in the following table shows various activities for the Delaware T<sup>2</sup> Center and for all the centers across the country.

2002 Activities	DE	USA
Agencies Served	60+	12,500
Persons Trained	1500	115,000
Newsletter Circulation	550	131,000
Distribution of Materials	350	250,000

**Agencies Served:** Most states have extensive county and local highway and transit systems. Delaware is much more centralized than the typical state. DelDOT has jurisdiction over 90% of the streets and highways and all of the other modes of transportation. Nevertheless, there are 640 miles of town and city maintained streets throughout the state. Most local governments have little dollars available for training or technical advice. The T<sup>2</sup> Center provides these services at no cost. DelDOT is also a very important customer. Many T<sup>2</sup> workshops and courses are directly targeted to meet DelDOT's needs. We also work with WILMAPCO, the Dover-Kent MPO, the Delaware River and Bay Authority, and the Federal Highway Administration.

**Persons Trained:** Fifteen hundred transportation agency staff and others attended workshops, courses, and conferences sponsored or co-sponsored by the T<sup>2</sup> Center. The great majority came from DelDOT and Delaware's local governments, but a few were from surrounding states. In cooperation with the Maryland T<sup>2</sup> Center, we are making a special effort to work with transportation agencies on the Eastern Shore who sometimes find it difficult to travel to the Baltimore-Washington area.

**Newsletter Circulation:** Every T<sup>2</sup> Center publishes a periodic newsletter that included information on new products, completed research, better management practices, and many other transportation issues. Our newsletter is circulated to more than 500 transportation decision makers in Delaware.

**Distribution of Materials:** The T<sup>2</sup> Center sent printed reports, CD-ROMS, and video tapes to all of our customers on request. These materials may, for example, discuss improved methods to remove snow and ice, improved communications tools to improve staff productivity and morale, or very technical applications to ensure the selection and installation of improved pavements.

When looking at the magnitude of national activities, it appears that a great number of people are reached by the T<sup>2</sup> Centers. Actually, the national association of T<sup>2</sup> Centers (the Delaware T<sup>2</sup> Center is an active member) estimates that less than half of the country's transportation agencies take part in T<sup>2</sup> programs. There appear to be three reasons for this. First, each Center's budget limits the number of outreach activities it may produce. Second, most Center's charge for their programs, and many smaller agencies cannot afford even these modest fees. Third, many agencies complain that they can't afford "time lost from the job" to train their employees. These are all valid issues that we will discuss in the next issue of TranSearch.

Delaware Center for Transportation

## DELAWARE T<sup>2</sup> CENTER EVENTS CALENDAR

### Fall 2003

*Lecture by The Honorable Thomas Carper, United States Senator from Delaware*

Senator Carper is a member of the Senate Public Works Committee that has jurisdiction over transportation security matters and Amtrak. A specific date will be set soon and widely disseminated. This event will take place at the University of Delaware main campus.

### September 8-9, 2003

*National Highway Institute Course 231022A, Federal-Aid Highways-101 Kent Poly Tech High School Adult Conference Center, Woodside, DE*

This 2-day course provides an overview of the key elements of the Federal-Aid Highway Program and its general requirements and laws. Target audience: Delaware DOT, MPOs, and consultants.

### September 16-17, 2003

*National Highway Institute Course 151018A, Application of the FHWA Traffic Monitoring Guide.*

*Delaware Technical and Community College, Dover, DE*

This 2-day course discusses federal traffic monitoring procedures. Accurate traffic counts and related information are essential to analyzing highway system performance and planning future improvements. Target audience: state and local transportation planners and engineers and consultants.

### September 18, 2003

*Winter Survival Techniques*

*Delaware Technical and Community College, Dover, DE*

A one-day course explaining how snow removal crews can minimize the dangers of very heavy snows, extremely cold temperatures, fatigue, and other severe conditions. Taught by Steve Jenkins of the Montana T<sup>2</sup> Center – plenty of snow there! Target audience: state and local snow removal crews and supervisors.

### September 23-24, 2003

*ITS – Managing Traffic Congestion*

*Delaware Technical and Community College, Dover, DE*

This 2-day course looks at causes for both recurring and nonrecurring traffic congestion and suggests ITS strategies for overcoming congestion. Target audience: State and local transportation planners and engineers who can apply ITS techniques to traffic congestion problems. Also open to consultants.

### November 6, 2003

*2003 Research and Education Forum Clayton Hall, University of Delaware*  
See additional article for more information.

## COURSES BY T<sup>2</sup> ENGINEER

This fall's courses to be taught by Alan Kercher, P.E., T<sup>2</sup> Engineer, are under development. Full details will be announced later on the DCT web site.

Most events presented by the T<sup>2</sup> Center are free to public sector employees in Delaware and to employees of the United States Department of Transportation. Public sector employees from other states, consultants, and others pay modest fees. For more particulars and to register for courses on-line, please visit this web site: [www.engr.udel/outreach](http://www.engr.udel/outreach). Click on the T<sup>2</sup> logo and find the event of your choice.

## FALL 2003 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 hard skills courses that the University will offer during the Fall 2003 semester. This list is provided as a guide. For more information about a particular course, see the Fall 2003 Educational Opportunities for the Transportation Community, a DCT booklet mailed to all newsletter recipients. Also refer to the Fall '03 Undergraduate and Graduate Registration Booklet and the Fall 2003 Professional and Continuing Studies Bulletin available in print or at [www.udel.edu](http://www.udel.edu).

### Construction

Construction Management and Engineering  
Civil Infrastructure Systems  
Foundation & Geotechnical Engineering Design  
Mechanically Stabilized Earth Walls & Reinforced Soil Slopes  
Ground Improvement Technologies and Systems

### Environmental Engineering

Introduction to Environmental Engineering  
Fluid Mechanics  
Environmental Engineering  
Solid Waste Management  
Water & Wastewater Quality  
Water & Wastewater Engineering  
Principles of Modern Water & Sediment Quality Criteria  
Water Resources Engineering  
Chemical Aspects of Environmental Engineering  
Physical Aspects of Environmental Engineering  
Fate of Organic Pollutants in the Environment  
Land and Water Management  
Storm Water Management  
Coastal & Maritime Law  
Soils and Environmental Issues  
Politics & the Environment  
Ground Improvement Technologies & Systems

### Geotechnical Engineering

Soil Mechanics  
Soil Mechanics Lab  
Foundation & Geotechnical Engineering Design  
Ground Improvement Technologies & Systems  
Mechanically Stabilized Earth Walls & Reinforced Soil Slopes

### Government Policy

Solid Waste Management  
Marine Transportation Policy  
Coastal & Maritime Law  
Environmental Ethics  
Soils and Environmental Issues  
Introduction to Public Policy  
Public Administration  
Urban Politics and Community Development  
Regional Watershed Management  
Planning Theory & Urban Policy  
Case Studies in State & Local Management  
Cyberlaw & E-Liability: Issues for Managers  
Contemporary Topics in Urban Affairs & Public Policy  
GIS in Public Policy  
Environmental Values, Movements & Policy  
Seminar in Public Administration  
Economics in Public & Nonprofit Sectors  
Organization & Management in Public & Nonprofit Sectors  
T<sup>2</sup> Short Course: Highway Program Financing  
T<sup>2</sup> Short Course: Application of the FHWA Traffic Monitoring Guide

### Licensing Review Course

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

### Maintenance

Bridge Maintenance

### Management & Leadership

Construction Management & Engineering  
Civil Infrastructure Systems

- Emphasis is placed on courses scheduled after 4:00 p.m. to address the needs of full-time workers. Those who may want to take day courses should consult the publications listed above.
- Courses are not reserved exclusively for DelDOT staff. Staff of federal, local, and other state agencies and consultants are encouraged to attend as well.
- Participants and their employers are responsible for taking care of tuition, fees, time off, supervisory approval, etc.
- It is important to meet all deadlines regarding registration, payments, etc.

Introduction to Public Relations  
Public Relations Writing  
Oral Communications in Business  
Introduction to Public Policy  
Public Administration  
Leadership in Organizations  
Case Studies in State & Local Management  
Cyberlaw & E-Liability: Issues for Managers  
Dealing with Cultural Differences & Organizational Advancement  
Performance Management  
Seminar in Public Administration  
Qualitative Methods for Program Evaluation  
Public Management Statistics  
Economics in Public & Nonprofit Sectors  
Organization & Management in Public & Nonprofit Sectors  
Human Resources Management in the Public & Nonprofit Sectors  
T<sup>2</sup> Short Course: Highway Program Financing  
T<sup>2</sup> Short Course: Application of the FHWA Traffic Monitoring Guide

### Roadway Capacity & Design

Traffic Network Simulation & Modeling  
T<sup>2</sup> Short Course: Application of FHWA Traffic Monitoring Guide  
T<sup>2</sup> Short Course: Intelligent Transportation Systems (ITS)-Managing Traffic Congestion

### Structural Engineering

Structural Analysis  
Building Design  
Structural Dynamics Design  
Foundation & Geotechnical Engineering Design  
Advanced Steel Design  
Composite Materials Structures

Mechanically Stabilized Earth Walls & Reinforced Soil Slopes  
Ground Improvement Technologies & Systems

### Traffic Engineering

Traffic Network Simulation & Modeling  
T<sup>2</sup> Short Course: Application of the FHWA Traffic Monitoring Guide  
T<sup>2</sup> Short Course: Intelligent Transportation Systems (ITS)-Managing Traffic Congestion

### Transportation & Land Use Planning

Urban Transportation Planning  
Civil Infrastructure Systems  
Traffic Network Simulation & Modeling  
Land and Water Management  
Intro to Land Surveying  
Storm Water Management  
Regional Watershed Management  
Planning Theory & Urban Policy  
GIS in Public Policy  
T<sup>2</sup> Short Course: Application of the FHWA Traffic Monitoring Guide  
T<sup>2</sup> Short Course: Intelligent Transportation Systems (ITS)-Managing Traffic Congestion

### Other

Reliability of Engineering Systems  
Introduction to Finite Element Method  
Urban Communities  
GIS in Public Policy  
Info Technology in the Public & Nonprofit Sectors

### Certificate Programs

Graduate Certificate in Composite Materials  
Geotechnical Engineering  
Maintenance Engineering

## DCT MANAGES 2003 DELDOT SUMMER INTERN PROGRAM

Many accomplished transportation professionals say that their younger colleagues, recent graduates, have relatively little "real world" knowledge or experience. While these recent graduates are usually academically proficient, they are not equipped to deal with many problems faced daily by state and local transportation agencies and consultants. Such problems include negotiating with irate citizens, managing contractors, or quickly recognizing low-cost and practical solutions to quickly deteriorating situations.

The Delaware Center for Transportation has recently taken two steps to give our undergraduate and graduate students more "real world" experience.

Two graduate students, Brigitte Odum-Ewuakye and Stephen Mensah, took part in a meeting between the T<sup>2</sup> Circuit Rider, Alan Kercher, P.E., and the City of Newark, Public Works Department. The Circuit Rider makes on-site visits to Delaware's towns and cities, to provide technology transfer and technical advice on a variety of transportation issues. During the meeting the discussion focused on the pavement management system that the T<sup>2</sup> Center is helping the City to install and operate. Matter-of-fact concerns such as pavement rehabilitation strategies, project scheduling priorities and budgetary restrictions were all on the table. Both students came back to campus with a richer understanding of local government problems.

Fifteen students are participating in the joint DCT/DelDOT Summer Internship Program. DelDOT has hired summer employees before, but this is the first year that the University has played such a major role in the program. The DCT and the Institute for Public Administration are making

regular visits to the students. They are also working closely with DelDOT supervisors and mentors to ensure that each student has a meaningful summer experience. Our students are assigned to several DelDOT buildings and construction sites throughout the state. They are working on construction, maintenance, planning, traffic operations, utilities, and subdivision projects.

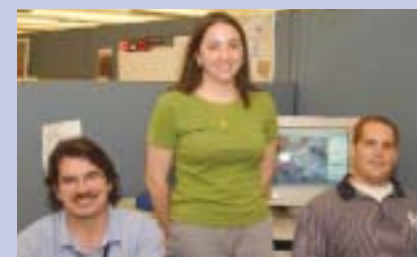
In early July 2003, each intern and DelDOT mentor wrote a short summary of his or her experiences during the first month of work. The following three quotes from interns illustrate that the program is working.

"This past month has been a very amazing learning experience."

"I have begun to learn many of the basic concepts of civil engineering."

"All the theory, methods and techniques that I have learned in school are being put into practice."

We will prepare a complete evaluation of this year's summer intern program after it finishes the end of August.



Three of the fifteen interns shown (from left) Bill Schiavi, graduate student in Urban Planning, Evy Vlahos and John Tilson, both seniors in Civil Engineering.

# DSWA Computerizes Its Routing of the Recycle Delaware Program

The RECYCLE DELAWARE Program is a voluntary source-separation recycling program. At no cost to taxpayers, Delaware Solid Waste Authority (DSWA) operates the statewide program, which averages three million pounds of recyclables received each month.

Besides other problems related to recycling of waste materials and avoiding environmental pollution that may result as a by-product, DSWA has to face another issue which is related to routing of recycle technician trucks. Each morning 9-10 trucks move out of the Delaware Recycling Center for inspection purposes throughout North and South Delaware. The major problem faced by managers each morning is to decide the route that each truck will follow so that all the sites spread throughout the state of Delaware are visited in minimum possible time. The number of available drivers and trucks changes each morning. In fact the sites which need to be visited also changes each morning making the routing problem more complex and intriguing for the managers. This problem



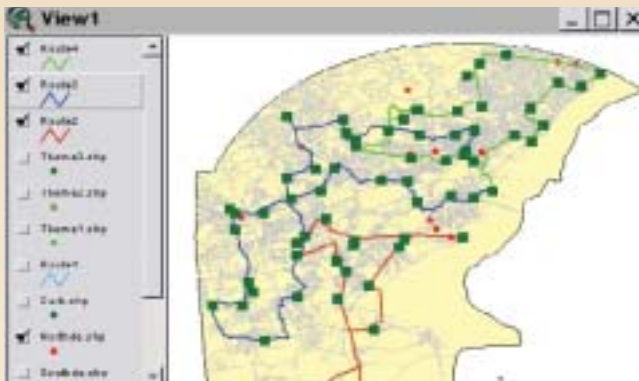
GIS in action

faced by DSWA is not new but has been mentioned time and again in various transportation research papers and is formally called the Vehicle Routing Problem.

This is where the Delaware Center for Transportation steps in. Over the past 2 year researchers at DCT led by Dr. Faghri have developed a software tool which automates the route determination process for managers at DSWA. The software based on Geographic Information System (GIS) makes the life of managers easy by giving them the flexibility of changing the number of routes to be generated, changing the number of sites to be



An example of DSWA Recycle Delaware Program bins



Network of routes generated by the Decision Support System

visited every day and managing the site database. The software tries to generate the most efficient route such that the total time taken for waste collection is minimized and also the route generated is logical and more organized.

The research team worked with DSWA managers, traveled with recycle technicians, collected field travel time data and finally came up

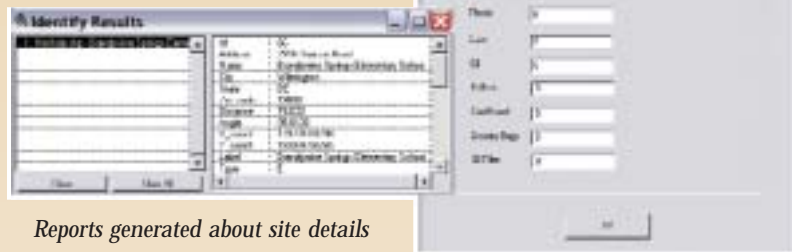


Finding closest collection sites around a given address

with a custom routing algorithm which serves the needs of Recycle Delaware program the best. The Shift and Swap algorithm which is heuristic in nature has been designed to solve specifically the Recycle Delaware routing problem working under various constraints such as truck volume, service time and travel time. The algorithm that has come out of this intensive research is not only computationally efficient but is also easy to implement.

A possible application of this software tool for DSWA would be in handling the bids that various contractors place for material collection. The estimates indicated by the contractors can be verified by DSWA managers using this tool which gives a fair and balanced idea of the travel time involved in the routes.

The software has been rightly nicknamed Decision Support System as it not only helps managers in deciding



Reports generated about site details

the most optimum route sequence but also provides unique features such as Find Closest Site, Get Site Information, and Locate Sites on the basis of site characteristics. The end user can input an address and the tool finds all the collection sites closest to the given address within a certain radius. It not only locates the sites on the map but also provides driving directions from the given address.

Finding site details such as geographic location of the site, solid-waste bin details, travel time, service time, etc. was never so easy. With just a few clicks customized reports on site details can be generated and printed.

Presently the research team is working on extending the software to include the curbside collection program introduced recently by DSWA in the state of Delaware.

Article Submitted by: Vishal Arora  
Graduate Student, Computer Science



## Pavement, Materials and Construction Engineering

The Pavement, Materials, and Construction Engineering Program at the University of Delaware was initiated in August 1999, when Dr. Nii Attoh-Okine joined the Department of Civil and Environmental Engineering. In the four years since then, the program has developed rapidly and begun to achieve national recognition.

Currently there are eight graduate students in the program. Various courses have been developed, including pavement design, pavement materials evaluation, civil infrastructure systems, construction engineering and management, and sensing applications in civil engineering.

The department has also developed state-of-the-art research laboratories for both teaching and research in pavement and materials engineering. "The unique feature of this program is the strong relationship between the Civil Engineering Department and DelDOT," says Arde Faghri, DCT Director. "DelDOT has been providing both financial resources and materials for research in the laboratory."

The primary focus is on training high-caliber students in the area of pavement, materials, and construction engineering and providing research solutions to pavement and materials problems encountered in Delaware and elsewhere in the nation.

"The size of Delaware and our close collaboration have provided us with a unique advantage that most states can only dream of," says Faghri. "We're constantly exchanging information with state engineers, and we're also able to implement any research findings within the shortest possible time."

"Various consultants and other city departments use our expertise in materials and construction," says Attoh-Okine. "We've tested and



evaluated a variety of construction materials for different cities and also provided specialized expert advice to consultants, both in and outside of the state."

"In the area of construction engineering," he continues, "we're fortunate to have the services of Bob

Muir, an experienced and knowledgeable engineer, who assists with our classes. Bob's classes are among the most popular in the department. He brings a unique perspective to the class because of his daily interaction with clients in the field."

Another major focus area is sensing applications in civil engineering. This has broad importance for the future of civil engineering infrastructure monitoring systems. One area of current interest is the development of sensors to monitor various civil structures, as well as the development of maintenance-on-demand strategies based on sensor data collection.

Reports and papers from the program have been published in major journals and conference proceedings worldwide. A circular developed for the Transportation Research Board on Micro-Electromechanical Systems Application in Transportation Infrastructure has become a premier document in the field and is now used all over the world.

"This is an exciting time for us, and we would like to extend an invitation to you to visit our lab," says Attoh-Okine. "We want to form collaborative ventures with industrial and government organizations."

## UD Bridge Center Researchers Contribute to I-95 Bridge Crack Repair



Researchers from the UD Bridge Center instrument the bridge to monitor the fracture on the northbound fascia girder (courtesy of the Wilmington News Journal).

When a bird-watcher in Wilmington spotted a cracked bridge girder instead of the blue egret he was looking for on Thursday, April 10, 2003, he called the Delaware Department of Transportation. The crack that he saw in the I-95 bridge over the Brandywine River was large enough for sunlight to shine through, and DelDOT immediately closed the lane above it to avoid further stressing the weakened area. Within the next few days, steel splice plates were bolted to the beam's bottom flange as an emergency repair.

While engineers were developing a permanent repair scheme for the bridge, which has since been

implemented, researchers from the University of Delaware Center for Innovative Bridge Engineering (CIBrE) were called in to help answer some tough questions about what had happened to the bridge.

"It's not as simple as closing down a lane to reduce stress to the damaged girder," explained Harry "Tripp" Shenton, a civil engineering faculty member affiliated with CIBrE. "Each girder is designed to carry a certain amount of dead load; when one is damaged, some of that load is transferred to the others. What we don't know is how it is redistributed to the other, undamaged girders. And that's an extremely difficult question to answer with any degree of precision."

The CIBrE team instrumented the cracked edge girder and the three adjacent to it with strain gauges; limited access prohibited instrumentation of the remaining two girders. With the gauges in place, three trucks—two loaded dump trucks and a UBIV (Under Bridge Inspection Vehicle)—were run across the bridge in various configurations to see whether the splice plates were carrying load as well as to determine how much load the damaged girder was carrying and how the loads were being redistributed. For comparison, the same tests were carried out on the undamaged southbound span.

"The tests indicated that the temporary splice plate repair was functioning properly and that the remaining girders were not seeing larger than expected traffic loads," said Michael Chajes, Chair of the UD Department of Civil and Environmental Engineering and a Bridge Center affiliate. "Testing of the southbound span supported the con-

Story continued on page 12

## TECHNICAL ASSISTANCE

The Delaware Center for Transportation does short-term projects, which includes, 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 2002-2003 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.

- Electric Buses
- Aging Population and Traffic
- Evaluation of Contractors' Past Performance
- Mechanical Means of Applying Snow Melting Materials
- Increasing the Depth of Rolled Curbs and its effect on Longevity
- Use of Slurries for Improving Hot-mix Pavement
- Flowable Fills
- Condition Requiring Repair of Storm Water Pipes
- Utility Cut Pavement Treatments
- Delaware ITS
- Assessment of Different Public Involvement Methods
- Adding pedestrian and Bicycle Facilities on Existing Bridges
- Patent Financial Allocation
- Succession Planning
- Assistance of Disabled During Inclement Weather (for transit use)
- Joint Sealants
- Research on Salt Additives

During the 2003-2004 fiscal year the Center will be doing literature searches for the following topics:

### System Evaluation/Customer Perspective. Are We Using the Right Measures?

We currently use several methods to help us understand the degree to which the transportation system meets the needs of our customers. We need to know whether there are better measures and standards that we should be using

### Predicting Toll Revenue

Ability to predict toll revenues with a greater degree of accuracy based on the data obtained from the traffic counters located near the SR1 Canal Bridge, SR1/I-95 Interchange and the I-95 toll booths. Once SR1 opens this spring, we should experience a difference in traffic patterns and toll revenues especially near the Boyd's Corner toll facility. The now tolled ramps in Odessa and at the bridge should change traffic patterns which will impact toll revenues. Periodic follow-up for the first year would also be beneficial.

### Flashing Lights/Off-Peak

Traffic lights that cycle during non-peak times in some locations result in a reduction in mobility. How could we determine which signals could

go to flashing during off-peak times to increase mobility, reduce motorist frustration, reduce wear and tear, and reduce emissions.

### New Materials Evaluation for Cork Curbs in Urban Sidewalks

Evaluate of the feasibility to use materials other than natural cork for joints in sidewalks and curbs.

### Early Life (72 hours) Concrete Shrinkage

Determine the impact of early-life (first 72 hours) shrinkage of typical concrete mixtures used by DelDOT for bridge decks and pavements.

### Aggregate Skid and Noise - MD/PA

Determine the relationship between the typical aggregates used in DelDOT pavements (both concrete and hot mix asphalt) and long-term skid resistance performance.

### Transit Ridership Fares

Determine the long-term impact on transit ridership as a result of a free or drastically reduced fare.

### Advances/New Technology Implementation

Need a coordinated approach within DelDOT to implement new technology and innovations. Identify needs to align with the FY2003-2008 Capital Transportation Program and Livable Delaware initiatives and other strategic initiatives such as safety and security, congestion mitigation, and environmental stewardship. Seek new technology and innovations to address identified needs (i.e., contracting, materials, operations, safety, pavements, construction, bridges, environment, DelTRAC, transit, etc.) Coordinate with TRB, AASHTO and FHWA's Technology and Implementation Group to identify existing or new technology and innovations ready for implementation. Develop a multi-year approach.

### EZ-PASS

Development of a new EZ-PASS partnership. DelDOT has decided to form a new partnership. Research on the best way to do this.

# 2003 Transportation Education & Research Forum

Please join us in identifying the most important issues facing the transportation system in Delaware and surrounding region, including:

The most important educational opportunities/issues

The most important research opportunities/issues

Thursday, November 6, 2003

Clayton Hall, University of Delaware

7:30 a.m. – 4:30 p.m.

## Break-Out Sessions

### Bridge & Structures

- Design of steel, concrete and timber bridges; bridge safety, economy and service life; field testing and dynamic responses of bridges; tunnel design, construction and performance; structural uses of composite materials

### Planning & Multi-Modal

- Planning process; state, regional and urban transportation planning; land use; forecasting, market estimation and modal selection; travel behavior; transportation demand management
- Pedestrian and bicycle planning and forecasting
- Aviation planning, forecasting, finance, socioeconomics, market analysis, airside and landside airport design and operations, air traffic control, intergovernmental relations, airlines (including regional and commuter), business and general aviation, safety, user needs
- Rail planning, administration, regulation, safety, and operation of rail systems, both passenger and freight; design, construction and maintenance of track systems and train control; and communication systems
- Marine planning and management of marine operations including: ports, inland waterways, barge and ship cargo systems, ferryboat operations, and intermodal terminals; global freight logistics, intermodal information technologies, marine environment issues and related regulations
- Freight transportation; truck, rail, water, pipeline and intermodal freight transportation; planning, administration, design, construction, maintenance, regulation, operations, and safety; and transportation of hazardous materials

### Administration, Government & Policy

- Agency organization; personnel management; finance and economics; data and information systems; strategic management; soft skills

### Maintenance

- Maintenance management; runway and guidance maintenance; structures, roadway and roadside maintenance; traffic service maintenance; snow and ice control; equipment maintenance; work zone safety

### Traffic & ITS

- Transportation systems operations; traffic flow and highway capacity; law enforcement; parking and parking facilities; operating effects of roadway elements; traffic control devices and systems; railroad-highway grade crossings; transportation communication systems; traffic measurements

and evaluation methods; high occupancy vehicles; Intelligent Transportation Systems (ITS)

- Safety and human performance; system safety; accident countermeasures; right-of-way and vehicular design, operations and maintenance; human behavior and performance associated with transportation; emergency medical services; trauma treatment; work zone safety; the measurement of safety performance (e.g., accident data and exposure) and the planning, management and financing of safety

### Construction, Pavement & Materials

- Construction, quality control; bituminous materials and mixes, cement and concrete, general materials, mineral aggregate specifications
- Exploration, properties, identification, classification and treatment of surface and subsurface soil and rock, subsurface drainage; earthquake and landslides; environmental effects on soil; mechanics of soil, rock and layered systems
- Pavement management, flexible and rigid pavement design, rehabilitation strategies, response of pavements to load and environmental forces, pavement data collection and analysis, surface unevenness, pavement distress, skid resistance, systems for vehicle counting, classification and weigh-in-motion

### Transit & Public Transportation

- Planning, administration, economics, finance and performance of rail, bus and new technology transit systems; commuter rail; paratransit and transportation of the disadvantaged; rural public transportation; safety; design, operations, and maintenance of vehicles and fixed facilities

### Environment

- Alternative fuels, fuel economy, ecological systems, noise and air quality, water quality; wetlands; historic preservation; hazardous wastes; highway vegetation

### Local (Towns) Issues

- Management Systems (pavement, equipment, signs, GIS applications), utility control policies, work zone safety, snow and ice removal, management and supervision

### Design

- Photogrammetry, digital mapping, remote sensing and surveying; highway geometrics; traffic barriers, sign supports and highway safety appurtenances; environmental design and mitigation; archeological, scenic vistas, utility accommodation; design of culverts and hydraulic structures; hydrology and hydraulics

## Tentative Agenda

7:30 – 8:30 a.m.	.....Breakfast and visiting the vendors
8:30 – 9:30 a.m.	.....Welcome and Introduction
9:30 – 10:30 a.m.	.....Break-Out Sessions (Specific)
10:30 – 10:45 a.m.	.....Break and visiting the vendors
10:45 – Noon	.....Break-Out Sessions (Specific & General)
Noon – 1:30 p.m.	.....Lunch
1:30 – 2:30 p.m.	.....Re-Visiting the Vendors
2:30 – 4:30 p.m.	.....Wrap-Up



# I-95 Bridge Crack Repair

Story continued from page 9



Temporary jacking towers are installed to enable the bridge to be repaired with steel plates.

clusion that the northbound section was functioning pretty much as it was before in carrying truck loads." The testing did not involve putting trucks in the outermost lane; further repairs were needed to open traffic above the damaged girder.

The fracture appears to have initiated due to a faulty weld. According to Bridge Center Director Dennis Mertz, the quality of the welding and fabrication inspection techniques was not as good back in 1963, when the bridge was built, as it is now. "It's likely that a lack of fusion within the weld caused the crack to initiate," he said. "Also, the lane over the cracked girder was originally a breakdown lane, so it did not see much traffic; however, the current construction project on I-95 resulted in the traffic being shifted over to that lane

on the Saturday before the crack was discovered. The increased traffic, combined with the severe drop in temperature the next day, probably caused the fracture to initiate and propagate instantaneously."

From the day the crack was discovered, engineers from the consulting firm DMJM+HARRIS, at DelDOT's direction, had begun developing the design for the permanent repair of the cracked girder. Repair began on June 11, when a set of 100-ton jacks raised the bridge so that workers could bolt 500-pound steel plates to the crack. "The permanent repair is intended to allow for the restoration of three northbound lanes of traffic," said Chajes. "It is also intended to restore the remainder of the bridge to the load-carrying capacity that it had prior to the crack."

DelDOT, DMJM+HARRIS, and the steel contractor, J.D. Eckman, worked cooperatively in the final design of the permanent repair splice to minimize the time and cost for design and construction. The CIBrE team worked with them to establish and carry out a field testing program to monitor the permanent repair process and to ensure that the permanent repair was effective in returning the bridge to its prior state.

Delaware Secretary of Transportation Nathan Hayward visited the site during the repair process and praised "the work of DelDOT employees, contractors, and the University of Delaware's Department of Civil and Environmental Engineering for designing a quick, cost-effective, and lasting fix."

Article Submitted by: Diane Kukich

Research Administrator, CIBrE

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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.*