



Recently Completed and Implemented Projects by the Delaware Center for Transportation

Compiled and Edited By
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November 2013





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Delaware Department of Transportation

Federal Highway Administration

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(The opinions, findings and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies)

Delaware Center for Transportation Staff



Standing from left to right: Ellen Pletz, Sue McNeil, Sandra Wolfe, Earl "Rusty" Lee, Matheu Carter, Mingxin Li
Seated left to right: Jerome Lewis and Ardeshir Faghri



Secretary Ray LaHood and Ardeshir Faghri at the Transportation Research Board Annual Meeting

RECENTLY COMPLETED AND IMPLEMENTED PROJECTS BY THE DELAWARE CENTER FOR TRANSPORTATION (DCT)

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Part 1 Environmental

National Pollutant Discharge Elimination System (NPDES) and Nonpoint Source Pollution

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
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Principal Investigator	Martha Corrozi Narvaez Associate Policy Scientist Institute for Public Administration University of Delaware Newark, Delaware 19716-7380 Phone:302-831-4931 Fax: 302-831-4934 E-mail:mcorrozi@udel.edu
Start date/ End Date	9/1/2010 – 8/31/2012
Project Abstract	DeIDOT owns and operates nearly all the roadway systems in Delaware, comprising over 5,000 miles of roads and associated storm-drainage systems. Controlling and managing stormwater that runs off of these impervious surfaces into the state's surface waters are a major part of DeIDOT's highway construction budget. As authorized under the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) controls water pollution by regulating point sources that discharge directly into surface waters. In order to meet the requirements of the NPDES permit, the co-permittees must develop and implement public education campaigns about stormwater quality.
Cost	\$ 48,264
How DeIDOT has benefited from the project:	This project helped DeIDOT and other permit holders meet the goal of educating the general public about pollution from runoff, as required by state laws.
How the project was implemented:	The University's storm water webpage has been updated. Trainings were provided to University employees on stormwater protection measures. One stormwater related training was conducted for the City of Newark employees as outlined in the interjurisdictional agreement. Conduct one storm water related presentation/workshop for residential population as outlined in the interjurisdictional agreement.

In-Depth Evaluation of DTC Fuel Efficiency and Emissions

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Mark Glaze Division of Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903-0778 Phone: (302) 760-2529 Fax: (302) 739-2251 E-mail: mark.glaze@state.de.us
Principal Investigator	Arde Faghri Professor Department of Civil & Environmental Engineering Director Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831 – 1446 FAX: (302) 831 – 0674 E-mail: Faghri@udel.edu
Start date/ End Date	9/1/2009 – 8/31/2010
Project Abstract	There is a tremendous need to make the DTC fleet as energy efficient and air quality friendly as possible. For this study, 1) the DTC fleet will be analyzed for its fuel efficiency and emissions, 2) the latest world-wide technological developments for buses with new alternative fuels will be researched, and 3) technologies most suited for Delaware will be identified.
Cost	\$29,797
How DelDOT has benefited from the project:	This project has identified the technologies most suited for Delaware.
How the project was implemented:	Hybrid diesel-electric was proven to be the most optimal for DART and Delaware existing infrastructure. Other fuels including hydrogen fuel cells and compressed natural gas and others were thoroughly evaluated.

Impacts of Bird Droppings and Deicing Salts on Highway Structures: Monitoring, Diagnosis and Prevention

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778, Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us
Principal Investigator	C. P. Huang Donald C. Phillips Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-8428 Fax: (302) 831-3640 E-mail: huang@ce.udel.edu
Start date/ End Date	9/1/2009 – 8/31/2011
Project Abstract	Transportation structures are crucial to the sustainable development of economy and life supporting facilities. Yet, it is estimated that approximately \$46.8 billion dollars are spent on the maintenance, prevention and improvement of current transportation systems through 2009, due to the deterioration of highway infrastructures (SAFETEA-LU 2005, FHWA 2005). The common mechanisms for the deterioration of transportation structures include corrosion, sulfate attack, alkali-aggregate reaction, freeze-thaw cycling, creep and shrinkage, and temperature related effects. Corrosion caused by various salts, e.g., bird droppings and deicing, has contributed greatly to the deterioration of transportation structures and brought huge economic and societal losses. Salts can diffuse into the construction materials and thus lead to corrosion, concrete cracking and structures damages. Bird droppings are extremely acidic and contain high concentration of various salts that can significantly penetrate the concrete or steel structure. Deicing salts that the Delaware Department of Transportation (DelDOT) used on transportation structures during cold-weather periods to promote highway safety, is another major contributing source to the corrosion of transportation structures. Once the run-off from the birds droppings and deicing salts migrate to the surrounding environment, it can pose long-term corrosion potential to existing transportation structures and drainage systems.
Cost	\$ 15,484
How DelDOT has benefited from the project:	This project developed decision-making criteria and tools useful to DelDOT in monitoring, diagnosis and corrosion prevention brought about by bird droppings and deicing salts. The information established in this proposed research is valuable to life cycle cost modeling of transportation structures.
How the project was implemented:	This research project developed data and tools necessary for decision-making process at DelDOT in transportation structure monitoring and corrosion prevention due to bird droppings. Using the information gathered during research a life cycle cost analysis can be made.

Long-Term Performance Monitoring of a Recycled Tire Embankment in Wilmington, DE

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone : 302-760-2379 E-mail : james.pappas@state.de.us
Principal Investigator	Victor N. Kaliakin Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, Delaware 19716 Phone : 302-831-2409 FAX : 302-831-3640 E-mail : kaliakin@udel.edu
Start date/ End Date	7/1/2008 – 6/30/2012
Project Abstract	In the United States over 281 million “scrap” tires are discarded annually, and it is estimated that well over 500 million scrap tires are currently being stored in open stock piles (Rubber Manufacturer’s Association, 2005). In the state of Delaware, about 780,000 scrap tires are generated each year and there are currently 38 known stockpiles. The creation of open tire piles is extremely undesirable because the open spaces between tires provides an ideal breeding ground for rodents and mosquitoes, and large tire piles are vulnerable to fire from lightning strikes, arson, or spontaneous self-ignition. To avoid tire piling, approximately 50 million used tires are discarded annually into landfills (Garga and O’Shaughnessy, 2000). However, as available landfill space dwindles across the country, it is recognized that this is not a viable long-term solution for disposal of scrap tire materials. A long-term scrap tire management program is needed for the state of Delaware. At present, it appears that the two most sustainable approaches to tire disposal are burning tires or tire derived fuel (TDF) in tire-to-energy conversion facilities, or recycling tire materials for use in other applications. As of 2005, approximately 20% of the scrap tires that are being re-used or recycled nationwide are being utilized in various civil engineering and construction applications (Rubber Manufacturer’s Association, 2005).
Cost	\$69,499
How DelDOT has benefited from the project:	This project determined the environmental and engineering properties that should be monitored during the construction of shredded tire embankments, including instrumentation, installation, monitoring and an analysis plan.
How the project was implemented:	The settlement plates, lateral pressure transducers and leachate pans were installed at the test embankments in Wilmington, Delaware and have been monitored continuously. Computer results were compared with the values measured in the field. This will allow DelDOT to better assess the utility of modeling tools for designing future geotechnical structures constructed using mixtures of soil and tire shreds. The research team will perform long-term compression tests on representative mixtures of soil and scrap tire-shreds obtained from a local tire shredder to develop a better understanding of the long-term compressibility associated with embankment fills constructed out of locally generated scrap tire materials.

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

Sponsor Organization	Delaware Department of Transportation	
Project Category	Environmental	
Project Manager	<p>Mark Glaze Division of Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903-0778 Phone: (302) 760-2529 Fax: (302) 739-2251 E-mail: mark.glaze@state.de.us</p>	
Principal Investigators	<p>Young-Doo Wang Associate Director and Professor 276 Graham Hall Center for Energy & Environmental Policy University of Delaware Newark, DE 19716 USA Phone: (302) 831-1706 Fax: (302) 831-3098 E-mail: youngdoo@udel.edu</p>	<p>John Byrne Director and Distinguished Professor of Energy and Climate Policy Center for Energy & Environmental Policy University of Delaware 278 Graham Hall 111 Academy Street Newark, DE 19716 USA Phone: (302) 831-8405 Fax: (302) 831-3098 E-mail: jbbyrne@udel.edu</p>
Start date/ End Date	7/1/2005 - 06/30/2007	
Project Abstract	<p>This project will investigate the cost, liability, and reliability of anti-idling equipments for trucks; evaluate environmental, energy and economic impacts of trucks' anti-idling equipment; and develop a set of policy recommendations to both curb idling and facilitate the entry of anti-idling equipment in the marketplace in Delaware.</p>	
Cost	\$50,762	
How DeIDOT has benefited from the project:	<p>Because truck idling emissions are a significant contributor to ground-level ozone and particulate matter (PM), this project could help DeIDOT integrate efforts to curb truck idling into its state implementation plan (SIP) for EPA air quality standards attainment.</p>	
How the project was implemented:	<p>The research provided the guidelines regarding the attributes of an ideal anti-idling technology to be considered for adoption in Delaware.</p>	

Scrap Tire Engineering & Environmental Evaluation

Sponsor Organization	Delaware Department of Transportation		
Project Category	Environmental		
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone : 302-760-2379 E-mail: james.pappas@state.de.us		
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Start date/ End Date	7/1/2005 – 6/30/2007		
Project Abstract	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.		
Cost	\$50,700		
How DelDOT has benefited from the project:	A number of states have strong scrap tire management programs. 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.		
How the project was implemented:	This project developed a waste tire program which enable recycling and reuse of waste tires in embankments with reduction in the level of associated risk. Issues and challenges concerning the use of recycled scrap tires in construction and embankments were thoroughly evaluated.		

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

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
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Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831 – 1446 FAX: (302) 831 – 0674 E-mail: Faghri@udel.edu
Start date/ End Date	7/1/2004 – 6/30/2006
Project Abstract	This study evaluates and compares a single-lane roundabout with an unsignalized (two-way stop controlled) intersection and a signalized (pre-timed) intersection and recommends conditions under which the construction of a roundabout may be more appropriate for an intersection. The measures of effectiveness used for the comparisons were effective intersection capacity, major and minor road entry lane capacity, major and minor road average delay, major and minor road queue length, and emission rates (CO, NOX, HC, and CO2). These measures are provided by the aaSIDRA software package which could then be used to establish “thresholds” in the major road one-way volume. These volumes indicate the threshold values for which the roundabout performs better than the unsignalized and signalized intersections.
Cost	\$47,927
How DelDOT has benefited from the project:	This project facilitated the use of more roundabouts in the State.
How the project was implemented:	This project reinforced the benefits of roundabouts and will lead to more construction in the state.

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

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Marianne Walch Delaware Department of Transportation Stormwater Quality Program P.O. Box 778 Dover, DE 19903 E-mail: marianne.walch@state.de.us
Principal Investigator	Jack Gingrich Research Scientist, Medical Entomology Department of Entomology & Wildlife Ecology University of Delaware Phone:302-831-1304 E-mail:gingrich@udel.edu
Start date/ End Date	4/15/2004 - 4/15/2006
Project Abstract	Storm water retention ponds collect water as runoff from developed lands and roadways. They are found in abundance wherever developments have been built or where highways have encroached on previously unpaved areas. Such ponds hold water for extended periods of time, usually more than ten days, and often create habitats that are ideal for mosquito development. The purpose of this project was to find a low-impact, sustainable treatment method to reduce the number of mosquito larvae in ponds.
Cost	\$99,996
How DelDOT has benefited from the project:	This work enabled improvements in retention pond construction.
How the project was implemented:	This project revealed insights into managing storm water, vegetation & design of ponds. In 2006, further investigations were conducted to test alum treatments over a longer period of time with an expanded number of control ponds. The goal will be to achieve statistically significant data.

Letting Scenic and Historic Roads in Delaware Tell Their Story - Phase I, II, III

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Maria Andaya Project Planner Delaware Scenic & Historic Highways Program Department of Transportation 800 S. Bay Road, Dover, DE 19901 Phone: 302-739-2128 E-mail: maria.andaya@state.de.us
Principal Investigator	David L. Ames Director, Center for Historic Architecture and Design Professor of Public Policy and Administration, Geography, and Material Culture Studies 331 Alison Hall University of Delaware, Newark, DE 19716 Phone: 302-831-1050 E-mail:davames@udel.edu
Start date/ End Date	7/1/2002 – 6/30/2005
Project Abstract	A web-based manual to facilitate the identification, designation and management of scenic and historic highways.
Cost	\$ 322,182
How DeDOT has benefited from the project:	To celebrate roads generally, and specifically designate historic roads, Delaware's Scenic and Historic Highways program embraces the notion that a road's history plays a central part in telling the story of a place.
How the project was implemented:	This project provided specific guidelines and background to help any interested party nominate a route, including individuals, local governments, counties, and tourism departments. The nomination process, important concepts and definitions about roads that are useful background for preparing a nomination were provided.

Enhancing Delaware's Highways: A Natural Vegetation Project - Phase I-VI

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Chip Rosan Roadside Environmental Supervisor Delaware Department of Transportation PO 778 Bay Rd., Route 113, Dover, DE 19903 Phone: 302-760-2185 E-mail: crosan@ mail.dot.state.de.us
Principal Investigator	Susan Barton Assistant Professor and Extension Specialist Plant and Soil Sciences University of Delaware 146, Townsend Hall, Carvel Center Newark, DE, 19716-2103 Phone: 302-831-1375 E-mail: sbarton@udel.edu
Start date/ End Date	10/16/2000 – 3/31/2009
Project Abstract	Planning for roadside landscapes must be an integral part of all road design projects and must begin with the initial phases of design. Early consideration of roadside landscape design maximizes opportunities for cost efficient, attractive and sustainable solutions that are sympathetic to roadway engineering and maintenance. This concept and planning manual is the result of a collaborative research process between the Delaware Department of Transportation (DelDOT), the Delaware Center for Horticulture (DCH) and the University of Delaware (UD). It is intended for all those involved in planning and designing Delaware's highways including DelDOT staff, consultants and community members.
Cost	\$ 1,346,382
How DelDOT has benefited from the project:	The manual defines and describes an orderly process for planning and design of diverse roadside landscapes utilizing a number of unique elements based directly on research results. Site-specific photography is used to illustrate broad concepts and explicit details. Although primarily designed as a tool for DelDOT designers and consultants, the research-based rationales presented in the manual will also prove useful in communicating the challenges and opportunities of roadside landscape design to local communities.
How the project was implemented:	Recognizing the need for designs matched to the varying priorities of visual appeal, regional conservation and economics, this project defined three distinct approaches and provided a matrix which was used as a tool for selecting the most appropriate approach for any given location. Illustrated exercises were provided to demonstrate the process of applying the matrix to actual projects. Two books out of this project and DelDOT has implemented research outcomes.

Environmental Impact of Growth in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Environmental
Project Manager	Michael Strange Deputy Director, Planning Delaware Department of Transportation P. O. Box 778 Dover DE 19903 Phone: 302-760-2121 Fax: 302-739-2251 E-mail: michael.strange@state.de.us
Principal Investigator	Edward Ratledge Associate Professor, School of Public Policy & Administration Director, Center for Applied Demography and Survey Research University of Delaware Newark, Delaware 19716 Phone: (302) 831-1684 E-mail: ratledge@udel.edu
Start date/ End Date	7/1/2001 – 6/30/2002
Project Abstract	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.
Cost	\$ 52,348
How DeDOT has benefited from the project:	Several population-related issues were addressed. All of these issues will affect the demands for transportation infrastructure in the state.
How the project was implemented:	The environmental impacts of sprawling, low-density development were thoroughly evaluated.

Part 2 Pavement and Materials

Development of Specifications for the Use of Continuous Compaction Control Systems

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone:302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Christopher Meehan Associate Professor , Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	9/1/2010 – 8/31/2013
Project Abstract	Continuous Compaction Control (CCC) systems have demonstrated great promise for improving the efficiency of field compaction and revolutionizing the compaction control process. To evaluate the effectiveness and reliability of CCC systems in the State of Delaware, a field study was performed on a local soil (a poorly graded sand with silt), with compaction being performed using an MDP-CMV equipped compactor. A variety of in-situ test methods that are currently used for compaction control were also performed as compaction progressed in the study, for purposes of comparison with the CCC results. Comprehensive analyses were performed on the data obtained from the field study using various statistical techniques. As a first step, basic statistical analysis was performed on the recorded in-situ testing values. In general, it was concluded that there was significant scatter in the measured in-situ test results, which made it difficult to make a precise judgment on the quality of compaction. However, based on the dry unit weights measured by the nuclear density gauge (NDG), the quality of compaction was determined to be in an acceptable range, according to current DeDOT specifications. In addition, the measured water contents indicated that the compaction was performed on the dry side of the optimum moisture content.
Cost	\$50,000
How DeDOT has benefited from the project:	Statistical analysis of the CCC roller data illustrated a promising trend for MDP and CMV values as the compaction progressed: MDP values decreased and CMV values increased as the number of passes increased. It was also realized that MDP values contained less variability than simultaneously recorded CMV values.
How the project was implemented:	Continuous Compaction Control (CCC) and Intelligent Compaction (IC) systems showed great promise for improving the efficiency of field compaction and revolutionizing the compaction control process. The effectiveness of continuous compaction control was assessed. The statistical nature of the recorded CCC data sets was explored in detail.

Use of RAP to Reduce Pavement Thickness

Sponsor Organization	Delaware Department of Transportation	
Project Category	Pavement and Materials	
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us	
Principal Investigators	Dov Leshchinsky Professor University of Delaware Department of Civil and Environmental Engineering Phone : (302) 831-2446 FAX: (302) 831-3640 E-mail: dov@ce.udel.edu	Nii Attoh-Okine Professor Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone 302-831-3640 E-mail:okine@udel.edu
Start date/ End Date	9/1/2010 – 8/31/2012	
Project Abstract	The use of reclaimed asphalt pavement (RAP) helps to conserve natural resources and land needed for disposal of these materials. Since the mid-1970s, tens of millions of tons of RAP have been used to produce recycled hot mix asphalt (HMA) around the country. The use of RAP has evolved into routine practice in many areas around the world. Using RAP is environmentally friendly. It helps to conserve natural resources and land needed for disposal of these materials. Increasing the percentage of the RAP and improving the quality of recycled mixtures will facilitate the further utilization of the RAP; however, reliable figures for the generation of RAP are not readily available from all state highway agencies or local jurisdictions.	
Cost	\$56,654	
How DelDOT has benefited from the project:	They have been used with virgin resources to produce new asphalt pavements, proving to be more both economical and effective in protecting the environment.	
How the project was implemented:	RAP was used in new hot mix asphalt (HMA) mixtures and in base courses for pavement construction under full-scale traffic loads.	

Using Electrical Density Gauges for Field Compaction Control

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Christopher Meehan Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	9/1/2009 – 8/31/2011
Project Abstract	In the United States, the current state of practice for quality control of soil compaction is based upon measurements of soil density and soil moisture content at the time of compaction. The current approach that is used in the State of Delaware compares measurement of in situ soil density and moisture content with measurements of soil density and moisture content obtained from a standard-energy compaction test approach (1-Point Proctor Compaction). Measurement of in situ soil density and moisture content are typically obtained via measurements from Nuclear Density Gauges (NDGs). NDG test equipment uses a nuclear-based approach to obtain radioactive counts that are correlated to soil densities and moistures. The results of NDG test exhibit significant scatter when compared to previous in-situ density test standards (e.g. sand cone tests, "water balloon" tests, etc). Nonetheless this equipment has become the accepted industry standard for quality control of soil compaction, because tests are much faster and easier to perform than other density-based quality control tests. In addition to inherent inaccuracies with NDG test results, there are significant regulatory compliance issues that are present when dealing with NDG test equipment.
Cost	\$50,000
How DelDOT has benefited from the project:	This Electrical Density Gauge (EDG) equipment does not contain any nuclear material, and consequently does not have the same regulatory obstacles that are present with NDG. Additionally, this equipment may allow for more accurate measurements of in situ density and moisture content than those that are currently being made with the NDG. Electrical density gauges have the potential to replace nuclear density gauges for field evaluation of in situ soil density and moisture.
How the project was implemented:	The program of research provided the necessary information to assess the benefits of this technology for the DOT.

Investigation of Intelligent Compaction Technology: Phase 2 – A Field Study

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Christopher Meehan Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	7/1/2008 – 6/30/2010
Project Abstract	Evaluation of how other state departments of transportation (DOTs) are incorporating intelligent compaction technology into their state quality-control specifications. Exploration of new areas for knowledge growth in intelligent compaction that may be beneficial for the State of Delaware.
Cost	\$40,729
How DeIDOT has benefited from the project:	Implementation of Continuous Compaction Control (CCC) systems and Intelligent Compaction (IC) systems can revolutionize how soils and asphalts are compacted in the field, improving the quality of compaction and the long-term performance of roadways and other geotechnical structures while reducing the need for continuous technician monitoring during compaction.
How the project was implemented	This project demonstrated the utility of this technology to local contractors to ensure that it is successfully adopted, and showed a need to engineers at the Delaware Department of Transportation (DeIDOT) the improvements in compaction monitoring and construction quality that can result.

Investigation of Intelligent Compaction Technology

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Christopher Meehan Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	2/1/2007 – 8/31/2008
Project Abstract	Evaluation of how other state departments of transportation (DOTs) are incorporating intelligent compaction technology into their state quality-control specifications. Exploration of new areas for knowledge growth in intelligent compaction that may be beneficial for the State of Delaware. In addition to Greggo and Ferrara, DeIDOT, and Caterpillar, the project was enabled by donations of materials, equipment, and expertise from Giles and Ransome CAT, Kessler Soils Engineering, Humboldt Manufacturing Company, the Electrical Density Gauge Corporation, and the Maryland Department of Transportation.
Cost	\$60,000
How DeIDOT has benefited from the project:	Any time soil is placed during construction - whether it's for a road, an embankment, or an earth dam - it needs to be compacted. The compaction process determines the ultimate engineering properties of the soil, including the shear strength, compressibility, and permeability, and these properties are critical to the design of earthworks structures. "This intelligent compaction project has a lot of potential benefit to DeIDOT and the contracting community," says Jim Pappas, chief materials and research engineer at DeIDOT. "Potential benefits include quicker information gathering for both DeIDOT and the contractor, real-time information for the equipment operator, and efficiency increases for the contractor."
How the project was implemented:	At this point, the IC work is still in the experimental phase. The project is looking forward to providing hard data that will support implementation of this new technology.

Establishment of Geotechnical Information Database

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Christopher Meehan Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2010
Project Abstract	The Delaware Department of Transportation (DeIDOT) currently has numerous subsurface investigation test results for foundation studies located throughout the State of Delaware. Currently, this information is located on paper, tape, and disks. This data needs to be converted into a standard format that can be easily accessed with current technology and easily converted to future storage technology.
Cost	\$42,000
How DeIDOT has benefited from the project:	Assessment of existing database technology indicated that there was significant benefit to moving towards a database platform that supported integration with Geographic Information System (GIS) technology. A GIS-based data management platform would allow for superior visualization and three-dimensional data management, which could offer significant potential benefit to DOT engineers and project managers.
How the project was implemented:	After detailed discussion with the DOT Project Manager for this project during the course of this study, it was concluded that the cost of a GIS-integrated data management system was prohibitive at this time. Additionally, using existing geotechnical data management infrastructure at the DOT (a GEOSYSTEM® software platform) had some significant benefits, most notably that a large amount of data was already in this format for existing projects, and that additional training and experience would be required for DOT employees to learn and become comfortable with a new data management platform. Consequently, as a result of work conducted in conjunction with DeIDOT engineers and the Project Manager for this project, the GEOSYSTEM® software platform was selected for management of DeIDOT's existing geotechnical data, and continued data entry at the University of Delaware.

Pavement Performance Models

Sponsor Organization	Delaware Department of Transportation	
Project Category	Pavement and Materials	
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us	
Principal Investigators	Sue McNeil Professor Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail: smcneil@udel.edu	Nii Attoh-Okine Professor Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone: 302-831-3640 E-mail: okine@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2010	
Project Abstract	<p>The Delaware Department of Transportation (DelDOT) uses its pavement management system to monitor the condition of road pavements within its jurisdiction. As part of the pavement management system, DelDOT has in place a database containing an inventory of roads with features such as location, geometry, functional class, age, type of surface overlay, pavement condition rating and the annual average volume of traffic carried. Essential tools for any pavement management system are a database of pavement performance data and a suite of pavement performance models that portray past roadway performance and predict future roadway condition. This gives managers and other practitioners information about the state of their roads and equips them with the background needed to make informed decisions about interventions to keep roads in good condition. This study sought to develop performance models for the DelDOT pavement management system. The study began by reviewing literature on how pavement performance models have been developed in the past. The knowledge obtained served as basis for the development of the models. Performance models were developed using data from the pavement management system after data had been checked for completeness and consistency.</p>	
Cost	\$50,000	
How DelDOT has benefited from the project:	Pavement performance models can be developed for a family of road pavements at the network or project level. At the network level, performance models are used for condition forecasting, budget planning, inspection scheduling and work planning. On the other hand, performance models at the project level are used to select specific rehabilitation alternatives to meet expected traffic and climatic conditions.	
How the project was implemented:	This study developed network and project level pavement-performance models which has been used by DelDOT to aid in the management of road pavements. Models developed were statistically sound and related a set of explanatory variables to the pavement condition rating for a particular family of road pavements.	

Analysis of Hot Mix Asphalt QA Specification Research

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor, Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone: 302-831-3640 E-mail: okine@udel.edu
Start date/ End Date	7/1/2005- 6/30/2008
Project Abstract	The objective is the development of an appropriate statistical acceptance procedure for the Delaware Department of Transportation. DELDOT's modification of its specifications for the acceptance of Hot Mix Asphalt (HMA) in order to incorporate quality assurance concepts lead to requirements such as the emphasis laid on the HMA producer in terms of quality control activities such as performing component material tests, tracking test results on control charts and following the plan developed by DELDOT. The incorporation of new statistically based acceptance specifications used new criteria for acceptance rather than the previous methods of minimum test result requirements for numerous criteria. After the statistical acceptance procedure was reviewed and used for quantifying and evaluating the DELDOT's statistical plan, a comparative analysis between the developed procedure and the FAA and FHWA procedure was done for achieving the objective and providing recommendations and new composite pay factors were developed.
Cost	\$28,877
How DelDOT has benefited from the project:	Sound technical guidelines for QA in Delaware.
How the project was implemented:	This project looks into fairness of specifications and has come up with some suggestions. Some data base was produced for future research.

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

Sponsor Organization	Delaware Department of Transportation (DD/SPR)
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor, Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone: 302-831-3640 E-mail: okine@udel.edu
Start date/ End Date	7/1/2005 – 6/30/2007
Project Abstract	Review of Resilient Modulus Project and check for any gaps between products from that project and the recently released pavement design procedure.
Cost	\$46,092
How DeDOT has benefited from the project:	The resilient modulus of pavement materials is an important material property in any mechanistically based design/analysis procedure for flexible pavements. With the introduction of resilient modulus value into the AASHTO design process, DeDOT is able to develop the resilient modulus data required for immediate use in design projects.
How the project was implemented:	This project yielded valuable information about physical properties and strength characteristics of unbounded pavement materials in Delaware. The methodologies presented could be easily adapted by DeDOT to local conditions. The result of this research will be used to develop material database for updating pavement design input values.

Durability of Thin Overlays

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor, Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone 302-831-3640 E-mail: okine@udel.edu
Start date/ End Date	7/1/2004 – 7/30/2005
Project Abstract	The performance of a pavement is affected by the type and quality of maintenance it receives, as well as when the maintenance is performed. Timely preventive maintenance can slow the rate of deterioration of pavement. Delays in maintenance and deferred maintenance can increase the quantity and severity of defects. Therefore, preventive maintenance is becoming the norm for most local highway agencies. Such maintenance increases the pavements condition and service life and shows promise in reducing the long-term costs of highway pavement management. Pavement preventive maintenance treatments preserve rather than improve the structural capacity of the pavement structure, and keep the pavements in sound structural condition. In addition, in order to be cost effective, preventive maintenance should be applied before a significant amount of environmental distress occurs. This work seeks to evaluate the advantage of thin overlay by performing a comparative analysis of preventive maintenance methods, and by surveying the use of thin overlays used by local communities in Delaware.
Cost	\$55,000
How DelDOT has benefited from the project:	Development of a selection procedure for the most appropriate overlay technique for Delaware.
How the project was implemented:	The result of this study can be used to start the development of a unified pavement maintenance program that can be implemented by local communities.

Hot Mix-Skid and Noise

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor, Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone: 302-831-3640 E-mail: okine@udel.edu
Start date/ End Date	7/1/2005 – 6/30/2008
Project Abstract	Traffic and pavement noise constitute environmental noise pollution that is of much concern. They can have adverse effects on the health of humans, reduce real estate values and create difficulties in speech communications. It can also have a negative impact on sleep patterns and cause general annoyance. The state of Delaware, like other states in the USA and many parts of the world, faces problems with annoying noise from tire/pavement interaction. It is a challenging problem since the noise is generated from a complex combination of various sources and mechanisms. When one source of noise is reduced, the other sources become pronounced. That is, it is difficult to separate the sources and deal with them in isolation. This presents a formidable problem, but which problem needs to be solved to ensure quieter pavements, and more enjoyable residential neighborhoods that abut busy streets and freeways. This study will evaluate skid and noise of DelDOT superpave HMA mixtures and compare DelDOT SMA and open-graded HMA mixtures.
Cost	\$56,900
How DelDOT has benefited from the project:	Conducting tests for Delaware using our materials vs. other states. The evaluation can help the Delaware Department of Transportation (DelDOT) develop quieter pavements in the state of Delaware through better testing methods for the acoustic properties of DelDOT superpave mixes.
How the project was implemented:	Comparative testing on the mixes used in Delaware and in other states was conducted to ensure quieter pavements. The parameters that are involved in tire/pavement noise generation and current pavement noise testing methods were thoroughly evaluated.

Sealing Materials Research-Add Survey

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor, Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone 302-831-3640 E-mail:okine@udel.edu
Start date/ End Date	7/1/2002 – 6/30/2004
Project Abstract	The purpose of this project is to document and compile information on high performance sealant material which is economical enough to utilize extensively.
Cost	\$35,000
How DeIDOT has benefited from the project:	The proper sealing and maintenance of concrete pavement joints is essential for the overall performance of the rigid concrete pavement. This project found out the factors that affect sealant life and performance and how to mitigate these to improve performance and reasonably extend sealant and thereby pavement life.
How the project was implemented:	This project provided a guideline for sealant system selection.

Service Life Assessment of Concrete with ASR and Possible Mitigation

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Nii Attoh-Okine Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-4532 E-mail: okine@udel.edu
Start date/ End Date	7/1/2002 – 6/30/2006
Project Abstract	Alkali Silica Reaction (ASR) is a particular type of chemical reaction involving hydroxyl ions present in the pore water of concrete and a certain form of silica present in some aggregates. ASR can cause deterioration of concrete highways, runways, bridges and other structures. As there are many interacting and interdependent parameters that influence its occurrence, the ASR phenomenon is complex. ASR is difficult to recognize, identify, and monitor. There are conflicting views on the effect of ASR on concrete properties. It is recognized that of all the possible methods of controlling the deleterious expansion caused by ASR in concrete, the use of admixtures can impart the most realistic advantages to the properties of concrete. In spite of much research carried out on the role of admixtures in controlling ASR expansion, there are still some aspects of the mechanism of the reaction of admixtures and their effects that are not clearly understood. This project includes an extensive literature review of all these issues related to ASR. The guidelines of using admixtures in different states of the United States and organizations are also presented in this project. ASR expansion and Na_2O equivalent relationship equation is derived by using evolutionary algorithm.
Cost	\$45,000
How DeIDOT has benefited from the project:	Research contributed some information. However mitigation is part of grander scheme at national and international levels.
How the project was implemented:	A method for determining rating of ASR was developed by DeIDOT personnel. The method was to generate an approximate ASR reaction rate to predict concrete pavement life. ASR rating was developed using ASR test T-299.

Resilient Modulus of Construction Materials

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Wayne Kling, P.E. Research Engineer Materials & Research Section Delaware Department of Transportation 800 Bay Road, PO Box 778 Dover, DE 19903 Phone: (302) 760-2400 Fax: (302) 739-5270 E-mail: Wayne.Kling@state.de.us
Principal Investigator	Nii Attoh-Okine Professor Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone 302-831-3640 E-mail:okine@udel.edu
Start date/ End Date	7/1/2001 – 6/30/2003
Project Abstract	This project is aimed at establishing an indirect method for subgrade characterization through correlation between California Bearing Ratio (CBR) and basic soil tests, and then providing an approximate relationship for resilient modulus using CBR.
Cost	\$39,900
How DeIDOT has benefited from the project:	Perform basic soil tests, CBR and other strength tests on pavement material from the State of Delaware and to characterize their behavior under traffic loading and environmental conditions. Provide input necessary for modeling the material with the mechanistic pavement design and evaluation.
How the project was implemented:	Both models were utilized to predict the resilient modulus test data. The models can be developed for other subgrade soils, and can be useful to DeIDOT that lack the capability for high-production repeated-load testing.

High Density Polyethylene (HDPE) Pipe Evaluation

Sponsor Organization	Delaware Department of Transportation	
Project Category	Pavement and Materials	
Project Manager	<p>Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us</p>	
Principal Investigators	<p>Dov Leshchinsky Professor Department of Civil and Environmental Engineering University of Delaware Phone : (302) 831-2446 FAX: (302) 831-3640 E-mail: dov@ce.udel.edu</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/ End Date	5/1/2001 – 12/31/2002	
Project Abstract	<p>The performance of flexible pipes is derived from strong interaction with the embedding soil. Hence, it is apparent that proper installation is crucial for satisfactory performance. Consequently, the dimensions of the excavated trench, type of natural soil, bedding, backfill material and its level of compaction, sequence of layers backfilling, and embedment depth below live loads, are all critical elements for the long-term performance of the corrugated HDPE pipe.</p>	
Cost	\$35,476	
How DelDOT has benefited from the project:	<p>Corrugation stiffens the pipe section, increases its resistance to buckling, and allows for less material to be used. The end product is low in initial cost and light weight. Handling of HDPE pipes is easy, joining pipes together is quick, their flow regime is good, and they can be durable.</p>	
How the project was implemented:	<p>Fully Implemented. Use of HDPE drainage pipes by DelDOT started on an experimental basis in mid-1997. Two test installations were under periodical inspection. The research is used as guideline in selection or HDPE.</p>	

**Application of Novel Renewable Resource based Advanced Composite Materials in Transportation
Infrastructure in Delaware**

Sponsor Organization	Delaware Department of Transportation
Project Category	Pavement and Materials
Project Manager	Jim Pappas Assistant Director-Design Delaware DOT Phone: 302-760-2379 E-mail: james.pappas@state.de.us
Principal Investigator	Richard P. Wool Professor Department of Chemical Engineering and Center for Composite Materials University of Delaware, Newark DE 19716-3144 Phone Work (302) 831-3312 E-mail: Wool@udel.edu
Start date/ End Date	7/1/2000 – 6/30/2002
Project Abstract	This project discusses the use of affordable composites from renewable resources (ACRES) in transportation infrastructures. Specifically, the use of soybean oil that has been made amenable to polymerization is described. These composites could be usefully utilized in lighting structures, bearing pads, box beams, communication towers, stay-in-place forms, and temporary signs. The project covers the experimental work involved, and presents results and a discussion.
Cost	\$250,000
How DelDOT has benefited from the project:	The replacement of traditional materials like metals and wood in infrastructural applications like bridges, pavements and highways with composites is expected to improve the service life of these constructions due to the high corrosion resistance of composites. The ACRES composites offer all the advantages of petroleum based composites at a low cost.
How the project was implemented:	These innovative materials have been increasingly used in transportation infrastructure applications, where lightweight, inexpensive, disposable materials are needed. Under the ACRES project, soybean oil is being used to make affordable and renewable fiber-reinforced composites for high-volume applications. P.S. The University of Delaware's Affordable Composites from Renewable Sources (ACRES) program was featured on the Discovery Channel at 8 p.m., Thursday, Nov. 20. The program was included in the "How Stuff Works" program episode entitled "Turkeys.

Part 3 Planning

Research Resilient Cartography: Using Interactive Online Mapping to Represent Corridor (Aero) mobilities

Sponsor Organization	Department of Transportation, Research and Innovative Technology Administration
Project Category	Planning
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov
Principal Investigator	Douglas Tuttle Policy Scientist, IPA School of Public Policy and Administration University of Delaware 177C Graham Hall Newark, Delaware 19716-7380 Phone: 302-831-0718 E-mail:dougt@udel.edu
Start date/ End Date	09/01/2011 – 08/31/2013
Project Abstract	Most maps that influence our everyday mobility decisions privilege representations of space over those of time. Maps and Cartograms providing spatiotemporal information are used primarily to identify and track patterns of change in the past and predict future occurrences in the future. But they also have potential for use by transportation researchers and the traveling public. New approaches to corridor resilience require innovative cartographic approaches that call attention to the travel time takes. The purpose of the first set of maps is to reinforce and demonstrate the idea that travel-duration within urban areas throughout the corridor network is highly contingent on mode and location. The second set of maps demonstrates the change over time in the relationship of the corridor to domestic and international aeromobility networks. As the second phase of a University of Delaware-University Transportation Center (UD-UTC) project, the proposed project builds upon and extends the cartographic methods of Phase I to account for nested scales, more variable and historical-data interactivity, thereby providing a richer illustration of the rapidity and redundancy properties of regional resiliency.
Cost	\$102,251
How DeIDOT has benefited from the project:	This project can implement two such approaches to create two sets of maps for use by corridor airport users, transportation policy-makers and regional researchers.
How the project was implemented:	The project developed cartographic methods for representing uneven (aero) mobilities and the relative position of corridor transportation nodes to one another as well as to those at the national and global scales.

The Effects of Learning through the Arts on Transportation Knowledge and Skills of Elementary School Students, University Students and Classroom Teachers

Sponsor Organization	Department of Transportation, Research and Innovative Technology Administration
Project Category	Planning
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov
Principal Investigator	Lynnette Overby Director, Undergraduate Research Program University of Delaware 180 S. College Avenue Newark, DE 19716 Phone:(302) 831-8995 E-mail: overbyl@udel.edu
Start date/ End Date	09/01/2011 – 08/31/2013
Project Abstract	The purpose of this study is to enhance knowledge of geographic concepts, particularly transportation, through the lens of dance and theater. Students and their teachers will gain knowledge through an interdisciplinary approach that combines the teaching of geography with the arts. The participants will include 4th and 5th grade students attending elementary school in Newark, Delaware, their teachers, and University of Delaware students with expertise in the arts and geography.
Cost	\$99,232
How DelDOT has benefited from the project:	This project can benefit current and future educators, artists, and geography researchers.
How the project was implemented:	Scholars created interdisciplinary lessons using creative and artistic strategies. Scholars gained knowledge and skills in creating, teaching, and assessing interdisciplinary lessons. Teachers who do not have arts-related expertise learn to incorporate the arts in their classroom lessons.

Developing an Infrastructure Index - Phase II

Sponsor Organization	Michael Gallis & Assoc/US Chamber Foundation
Project Category	Planning
Project Manager	Janet Kavinoky Director, Transportation Infrastructure Vice President, Americans for Transportation Mobility Coalition U.S. Chamber of Commerce 1615 H Street, NW Washington, DC 20062 Phone: 202-463-5871 E-mail:jkavinoky@uschamber.com
Principal Investigator	Sue McNeil Professor, Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail:smcneil@udel.edu
Start date/ End Date	03/30/2010 – 02/01/2012
Project Abstract	Building on the work in Phase I of our project with Michael Gallis & Associates to develop an infrastructure index for the US Chamber of Commerce, this phase requires continued interaction with the US Chamber of Commerce Staff, and the project team in the form of meetings and regular conference calls. The meetings will also include stakeholder input. Our role in this phase focuses on refining the transportation index and developing the sector specific infrastructure indices for energy, water and broadband. This includes gathering the data, assembling the input for the weighting and developing the model that serves as the calculator for the index. The methodology will follow a similar approach to that used for the Transportation index with some recognition that the sampling strategy will be modified to reflect the organizational structure of the data and the specific types of data may vary. In the last part of this phase the interaction will largely be in the form of discussion with Susanne Trimbath of STP Advisory Services to explore the relationship between the indices and the US economy.
Cost	\$309,737
How DelDOT has benefited from the project:	The Index includes measures of the performance of infrastructure as it meets the needs of productive businesses working toward economic prosperity. The Infrastructure Index can be used to measure the effect of infrastructure on the U.S. economy by relating changes in the Index to changes in U.S. economic performance.
How the project was implemented:	The final Infrastructure Index recognized the interconnections among the different infrastructure networks for a balanced presentation of all components.

The Impact of Disruptions along the I-95 Corridor on Congestion and Air Quality

Sponsor Organization	Department of Transportation
Project Category	Planning
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov
Principal Investigator	Earl Lee Assistant Professor Director, T2 / LTAP Center Department of Civil and Environmental Engineering University of Delaware 355A Dupont Hall Newark, DE 19716 Phone: (302) 831-6241 E-mail: elee@udel.edu
Start date/ End Date	09/01/2008 – 08/30/2012
Project Abstract	The resilience of a corridor can be defined as its ability to maintain its full functionality during an incident. While transportation corridors may be viewed as highly resilient due to the number of alternative paths that generally exist, the principal path and the alternatives may not have similar capacity. This research will evaluate resilience of the Interstate 95 corridor in Delaware and the impact of disruptions on congestion and air quality.
Cost	\$ 50,605
How DeIDOT has benefited from the project:	The Delaware Department of Transportation has established re-routing plans for four closures areas of Interstate 95. While based on expert opinion and judgment, no evaluation had been done on the impact of these closures. This project evaluated the impact on regional traffic and the emission effects from these proposed closures.
How the project was implemented:	By using a simulation model, DeIDOT re-routing plans for portions of I-95 without disrupting traffic were thoroughly evaluated.

An Engineering Evaluation of the Panama Canal Widening on East Coast Freight Corridors

Sponsor Organization	Department of Transportation
Project Category	Planning
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov
Principal Investigator	Earl Lee Assistant Professor Director, T2 / LTAP Center Department of Civil and Environmental Engineering University of Delaware 355A Dupont Hall Newark, DE 19716 Phone: (302) 831-6241 E-mail: elee@udel.edu
Start date/ End Date	09/01/2009 – 08/30/2013
Project Abstract	The impact of the widening of the Panama Canal on East Coast ports is unsure. The projections of the amount of freight that will shift ports and the impacts in port and regional transportation infrastructure are at best conflicting. This research will combine engineering and policy. Data will be collected from a variety of government sources, analyzed and placed in a framework to support or refute many projections and position reports that can be found in a variety of print media. The U.S. ports that will be available to support these new and larger ships will also be investigated. The study will also include an analysis of the impact on the east coast interstate corridors.
Cost	\$108,194
How DelDOT has benefited from the project:	The impact of the widening of the Panama Canal on East Coast ports will be investigated.
How the project was implemented:	This research examined the effects the expansion of the Panama Canal will have on U.S. East Coast and Gulf Coast ports.

Development and Evaluation of a Residential Allocation Model Using Time-Series Tax Parcel Data in GIS

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302-831-1698 E-mail: dracca@udel.edu
Start date/ End Date	9/1/2011 – 12/21/2012
Project Abstract	Residential projection allocation models in Delaware currently function at an aggregate level typically producing data for modified grids, traffic analysis zones, or census geographies. These methods are satisfactory for developing draft allocations subsequently reviewed by agency staff prior to use in travel models or other planning efforts. This project intends to develop an additional allocation model which can be used to supplement existing methods and will be especially beneficial to applications in small-area transportation or land use planning studies.
Cost	\$54,000
How DeIDOT has benefited from the project:	The results have significant advantages over current methods. The property tables and related GIS maps provided an excellent framework to manage detailed information about properties and allow for easier examination, defense and adjustment of probabilities. The tight correspondence with GIS representations allows for the use of spatial analysis tools to update factors and select areas for study and adjustment.
How the project was implemented:	The model estimating relative probabilities for lot construction was created after an extensive data preparation and examination of many potential factors. Projections were produced and compared to current methods.

Transit-Oriented Development (TOD): Identification of Optimal Characteristics in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Catherine C. Smith Delaware Transit Corporation 119 Lower Beech Street / Suite 100 Wilmington, DE 19805 E-mail: catherine.smith@state.de.us
Principal Investigator	Ed O'Donnell Policy Scientist, Institute for Public Administration University of Delaware 180 Graham Hall Newark, DE 19716 Phone: 302-831-4928 FAX:302-831-4934 E-mail:troutbum@udel.edu
Start date/ End Date	9/1/2009 – 8/31/2010
Project Abstract	In recent years the concept of transit oriented development (TOD) is being more widely implemented by communities throughout the United States as a tool to promote smart growth, enhance mobility, curb sprawl, foster multi-modal transportation options, and boost transit ridership. Many of the successfully implemented TODs in the United States are centered around transit hubs; involve public-private partnerships; and feature compact, mixed-use development with high quality pedestrian environments. Specific sections in the DCT document that relate to TOD include Design (interconnectivity and internal circulation), Local/Town Issues (town center projects and infill development), Planning and Multi-Modal (Planning process for interconnectivity, outreach on planning vision, supportive concepts for complete streets / complete trips, and link between healthy communities, land use, and complete streets). This problem statement builds on work previously conducted by IPA. Previous work explored the concept, financing requirements, private sector experience, and model code aspects of TOD and produced an informational brochure. This subsequent phase of work will involve research analysis of optimal characteristics of TOD in Delaware. An overview will be provided of possible TOD sites and corridors in Delaware based on the optimal characteristics analysis.
Cost	\$49,412
How DelDOT has benefited from the project:	This project provided local and regional strategies for TOD evaluation and implementation that will empower Delaware officials to create environments favorable to TOD projects.
How the project was implemented:	Parking policy and pricing was identified as crucial to TOD and needs further investigation. TOD potential exists in Middletown and Newport pertaining to transit-ready development (TRD) and bus/train TOD. Public officials can prepare for TOD through implementing TRD. Station area planning could be further defined and prioritized to outline a real plan for TOD implementation in Delaware.

Developing an Infrastructure Index - Phase I

Sponsor Organization	Michael Gallis & Assoc/US Chamber Foundation
Project Category	Planning
Project Manager	Janet Kavinoky Director, Transportation Infrastructure Vice President, Americans for Transportation Mobility Coalition U.S. Chamber of Commerce 1615 H Street, NW Washington, DC 20062 Phone: 202-463-5871 E-mail:jkavinoky@uschamber.com
Principal Investigator	Sue McNeil Professor, Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail:smcneil@udel.edu
Start date/ End Date	09/16/2009 – 03/03/2010
Project Abstract	Over the past decade the American Society of Civil Engineers has used the Infrastructure Report Card to raise awareness of infrastructure issues. Aging and deteriorating infrastructure has recently been highlighted in the popular media. However, this is not enough. The US is losing its competitive capacity as the gap between an ageing and deteriorating American infrastructure and that being developed around the world in developed and emerging economies and trading blocs is growing. To be able to build the private and public support for the investments needed to provide a world class infrastructure that supports the economic competitiveness of the US, and restores the US to a position of technological leadership, a clear concise, consistent mechanism for communicating the state and implications of our underinvestment and support future investments. The University of Delaware in collaboration with Michael Gallis & Associates, STP Advisors and Global Systems Solutions is developing an Infrastructure Index to benchmark US regions for the U.S. Chamber of Commerce as part of the "Let's Rebuild America" Initiative. The proposal represents the first phase of this work. This phase focuses on developing the concepts for sector specific infrastructure indices for transportation, energy, water and broadband, exploring strategies to combining the sector specific indices into a composite infrastructure index, identifying possible sources of data and developing a prototype index for one sector, either transportation or water.
Cost	\$53,600
How DelDOT has benefited from the project:	The Index includes measures of the performance of infrastructure as it meets the needs of productive businesses working toward economic prosperity. The Infrastructure Index can be used to measure the effect of infrastructure on the U.S. economy by relating changes in the Index to changes in U.S. economic performance.
How the project was implemented:	In the next stage of the project, the project team broke down the Index into state-by-state measurements, indexed the performance of the individual components of infrastructure, and extrapolated the Infrastructure Index into the future.

Infrastructure Security and Emergency Preparedness

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Dwayne Day Delaware Emergency Management Agency 165 Brick Store Landing Road Smyrna, DE 19977 Phone: (302) 659-2214 E-mail: dwayne.day@state.de.us
Principal Investigator	Sue McNeil Professor, Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail: smcneil@udel.edu
Start date/ End Date	7/1/2008 – 8/31/2010
Project Abstract	Transportation Infrastructure security and emergency preparedness presents an enormous challenge for both the State of Delaware and for the major transportation corridors that run through the state. DeIDOT and its extensive network of partner organizations have a strong coalition in place to plan, train, and run exercises related to regional evacuation issues. Most notably the state’s Transportation Management Team is charged with jointly making decisions on how an incident or an event that impacts the transportation system will be handled. Given the complexity of this task and the many intersecting areas of interest, it is vital that relevant engineering and social sciences be brought to bear on the planning processes already underway. The objective of this project is to review the current state of practice for Delaware, review external research and apply insights from state of the art social science and engineering, and develop a plan for integrating research insights into practice.
Cost	\$52,741
How DeIDOT has benefited from the project:	The quantitative system developed can maximize the effectiveness of the selected set of countermeasures to protect DeIDOT critical assets.
How the project was implemented:	The project team formulated a work plan for improving infrastructure security and emergency preparedness.

Integrating Transportation/Transit Planning in the Overall Planning Process

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Catherine C. Smith Delaware Transit Corporation 119 Lower Beech Street / Suite 100 Wilmington, DE 19805 E-mail: catherine.smith@state.de.us
Principal Investigator	Ed O'Donnell Policy Scientist, Institute for Public Administration University of Delaware 180 Graham Hall Newark, DE 19716 Phone: 302-831-4928 FAX:302-831-4934 E-mail:troutbum@udel.edu
Start date/ End Date	7/1/2008 – 12/30/2009
Project Abstract	A trend of population growth and decentralization necessitates a proactive and aggressive approach to transportation/land integration in Delaware. This project accomplishes the following objectives: Provide a matrix highlighting perceived and realized deficiencies in transportation/land use integration based on respondent interviews conducted via conference calls; provide recommendations to address integration deficiencies; conduct a literature review of possible policy outcomes that will improve land use/transportation integration in Delaware; examine the current transportation/land use integration practices in Delaware.
Cost	\$64,000
How DelDOT has benefited from the project:	This project produced recommendations that will foster more transportation and land use integration throughout the overall planning process in Delaware.
How the project was implemented:	This project provided a matrix highlighting perceived and realized deficiencies in transportation/land use integration based on respondent interviews. The current transportation/land use integration practices in Delaware were thoroughly evaluated.

Safe Routes to Schools for Children – Mode Share Data Analysis

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Sarah Coakley, AICP Division of Planning Delaware Department of Transportation PO Box 778 Dover, DE 19903 Phone: (302) 760-2236 Fax: (302) 739-2251 E-mail: Sarah.coakley@state.de.us
Principal Investigator	Ed O'Donnell Policy Scientist, Institute for Public Administration University of Delaware 180 Graham Hall Newark, DE 19716 Phone: 302-831-4928 FAX:302-831-4934 E-mail:troutbum@udel.edu
Start date/ End Date	7/1/2000 – 6/30/2002
Project Abstract	Are walking or bicycling viable modes of transport for our state's school-aged children? What truly is a "safe route to school?" What does Delaware's Safe Routes to School (SRTS) program do? What can we learn from other states and regions that have begun to address the issue of allowing students to safely get to and from school? What does the survey data of students living within walking distance of school reveal for the state as a whole and for each of its counties? Finally, in terms of discussing and making sense of the data, what do school transportation officials, planners, health advocates, and school administrators feel is most relevant? This project's purpose was to provide that baseline for the state and each county through analysis of survey data collected from parents of school-aged children living within walking distance of school. Understanding why parents would either allow or not allow their children to walk or bicycle to school was also an area of interest.
Cost	\$58,000
How DeIDOT has benefited from the project:	Both approaches could be used to outline a "Minimum Level of Service" for SRTS, or school construction in the state in general.
How the project was implemented:	This research project has provided DeIDOT with baseline rates for modal choice to and from school statewide and for each of the three counties. A further study could endeavor to detail how many crossing guards, how wide of a sidewalk, what barriers are too hazardous, and what programs have proven useful.

Advancing Asset Management in DeIDOT

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us
Principal Investigator	Sue McNeil Professor, Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail:smcneil@udel.edu
Start date/ End Date	7/1/2008– 6/30/2011
Project Abstract	Asset management has been receiving greater attention at both the state and national level. Escalating demands by the public for increased accountability, aging infrastructure, increasingly constrained resources, new funding challenges, and increasing emphasis on the private provision of public service and public-private partnership all point to the need for asset management. Asset management is a data driven process that is rooted in comprehensive inventory of physical assets and their condition, and the quantification of the impacts of alternative decision.
Cost	\$50,000
How DeIDOT has benefited from the project:	Applying this framework to interstate and interstate-like highway systems in Delaware provides an opportunity for DeIDOT to better understand asset management and how a limited set of performance measures can be used to better manage these assets.
How the project was implemented:	This framework was used to address the asset management issues by focusing on I-95, I-295, I-495, and the tolled portion of Rte 1 in Delaware.

Estimating Vehicle-Miles-Traveled by Vehicle Class for the State of Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Mark Glaze Division of Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903-0778 Phone: (302) 760-2529 Fax: (302) 739-2251 E-mail: mark.glaze@state.de.us
Principal Investigator	Young-Doo Wang Associate Director and Professor 276 Graham Hall Center for Energy & Environmental Policy University of Delaware Newark, DE 19716 USA Phone: (302) 831-1706 Fax: (302) 831-3098 E-mail: youngdoo@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2009
Project Abstract	The initial stage of the project will involve a thorough literature search and review of documentation related to the existing body of knowledge and practices. A statistically accurate method for functional conversion of the raw vehicle registration and travel data will be developed to identify the contribution of each vehicle type to VMT. This project will convert Division of Motor Vehicle (DMV) reported registration data from percent registration by vehicle type to actual mileage accumulation rates as they contribute to VMT through- out the state.
Cost	\$56,337
How DelDOT has benefited from the project:	A statistically accurate method for functional conversion of the raw vehicle registration and travel data was developed to identify the contribution of each vehicle type to VMT.
How the project was implemented:	This project provided a statistically reliable automated process for converting available DMV registration information to an accurate on-road mileage based contribution by vehicle type, acceptable to both USEPA and FHWA as part of the transportation conformity air quality analysis process.

An Examination and Presentation of Travel in Sussex County

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2007 – 12/30/2009
Project Abstract	Sussex County needs to be the focus of a comprehensive compilation and presentation of available travel and demographic data including origins and destinations, projections and their impacts, trip purpose, employment, seasonal variation, and trip generation. Available population projections also need to be examined in terms of future impact to areas in Sussex County. The Delaware Transportation Monitoring System, the National Travel Survey, and the Census 2000 CTPP are among practically untapped data sources. These together with Travel Demand Forecasting outputs, traffic studies, and traffic counts could provide a vital resource for planning and understanding for the public.
Cost	\$45,899
How DeIDOT has benefited from the project:	This project developed methods for dissemination of travel demand and traffic count information.
How the project was implemented:	A sample website for dissemination of travel demand and traffic count information has been built.

A Feasibility Study of Bus Rapid Transit (BRT) in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Catherine C. Smith Delaware Transit Corporation 119 Lower Beech Street / Suite 100 Wilmington, DE 19805 E-mail: catherine.smith@state.de.us
Principal Investigator	Bernard Dworsky Assistant Professor, School of Public Policy and Administration Policy Scientist, Institute for Public Administration University of Delaware 191A Graham Hall, Newark, DE 19716-7380 Phone:302-831-8710 FAX: 302-831-3488 E-mail:bdworsky@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2009
Project Abstract	The State of Delaware like most states in the Mid-Atlantic region is experiencing increasing volumes of traffic and traffic congestion. Delaware is also experiencing an increasing proportion of its aging population (60+) and as a coastal state, an increasing influx of retirees seeking residence in the state. These changes in demographics and traffic volumes will produce greater demands and needs for transportation services and programs. They also suggest the need to explore alternative means to meet the anticipated transportation demands.
Cost	\$72,577
How DeIDOT has benefited from the project:	As a transit strategy, BRT adjacent to Delaware's I-95 corridors designed to improve mobility, reduce travel times, increase service predictability, and attract increased ridership. BRT also provides customer amenities such as faster service due to fewer stops and signal prioritization, real-time travel information, and improved passenger comfort and convenience.
How the project was implemented:	This regional, comprehensive transportation-planning process provided a strategy to seamlessly integrate multi-modal transportation modes across state lines. BRT may or may not be implemented as part of this comprehensive mobility strategy. In any case, BRT should be strongly considered during the alternatives-analysis process.

Delaware Travel Monitoring System

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	Edward Ratledge Associate Professor, School of Public Policy & Administration Director, Center for Applied Demography and Survey Research University of Delaware Newark, Delaware 19716 Phone: (302) 831-1684 E-mail: ratledge@udel.edu
Start date/ End Date	1/1/2008 – 12/31/2008
Project Abstract	The Delaware Travel Monitoring System (DTMS) is a monthly, statewide travel survey conducted by the University of Delaware's Center for Applied Demography and Survey Research (CADSR) since 1997 on behalf of the Delaware Department of Transportation. The survey uses a "computer assisted telephone interviewing" (CATI) technique through which the typical daily travel routines and behaviors of household members are identified by CADSR staff. The research now includes over 40,000 trips in the comprehensive database.
Cost	\$108,362
How DeIDOT has benefited from the project:	DTMS data supported development of DeIDOT's Peninsula travel demand model in 2004 and was integral for significant model updates completed in 2005, 2007, 2008, and 2010. Those models, in turn, have supported scenario analysis and air quality modeling for the WILMAPCO and Dover/Kent MPO long range plans and transportation improvement programs (TIPs) during that period, as well as major planning efforts undertaken by DeIDOT including studies of the US 301 and US 113 corridors.
How the project was implemented:	Data was collected into an annual file which was then periodically used to update travel demand model.

**A Meta-Analysis of Studies, Projects and Practices on Planning for a Sustainable Environment with
Special Emphasis on the States of VT and DE**

Sponsor Organization	Delaware Department of Transportation	
Project Category	Planning	
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us	
Principal Investigators	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831 – 1446 FAX: (302) 831 – 0674 E-mail: Faghri@udel.edu	Chandra Aleong Associate Professor College of Education Delaware State University Phone: (302) 857-7690 E-mail: caleong@desu.edu
Start date/ End Date	7/1/2007 – 8/31/2010	
Project Abstract	This project conducted a meta-analysis of scientific research and policy that review mega-projects related to transportation and sustainable development in several countries.	
Cost	\$37,500	
How DelDOT has benefited from the project:	This project analyzed clean energy use in Vermont and Delaware land use planning. It developed best practices for small states like the State of Delaware.	
How the project was implemented:	Theoretical framework has been set up. The results were used for environmental and transportation decision making and, also, became a framework for policy makers that can be adapted to future projects. Several case studies were examined as part of the research.	

Asset Management as a Strategic Decision Making Tool in DeIDOT

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us
Principal Investigator	Sue McNeil Professor Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail:smcneil@udel.edu
Start date/ End Date	7/1/2006 – 6/30/2008
Project Abstract	Asset management has been receiving greater attention at both the state and national level. Escalating demands by the public for increased accountability, aging infrastructure, increasingly constrained resources, new funding challenges, and increasing emphasis on the private provision of public service and public-private partnership all point to the need for asset management. Asset management is a data driven process that is rooted in comprehensive inventory of physical assets and their condition, and the quantification of the impacts of alternative decision.
Cost	\$50,000
How DeIDOT has benefited from the project:	This project included documenting the state of the practice of asset management in DeIDOT, gaps and issues, and an implementation plan developed to introduce asset management within DeIDOT as a strategic decision support tool.
How the project was implemented:	An asset management working group was established. An asset management manual was developed.

Interactive Data Set/Database for Trip Patterns (GIS and Traffic Count Project)

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Bruce Allen Planning Supervisor, Planning Delaware Department of Transportation PO Box 778, 800 Bay Road, Dover, DE, 19901 Phone:302-760-2135 bruce.allen@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2006 – 6/30/2007
Project Abstract	This project focuses on system improvement efforts. Effective management of directional information is vital for traffic data and has many applications such as routing. Methods that were established using GIS to manage and present information referenced to turning movements and travel flow direction will be presented. The project includes application of years of research in the development of standards for referencing travel data, and application of current GIS web based technologies. An ongoing challenge for transportation agencies is dealing with the immense amounts of information; much of it GIS information, and also discussed is the development of a collaborative data and document library site for archiving, data sharing, and presentation of traffic data.
Cost	\$39,054
How DeIDOT has benefited from the project:	The project can help DeIDOT disseminate the data through a variety of web feature services using ARCGIS Server and Google, and examples.
How the project was implemented:	This project examined how GIS is being used to reference and present traffic counts, speeds, impedances, level of service, and other travel and system data to support DeIDOT's Traffic Management Center.

Asset Management and Metropolitan Planning Organizations

Sponsor Organization	Midwest Regional University Transportation Center (MRUTC)
Project Category	Planning
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us
Principal Investigator	Sue McNeil Professor, Department of Civil and Environmental Engineering University of Delaware 301 Dupont Hall Newark, DE 19716, USA Phone: 302-831-6578 Fax: 302-831-8640 E-mail:smcneil@udel.edu
Start date/ End Date	07/01/2006 – 09/30/2007
Project Abstract	This research will focus on case studies of metropolitan planning organizations (MPOs) and their asset management practice in order to identify the data needs as well as tools to support asset management. The project will include structured interviews with stakeholders from various public agencies including local MPOs as well as various transportation entities in the region. This process, with theoretical underpinnings in public participation, will make use of Soft Systems Methodology (SSM). SSM is a qualitative approach to intervene in complex problem situations. It is a holistic and systematic approach.
Cost	\$20,000
How DeIDOT has benefited from the project:	This project identified gaps and needs in data and tools and explored tools to support asset management at the regional level.
How the project was implemented:	Gaps and needs in data and tools for asset management were identified.

Comparative Analysis of Best Management Practices in Transportation Design, Construction, Management, Planning to Accommodate Growing Elderly Needs in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Mark Luszcz, P.E., PTOE Delaware Department of Transportation, Traffic Section Chief Traffic Engineer 169 Brick Store Landing Road Smyrna, DE 19977 Phone:(302) 659-4091 E-mail: Mark.Luszcz@state.de.us
Principal Investigator	Bernard Dworsky Assistant Professor, School of Public Policy and Administration Policy Scientist, Institute for Public Administration University of Delaware 191A Graham Hall, Newark, DE 19716-7380 Phone:302-831-8710 FAX: 302-831-3488 E-mail:bdworsky@udel.edu
Start date/ End Date	7/1/2006 – 6/30/2008
Project Abstract	Delaware is experiencing a growing elderly population (60+) due to aging baby boomers. Also, the state is experiencing an influx of retiree's seeking residency, particularly in Sussex and Kent Counties. The number of elderly drivers with longer life expectancies than generations past is likely to present a challenge to the state's transportation system and produce greater demands and needs for transportation services and programs in certain areas. These include services and programs to accommodate the increasing number of elderly drivers, provide alternatives to driving, and improve overall elderly-friendly mobility standards.
Cost	\$68,960
How DelDOT has benefited from the project:	In light of Delaware's growing population age 60 and older (60+), it is important to plan for the state's projected increase in older drivers. This project provides a list of priorities and recommendations for consideration by units of the Delaware Department of Transportation (DelDOT) and other state agencies based on the Delaware's demographics trends and current transportation-planning practices and resources.
How the project was implemented:	A series of priorities and recommendations for consideration in addressing current issues related to Delaware's older drivers were provided. AARP, AAA and Roadway Safety involvement for more education.

Assessing the Needs of Delaware's Older Drivers

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Mark Luszcz, P.E., PTOE Delaware Department of Transportation, Traffic Section Chief Traffic Engineer 169 Brick Stone Landing Road Smyrna, DE 19977 Phone:(302) 659-4091 E-mail: Mark.Luszcz@state.de.us
Principal Investigator	Bernard Dworsky Assistant Professor, School of Public Policy and Administration Policy Scientist, Institute for Public Administration University of Delaware 191A Graham Hall, Newark, DE 19716-7380 Phone:302-831-8710 FAX: 302-831-3488 E-mail:bdworsky@udel.edu
Start date/ End Date	7/1/2006 – 6/30/2007
Project Abstract	Driving has always played a critical role in maintaining mobility and independence in many communities through the United States. The loss of driving privileges, whether by formal loss of license due to expiration, health impairments, or family concerns about the safety of an elderly loved, one, may lessen one's accessibility to important social opportunities, work or community activities, and social services. Therefore, many older adults without a reliable, accessible, and affordable alternative mode of mobility are subject to social isolation, lack of volunteer and economic opportunities, and overall poor health and decreased life expectancy. This project will assess the needs of Delaware's older drivers.
Cost	\$68,960
How DelDOT has benefited from the project:	In light of Delaware's growing population age 60 and older (60+), it is important to plan for the state's projected increase in older drivers. Information from the United States Census Bureau (2005) indicates that Delaware is projected to have the ninth largest percentage of elderly residents to general population by 2030. This project addressed current issues related to Delaware's older drivers.
How the project was implemented:	This project provided a list of priorities and recommendations for considered by units of the Delaware Department of Transportation (DelDOT) and other state agencies based on the Delaware's demographics trends and current transportation-planning practices and resources.

Succession Planning-Phase II

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us
Principal Investigator	Douglas Tuttle Policy Scientist, IPA School of Public Policy and Administration University of Delaware 177C Graham Hall Newark, Delaware 19716-7380 Phone: 302-831-0718 FAX: 302-831-0450 E-mail:dougt@udel.edu
Start date/ End Date	7/1/2005 -6/30/2006
Project Abstract	This project details the findings related to two of those recommendations: focusing effort on reducing vacancy rates within the Planner Series and establishing a Senior Mentoring Program within DeIDOT. The analysis of current, successful DeIDOT efforts to recruit Engineers and the availability of Planner programs at regional institutions of higher education resulted in the development of a conceptual model for Planner recruitment. Utilization of this model should directly address vacancy rates in the Planner series. Regarding the establishment of a Senior Mentoring Program within DeIDOT, the research findings highlight best practices regarding mentoring programs among comparable organizations. This project also produced the wholly unexpected result of discovering that a mentoring program already existed within the agency – but that it had not been utilized by the staff of the Planning Department. On the whole, this project directly illustrates the practical benefit of applied research. The recommendations that have been developed could be implemented in short order.
Cost	\$47,000
How DeIDOT has benefited from the project:	A key ingredient in the enhancement of the Planner Series recruitment effort would be to attract a better applicant pool for the vacant positions. Strategies toward that end should logically be based on some of the successful recruiting practices that DeIDOT has employed for the Engineer Series.
How the project was implemented:	The approach was taken to engineers' recruitment, with the goal of modeling internal "best practices" that could be emulated and applied to the recruitment of planners.

Active Adult (55+) Community/Trip Generation Rates

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	William Brockenbrough, P.E., AICP County Coordinator, Division of Planning Delaware Department of Transportation P.O. Box 778, Dover, DE 19903 Phone: (302)760-2109 E-mail: Thomas.brockenbrough@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2004 -6/30/2006
Project Abstract	In response to the growing number of applications for the development of age restricted communities (55 years old and older) the Delaware Department of Transportation (DelDOT) through the Delaware Center for Transportation sponsored this study to examine trip generation characteristics and traffic impacts.
Cost	\$44,850
How DelDOT has benefited from the project:	The models created in this project have the ability to predict the effects of age, income, vehicle availability, housing type, children in the household, employment, and home ownership on trip generation. With the various plans that are proposed for age restricted housing, and the relatively low amount of data available on trip generation for these facilities, the model has the ability to estimate the effects of a variety of factors that may come into play when examining the impacts of new housing developments.
How the project was implemented:	DelDOT uses a different approach for trip generation rates. It may be useful for network modeling.

Bike Path Adjacent to Residential Areas-Property Value/Desirability

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Anthony Aglio Project Planner/Bicycle and Pedestrian Coordinator Division of Planning, DeIDOT 800 Bay Road PO Box 778 Dover, DE 19901 Phone: 302-760-2509 Fax: 302-739-2251 E-mail: Anthony.Aglio@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	07/01/2005 – 11/30/2006
Project Abstract	Studies and surveys in other parts of the country have shown that bicycle paths (trails, greenways) can contribute to areas where they are established by providing recreation, transportation, a sense of community, increased property values, and lower crime. On the other hand, in some cases with many new initiatives for the creation of walking and biking paths there is resistance by members of the community who worry that property values may be negatively impacted, that there will be loss of privacy, and the potential for more crime in their neighborhood. Success of bike and walking trail projects depends often on planners understanding and communicating what is known about the impacts of bike and walk ways in a community. In addition to being used by bicycles, "bike paths" are typically designated for use also by pedestrians, skaters, and other non-motorized uses are typically referred to as paths, trails, or greenways. Bike lanes addressed in this project were from the most part, dedicated paths rather than portions of the public roadway simply striped or designated as a suggested bike way due to extra road width or shoulders. There is no information to suggest that a bike path designated as such by only the presence of a shoulder in the road would impact property values in Delaware as they are for the most part indistinguishable from the road corridor itself and are more a feature of the existing road rather than the neighboring properties.
Cost	\$37,522
How DeIDOT has benefited from the project:	This project performed a literature review of past information and studies concerning property values related to the presence of bicycle and pedestrian paths. In addition Delaware property values were examined to determine how the presence of a bicycle path may affect property values.
How the project was implemented:	This project examined the literature and presents what is known concerning the impacts on property values with the introduction of bicycle paths and also presents some information about crime in relation to bicycle and pedestrian paths. In addition a statistical model was developed in this project using Delaware property data to examine the impact of bicycle paths on nearby housing.

Succession Planning

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Margaret Failing Director of Human Resources Delaware Transit Corporation Department of Transportation Phone: 302-760-2837 Fax: 302-760-2915
Principal Investigator	James Flynn Assistant Professor and Director of the MPA Program School of Public Policy and Administration Associate Policy Scientist, IPA 180 Graham Hall University of Delaware Newark, Delaware 19716-7380 Phone: 302-831-4658 Fax: 302-831-3488 E-mail: jflynn@udel.edu
Start date/ End Date	7/1/2004 – 6/30/2005
Project Abstract	Succession planning is an organizational investment in the future. Institutional knowledge is a critical ingredient in the culture of an organization, and its intangible value becomes significant when an organization is faced with the need to pass this knowledge to a new generation of leaders or employees in key positions. An exploration of the current situation in the Delaware Department of Transportation (DeIDOT) was undertaken during Phase I of this project, which resulted in the development of three recommendations for future action.
Cost	\$42,350
How DeIDOT has benefited from the project:	Transfer of institutional knowledge to the next generation of DeIDOT 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.
How the project was implemented:	This project examined the need for a systematic, department-wide strategy to transfer institutional knowledge to the next generation of DeIDOT professionals; identified appropriate "best practices" among other state transportation agencies; evaluated the pros/cons of developing in-house staff competency versus utilization of external consultants; and, conducted preliminary staff analysis.

Commercial Vehicle Information System and Network (CVISN) for Delaware/I-95 Corridor Coalition

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Greg Oliver Assistant Director of Planning Delaware Department of Transportation 800 Bay Road P.O. Box 778 Dover, DE 19903-0778 Phone: (302) 760-2116 E-mail: gregory.oliver@state.de.us
Principal Investigator	Bernard Dworsky Assistant Professor, School of Public Policy and Administration Policy Scientist, Institute for Public Administration University of Delaware 191A Graham Hall, Newark, DE 19716-7380 Phone:302-831-8710 FAX: 302-831-3488 E-mail:bdworsky@udel.edu
Start date/ End Date	7/1/2003 – 8/31/2004
Project Abstract	The following study examined Commercial Vehicle Information Systems and Networks (CVISN) and evaluated the impacts of electronic-screening, electronic-credentialing, and safety information exchange on commercial vehicle operations in Delaware. CVISN is a collection of information systems and communications networks supporting commercial vehicle operations (CVO). These include information systems owned and operated by governments, motor carriers, and other stakeholders. The CVISN program provides a framework or “architecture” enabling government agencies, the motor carrier industry, and other parties engaged in CVO administration, safety assurance, and regulation to electronically exchange information and conduct business transactions. The goal of the CVISN program is to improve the safety and efficiency of CVO.
Cost	\$58,500
How DelDOT has benefited from the project:	CVISN can produce cost savings for agencies and motor carriers, enhance the efficiency and effectiveness of CVO, and improve CVO safety.
How the project was implemented:	The Delaware CVISN Planning Team, which includes representatives of DelDOT’s MFTA and IT department, DMV, DNREC, and the State Police, produced its first CVISN business plan in 1998. DelDOT also participated in two CVISN Field Operation Tests (FOTs) in conjunction with the I-95 Corridor Coalition. The state has reestablished the CVISN Planning Team and recently entered into a PRISM grant agreement, significant work remains for complete CVISN implementation

Costs and Benefits of Advanced Public Transportation System at DART FIRST STATE (GPS/AVL System Evaluation)

Sponsor Organization	Delaware Department of Transportation/ SPR
Project Category	Planning
Project Manager	John McGinnis Executive Director Delaware Transit Corporation Delaware Department of Transportation Phone: (302)760-2831
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2003 – 6/30/2005
Project Abstract	This project focuses on an evaluation of Automated Vehicle Locator (AVL), dispatching and routing software and hardware systems, security systems and related technologies that have been recently (May 2001) implemented at DART First State. These technologies are addressed and evaluated nationally under the category of Advanced Public Transportation Systems (APTS).
Cost	\$63,769
How DelDOT has benefited from the project:	This project examined the costs and benefits of new technologies implemented at DART First State. An evaluation framework is provided for the evaluation for a specific transit agency.
How the project was implemented:	The contractor has upgraded system based on recommendations from this project.

Subdivision Inter-Connectivity

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Ralph Reeb Director, Policy and Planning Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone:302-760-2080 E-mail: Ralph.Reeb@state.de.us
Principal Investigator	Ed O'Donnell Policy Scientist, Institute for Public Administration University of Delaware 180 Graham Hall Newark, DE 19716 Phone: 302-831-4928 FAX:302-831-4934 E-mail:troutbum@udel.edu
Start date/ End Date	7/1/2000 – 6/30/2002
Project Abstract	Various researchers have claimed that providing road connection 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.
Cost	\$60,000
How DeIDOT has benefited from the project:	This project identified if there is any statistically significant difference in travel pattern found in community that have different level of interconnectivity.
How the project was implemented:	This project justified that interconnectivity has significant role in travel behavior. Recommended for bigger research project to study this issue in Delaware.

Delaware Department of Transportation Soft Skills Workshop Series

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Carolann Wicks Secretary of Transportation Delaware Department of Transportation Delaware DOT P.O. Box 778 Dover, DE 19903 Phone: (302) 760-2303 E-mail: carolann.wicks@state.de.us
Principal Investigator	Kathy Wian Policy Scientist, Institute for Public Administration College of Human Services, Education, and Public Policy University of Delaware 177 Graham Hall Newark, Delaware 19716 Phone: 302-831-2927 FAX: 302-831-0450 E-mail: kmmurphy@udel.edu
Start date/ End Date	7/1/2002 – 6/30/2003
Project Abstract	The purpose of the DeIDOT Reorganization/Soft Skills Workshop project is to craft a training curriculum for DeIDOT employees that conveys the competencies required of the modern transportation professional, thereby eliminating the lack of organization and comprehensiveness in employee training from which the department currently suffers. The goals of the project are to research the field of transportation engineering so as to determine these competencies, to identify the strengths and weaknesses of DeIDOT's current training program. In accomplishing these goals, DeIDOT will have the benefit of a strategic plan for the development of engineers that will assure employees and managers that appropriate professional development opportunities are available as needed.
Cost	\$29,010
How DeIDOT has benefited from the project:	This project used this knowledge base in preparing an employee curriculum that fulfills the department's professional development needs.
How the project was implemented:	All project requests and goals have been met. The information contained in the attachments was developed specifically for DeIDOT employees and was given to Carol Ann Wicks and her staff in order to help them move through a reorganization effort that occurred in Fall of 2002. The proposed training curriculum was developed to meet specific needs of DeIDOT employees, especially those transitioning into work teams. If and when this curriculum is implemented, the trainers delivering the courses will need to work closely with employees in order to customize the training to their needs.

Evaluation of Training Methods

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Larry Klepner, Delaware T2 Center Delaware Center for Transportation University of Delaware Newark, DE 19716 Phone: 302.831.6241 Fax: 302.831.0674 E-mail: lklepner@ce.udel.edu
Principal Investigator	Kathleen Werrell Assistant Dean, College of Engineering University of Delaware Phone: (302) 831-4863 E-mail: werrell@udel.edu
Start date/ End Date	7/1/2000 – 6/30/2002
Project Abstract	To evaluate how good T2 training program is.
Cost	\$31,490
How DelDOT has benefited from the project:	Promote training, technology transfer, and research project implementation at state and local transportation agencies.
How the project was implemented:	This project has completed with changed scope. The scope changed to how to select the courses for training.

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

Sponsor Organization	Delaware Department of Transportation
Project Category	Planning
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2001- 6/30/2005
Project Abstract	In this project a functional prototype of web based documentation, search, cataloging, and organizational tool was created to demonstrate a potentially powerful aid to the Delaware Department of Transportation (DelDOT) Division of Planning. This utility is the Documentation Utility for Referencing, Organization, and Search (DUROS). The DUROS has the following features: Easy documentation tools; Ability to organize data in numerous ways without copying or moving data; Easily created customized views of files, directories, projects, and organizational areas; Availability of the tool from any internet browser on a network; Data management utilities; Fast search utilities that can operate across several data servers or other areas specified by the user; and Documentation at the time of data creation. While many other features than those demonstrated could be built into the DUROS, it represents a simple but powerful utility that could be developed and implemented in the near term with relatively low cost when compared to large scale data warehouse efforts.
Cost	\$49,000
How DelDOT has benefited from the project:	This project was conducted in response to concerns about data management issues and what could be done to improve information systems at the Division of Planning at the Delaware Department of Transportation (DelDOT).
How the project was implemented:	Completed successfully. Research came up with some useful recommendations. DUROS now has a database that tracks close to 100,000 directories, 7 servers, and about 1.5 million data files. This amount of data is at least comparable or probably much more than managed by Division of Planning. Databases are indexed in a number of ways so that records can be retrieved quickly. A part of the research outcome is being implemented in another project.

Part 4 Structures and Bridges

Investigation of Load-Path Redundancy in Aging Steel Bridges

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov
Principal Investigator	Jennifer Righman McConnell Associate Professor University of Delaware Department of Civil and Environmental Engineering 360H DuPont Hall, Newark, DE 19716 Phone: 302-831-6056 E-mail: righman@udel.edu
Start date/ End Date	9/1/2011 – 8/31/2013
Project Abstract	A key factor affecting the resiliency of transportation infrastructure is aging. Furthermore, the current age of the nation's transportation infrastructure relative to the financial resources available for infrastructure investments causes aging to be one of the biggest challenges facing civil engineers in the coming years. As a result of these demands, the project entitled "Investigation of Load-Path Redundancy in Aging Steel Bridges" was initiated in 2010 to systematically quantify the actual system capacity of steel bridges as a function of deterioration of the concrete bridge deck. This will be accomplished by first incorporating the influences of load path redundancy into the existing AASHTO rating format and then refining this approach based on the aging effects that were quantified in Phase 1.
Cost	\$100,386
How DeIDOT has benefited from the project:	This project can provide a rating procedure that can be readily applied by bridge owners.
How the project was implemented:	A systematic and quantified procedure was provided that will allow the aging structures that are in greatest need of rehabilitation or replacement to be better identified.

Development of Rapid Assessment Tools for Structural Parts after Extreme Events Using Stress Wave Methods

Sponsor Organization	University of Delaware University Transportation Center (UDUTC)	
Project Category	Structures and Bridges	
Project Manager	Dawn Tucker-Thomas Office of Research Development & Technology Research and Innovative Technology Administration 1200 New Jersey Avenue, SE, Building E 33-464 Washington, D.C. 20590 Phone: (202) 366-1300 E-mail: dawn.tucker-thomas@dot.gov	
Principal Investigators	Thomas Schumacher Assistant Professor Department of Civil and Environmental Engineering University of Delaware 301 DuPont Hall Newark, DE 19716, USA Phone:302-831-4559 E-mail: schumact@udel.edu	Nii Attoh-Okine Professor Department of Civil and Environmental Engineering University of Delaware 354 DuPont Hall Newark, DE 19716, USA Phone 302-831-3640 E-mail:okine@udel.edu
Start date/ End Date	9/1/2011 – 8/31/2013	
Project Abstract	Recent extreme events such as earthquakes and hurricanes have shown the need for improved rapid structural assessment tools. It has been recognized that successful recovery missions greatly rely on the reliability and safety of the existing transportation infrastructure. In particular, bridges represent crucial parts of an infrastructure network and authorities need to know whether they can rely on the bridges that survived an extreme event in order to plan their recovery missions. Tests on small steel parts in conjunction with numerical stress wave simulation will be used to establish quantitative analysis tools that can objectively detect flaws.	
Cost	\$59,473	
How DelDOT has benefited from the project:	The developed tools can increase the resilience of the infrastructure after an extreme event and enable a faster recovery.	
How the project was implemented	Quantitative analysis tools were provided for rapid inspection of critical structural parts after extreme events using stress wave methods.	

In-Service Monitoring for Improved Maintenance and Management of DelDOT Bridges (continuation)

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us
Principal Investigator	Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu
Start date/ End Date	9/1/2009 – 8/31/2011
Project Abstract	The objective of this investigation was to gather in-service strain data on a sample of typical bridges, some of which had been previously monitored, and to compare the new data with the historical data. Also, to develop methods for quantifying the differences between similar datasets, so that changes in behavior could be easily identified. In this study researchers from the University of Delaware, in collaboration with personnel from DelDOT's bridge management group, deployed the In-Service Bridge Monitoring System (ISBMS) in 16 different monitoring trials, on 14 different bridges in Delaware (eleven of these bridges had been previously monitored in 2006 or 2007), between November of 2009 and March of 2011. This project provides a brief description of the bridges, as well as where the strain sensor was placed on the bridge, and how access was gained to the bridges.
Cost	\$49,862
How DelDOT has benefited from the project:	This project illustrated how the in-service data can be used to determine rating factors that more accurately reflect the true capacity of the structure. It is recommended that in-service monitoring of typical highway bridges be considered for incorporation as part of the normal inspection program of these types of bridges in Delaware.
How the project was implemented	The benefit of gathering in-service strain data on typical highway bridges was demonstrated. The data can be used to determine if changes in the bridge behavior have occurred, which could be due to damage or deterioration of the structure.

Field Testing and FEM Analysis of the Route 141 Newport Viaduct

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us
Principal Investigator	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	3/1/2009 – 12/31/2010
Project Abstract	The Newport Viaduct located in Newport, Delaware carries Route 141 over the Christina River, Route 4, Amtrak and other local roads. The viaduct consists of 19 spans of welded steel box girders. The spans are numbered from the south to the north with span 1 starting at the south abutment and span 19 ending at the north abutment. The structure exhibits extensive fatigue cracking throughout. To mitigate the effects of fatigue cracks to the overall performance of the structure and suspend further growth of the cracks, the most critical crack locations (42 total) have been identified and drilled. Additional critical crack locations were drilled as specimens for fatigue core sample evaluation. To assist DMJM Harris in developing a strategy for managing the bridge, the University of Delaware will provide field testing and analysis support.
Cost	\$175,412
How DelDOT has benefited from the project:	This project conducted field tests of sections of the viaduct and developed detailed finite element models that would be used to conduct a fatigue evaluation of the viaduct, and to assist in developing a repair and retrofit strategy for the viaduct.
How the project was implemented:	The cause of the cracks was thoroughly evaluated. A fatigue evaluation was conducted using the global finite element models to see if the fatigue life was consistent with the observed cracking. The agreement between the model and test results for the global member behavior was sufficiently accurate to use the models for the subsequent fatigue evaluation and retrofit study.

Testing and Operation of Delaware's First "Smart Bridge"

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail Address: jiten.soneji@state.de.us
Principal Investigator	Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu
Start date/ End Date	7/1/2008 – 8/31/2011
Project Abstract	Bridges are a vital link in the nation's highway system. They also represent a tremendous investment for the owner. Therefore, it is necessary to have a system for maintaining and ensuring the reliability of these important structures. The Federal Highway Administration's Long-Term Bridge Performance Program (LTBPP), still in the planning phase at the time of this project, will consist of efficient maintenance and structural health monitoring (SHM) strategies for bridges across the nation. One of the SHM technologies being implemented in the program is permanently instrumented bridges. The project discussed in this study is Delaware's first permanently instrumented bridge, and it provides a prototype for future permanently instrumented bridges for the LTBPP. This project also serves as a building block for a larger permanent instrumentation system that will be installed on the replacement Indian River Inlet Bridge.
Cost	\$56,646
How DelDOT has benefited from the project:	All work completed in this portion of the first permanent instrumented Delaware bridge can be replicated and used on future long term instrumented bridges.
How the project was implemented	The LTBPP has recommendations on which types of gages will be used on permanently instrumented bridges. The recommendations were followed and the majority of the gages were installed on the prototypical bridge. Only WIM sensors and weather related gages were not included in the Delaware bridge.

Historic Resiliency of Bridges on the BOSFOLK Corridor

Sponsor Organization	Department of Transportation
Project Category	Structures and Bridges
Project Manager	Amy Stearns US DOT/RITA/mail code RDT-30 Work Station E33-472 1200 New Jersey Avenue, SE Washington, DC 20590-0001
Principal Investigator	Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu
Start date/ End Date	9/1/2009 -8/30/2012
Project Abstract	The Boston-Norfolk (BOSFOLK) corridor is a major transportation corridor in the northeast, the main artery of which is Interstate-95 (I-95). With construction initiating in the 1960's, many of the bridges on I-95 and in the corridor are nearing the end of their design life. This presents a unique opportunity to study the long-term performance of bridges on a major heavily traveled corridor. The questions can be asked – How resilient were the bridges in the BOSFOLK corridor? And – How did the bridges on I-95 perform compared to those not on I-95 in the corridor? The study will specifically examine the historic resiliency of bridges in the corridor. It will be done through a systematic investigation of historic data from the National Bridge Inventory (NBI) database. The proposed research falls under two thrusts of the UDUTC program: Planning, and Infrastructure Renewal. The research plan will involve (1) literature review, (2) gathering historical NBI data, (3) identifying NBI coding parameters relevant to performance, (4) creation of the BOSFOLK-NBI database, (5) data mining, and (6) final report. Condition rating, load rating, and sufficiency rating will be used as the measures of “performance of the bridges. The data will be used to study, for example, how the performance of the bridges in the corridor varied over time, how the bridges on I-95 performed compared to those not on I-95, and how the performance varied from state to state. Results will be presented in the form of graphs, charts or tables. Test of statistical significance will be used where appropriate.
Cost	\$50,605
How DelDOT has benefited from the project:	The benefits include a better understanding of the long-term performance of bridges, knowledge of the positive or negative influences on bridge performance of being on a heavily traveled transportation corridor, and better planning and management of our bridges, particularly those that are on a major corridor.
How the project was implemented:	The long-term performance of bridges on a major heavily traveled corridor was thoroughly evaluated.

Construction of Approach MSE Walls to IRIB: Reduction of Geotechnical Field Data

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone: 302 760-2312 douglass.robbs@state.de.us	
Principal Investigators	Dov Leshchinsky Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360C DuPont Hall Phone: (302) 831-2446 E-mail: dov@udel.edu	Christopher Meehan Associate Professor Department of Civil & Environmental Engineering University of Delaware Newark, DE 19716 360A DuPont Hall Phone: (302) 831-6074 E-mail: cmeehan@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2009	
Project Abstract	There were several sections along the north and south embankment where settlement plates, inclinometers, and piezometers were installed. This instrumentation served as construction monitoring assuring that there is no impending failure. However, no real reduction of data was made. Such reduction can provide DelDOT with accurate soil properties in that area as well as feedback regarding the design calculations.	
Cost	\$62,158	
How DelDOT has benefited from the project:	The Delaware Department of Transportation (DelDOT) planned to replace the existing bridge along Delaware Route 1 over the Indian River Inlet in Sussex County, Delaware. The construction of two new approach embankments was necessary for the new bridge.	
How the project was implemented:	The associated embankment fill for each abutment was planned to be contained on each side by geogrid reinforced mechanically stabilized earth (MSE) walls.	

Bridge Management Using In-Service Data – Phase II

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone: 302-760-2312 E-mail: douglass.robbs@state.de.us	
Principal Investigators	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu	Harry Shenton Professor Department of Civil and Environmental Engineering University of Delaware 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail: shenton@udel.edu
Start date/ End Date	7/1/2007 – 6/30/2009	
Project Abstract	Effective bridge management can aid in determining resource allocation and help a DOT in cost-effectively maintaining its inventory of bridges. The current methods used have inherent limitations: the use of as-built conditions and design capacities yields ratings that may be overly conservative, while full-scale load tests yield accurate data but are costly and require closure to traffic. The researchers used an in-house-developed In-Service Bridge Monitoring System (ISBMS) to collect data that was then used to develop a load rating for the bridges studied. Using two weeks of data collected during biannual inspections of bridges, a two-week rating for each bridge in the study was developed. This two-week rating was compared to the 50-year rating that is usually calculated for bridges based on design capacities. The study showed that the two-week rating factors are, for the most part, between three and eight times greater than the 50-year rating factor. The proposed project would be a continuation of the work done in the initial bridge management project, with the focus some of these as-yet unaddressed issues.	
Cost	\$53,908	
How DelDOT has benefited from the project:	The projected two-year rating from this data would lead to an increased rating factor in bridges. It would also be valuable to compare weigh-in motion (WIM) data to the stresses seen during a certain time period to help identify the average weight of trucks crossing the bridge and correlate the truck weights to the stress in the bridge.	
How the project was implemented:	Data for developing a load rating was collected. Additional work is needed to incorporate peak gauge data into the data collected by the ISBMS, enabling better prediction of the load rating stress.	

Near Real-Time Monitoring of Indian River Inlet Scour Hole Edge Evolution Seaward of the Bridge Piers

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone: 302 760-2312 E-mail: douglass.robbs@state.de.us	
Principal Investigators	Jack Puleo Associate Professor of Coastal Engineering Center for Applied Coastal Research Department of Civil and Environmental Engineering University of Delaware Newark, Delaware 19716 Phone: (302) 831-2440 Fax: (302) 831-1228 E-mail: jpuleo@udel.edu	Jennifer Righman McConnell Associate Professor University of Delaware Department of Civil and Environmental Engineering 360H DuPont Hall, Newark, DE 19716 Phone: 302-831-6056 E-mail: righman@udel.edu
Start date/End Date	10/1/2007 – 8/31/2012	
Project Abstract	The purpose of this project is to install 2 3D imaging sonars and accompanying acoustic Doppler current profilers (ADCPS) to investigate the change in scour hole depth and extent in the Indian River Inlet in Delaware. All equipment will be hard wired to local logging computers, radio to a receive computer and put on a forthcoming web page in near real time.	
Cost	\$792,397	
How DeIDOT has benefited from the project:	The ADCPs can help in measuring the tidal forcing conditions.	
How the project was implemented:	An estimate of the bathymetry coverage for two sonar units, one installed on each seaward bridge pier. Deployment of instruments was late 2007 to early 2008.	

Assessing the Vulnerability of Delaware's Coastal Bridges to Hurricane Forces

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Amy Stearns US DOT/RITA/mail code RDT-30 Work Station E33-472 1200 New Jersey Avenue, SE Washington, DC 20590-0001
Principal Investigator	Dennis Mertz Professor Department of Civil and Environmental Engineering University of Delaware 358B DuPont Hall Newark, DE 19716, USA Phone: (302) 831-2735 E-mail: mertz@udel.edu
Start date/ End Date	9/1/2007 – 8/31/2009
Project Abstract	There exists a need for new guidelines to address the threat of hurricane forces to coastal bridges. The purpose of this study is to analyze a sample of Delaware's coastal bridges to determine the applicability of the specifications to the Middle Atlantic coast and to determine any risk to Delaware's bridge inventory. Feedback will also be provided to DeIDOT on the specifications and the safety of their bridges. Three bridges in Delaware were chosen to analyze using the specifications. They are the Indian River Inlet Bridge (Bridge 3-156), the Fenwick Island Bridge (Bridge 3-437), and the Old Mill Bridge (Bridge 3-460). They were chosen because of their proximity to the coast, low elevations, and criticality in evacuation or rescue operations during a hurricane. The results for the study were that the 100-year wave crest elevation, in addition to the design storm water elevation, was not high enough to impact any of the three bridge superstructures. In each case, the minimum 1 ft of required clearance was maintained.
Cost	\$46,917
How DeIDOT has benefited from the project:	The Guide Specifications for Bridges Vulnerable to Coastal Storms provides clear guidelines to give owners the ability to determine bridges that should be analyzed for coastal loads and any damage the loads may cause to the bridge. It clearly and, from what was observed in this project, accurately allowed for the design wave crest elevation to be calculated. Since none of the bridges analyzed were impacted by the waves, it is not known if the forces on the superstructure that would have been calculated are critical. Also, for an engineer that does not have an extensive background in coastal engineering, the guidelines are easy to follow. Additionally, the explanation of all terms and techniques and the commentary provided were well thought out.
How the project was implemented:	Based on the finding from this project DeIDOT does not need to take immediate action to retrofit any of these three coastal bridges. However, they should become familiar with the new specifications and analyze any other bridges they may deem necessary. The new Indian Inlet River Bridge should take into consideration the storm surge and wave heights calculated in this project. Since the existing bridge elevation is more than adequate, the new design should meet the requirements easily. Additionally, it is recommended that DeIDOT familiarizes themselves with recovery techniques in case there is a storm that severely damages a coastal bridge.

Scour Monitoring of the Indian River Inlet Bridge

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone: 302 760-2312 E-mail: douglass.robbs@state.de.us	
Principal Investigators	Jennifer Righman McConnell Associate Professor University of Delaware Department of Civil and Environmental Engineering 360H DuPont Hall, Newark, DE 19716 Phone: 302-831-6056 E-mail: righman@udel.edu	Jack Puleo Associate Professor of Coastal Engineering Center for Applied Coastal Research Department of Civil and Environmental Engineering University of Delaware Newark, Delaware 19716 Phone: (302) 831-2440 Fax: (302) 831-1228 E-mail: jpuleo@udel.edu
Start date/ End Date	7/1/2006 – 6/30/2008	
Project Abstract	There is considerable concern regarding the scour near and around the existing Indian River Inlet Bridge. As a result, the bridge is scheduled to be replaced. However, since the initial design was deemed too expensive to build, the design process will need to start over again. This will result in the existing bridge needing to remain in service for longer than anticipated. As a result, there is concern over the safety of the existing bridge into the future. It is suggested that a research project be initiated that: evaluates existing scour detection technologies, develops a scour detection system for the existing bridge, and assesses the structural integrity and safety of the bridge throughout its remaining service life.	
Cost	\$50,112	
How DelDOT has benefited from the project:	A standard static survey over the benchmarks used to do the monthly total station surveys of the prisms on the piers was completed every 6 months in order to quantify the movement in the benchmark to which all prism survey data is referenced. Furthermore, it is suggested that rather than recording only the average height of the prism from the total station shot that all elevations are recorded.	
How the project was implemented:	The tilt sensors have been successfully operational and recording data. In late 2008, the tilt sensor installation was modified to allow for “live” data collection at the request of state personnel. The instrumentation schemes devised and resulting data obtained from this pilot study is now being utilized in the continuation of this project, Near Real-Time Monitoring of Indian River Inlet Scour Hole Edge Evolution Seaward of the Bridge Piers: Phase I.	

Bridge Management using in-Service Data – Phase I

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Douglas Finney, P.E. Bridge Management Engineer Delaware DOT Phone:(302) 760-2314 E-mail: Doug.Finney@state.de.us	
Principal Investigators	<p>Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/ End Date	7/1/2005 – 6/30/2007	
Project Abstract	<p>For this project, an In-Service Bridge Monitoring System (ISBMS) was deployed on selected steel bridges in Delaware for two-week periods during regularly scheduled bi-annual inspections. Two advantages of in-service monitoring over a diagnostic load test are that (1) no traffic control is needed to conduct the test, and (2) the data collected provides information about the actual bridge response due to ambient traffic over time. The six bridges selected were on Interstates 95 and 495, State Routes 7 and 4, Kirkwood Highway, and Newport Gap Pike. These roads were selected because they are major truck traffic routes in the geographical area being studied; the specific bridges were chosen based on a variety of criteria including ease of access. The ISBMS used in this project was developed at the University of Delaware. The current version consists of a Bridge Diagnostics Inc. (BDI) Strain Transducer and a Snap Shock Plus M4. The BDI gauge is mounted to the bridge using C-clamps, and the Snap Shock Plus collects strain events measured by the BDI.</p>	
Cost	\$58,250	
How DelDOT has benefited from the project:	This project investigated the use of in-situ strain data to directly calculate load ratings for bridges. By monitoring a network of bridges and by collecting new data sets every two years, bridge owners will be better able to track the health of their bridges.	
How the project was implemented:	Phase II data collection in progress.	

Load Rating Using an In-Service Monitoring System

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridge	
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone: 302 760-2312 E-mail: douglass.robbs@state.de.us	
Principal Investigators	Harry Shenton Professor Department of Civil and Environmental Engineering University of Delaware 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail: shenton@udel.edu	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	7/1/2006 – 9/30/2007	
Project Abstract	The goal of this project was to investigate the use of in-situ strain data to directly calculate load ratings for bridges. By monitoring a network of bridges and by collecting new data sets every two years, bridge owners will be better able to track the health of bridges. The original load rating for a bridge is determined using a numerical analysis based on as-built properties. Since numerical models often incorporate conservative assumptions regarding bridge behavior, the load ratings that result from the numerical analysis are often more conservative than they would be if they were based on actual bridge response data. Adding a quantitative aspect to the bridge inspection process would be helpful in more precisely indicating the capacity of a bridge. Measures of actual live load stresses induced by ambient traffic would provide inspectors with quantitative data evaluations, which are primarily qualitative.	
Cost	\$58,250	
How DelDOT has benefited from the project:	This two year rating could meet federal standards and give the bridge a realistic rating for the time between biannual inspections. The new rating method might allow larger loads to pass over a bridge and will produce a more quantitative way of measuring decreased load carrying capacity.	
How the project was implemented:	The work carried out in this project was the first phase of a project that is being continued by the research team. Future work will involve incorporating the peak gauges into the ISBMS data collection, enabling prediction of ratings for longer periods of time.	

Moment Redistribution and Service II Limit State

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone:302 760-2312 douglass.robbs@state.de.us
Principal Investigator	Jennifer Righman McConnell Associate Professor University of Delaware Department of Civil and Environmental Engineering 360H DuPont Hall, Newark, DE 19716 Phone: 302-831-6056 E-mail: righman@udel.edu
Start date/ End Date	7/1/2006 – 9/30/2007
Project Abstract	A concern regarding the use of design procedures that allow steel girder stresses to exceed the yield strength of the steel is the effect on permanent deformations, which are intended to be controlled by the requirements of the Service II limit state. In many situations, particularly for compact girders, the Service II limit state of the AASHTO LRFD Bridge Design Specifications governs the design. This limit state is calibrated to yield similar proportions as the overload check of the AASHTO Standard Specifications for Highway Bridges. The research reported here was carried out in the belief that the Service II limit state should be re-evaluated in light of the calibration of the strength limit states of the LRFD Specifications. The objective of the work was to evaluate the current stress limits for steel I-girders at the Service II limit state. AASHTO Specifications (2004) limit the maximum allowable stress to 95% of the yield stress for composite girders and 80% of the yield stress for non-composite girders. These limits were originally intended to prevent objectionable levels of deformation. However, the basis for these limits is not well founded. Because these stress limits frequently control the design of compact sections in positive bending, a more thorough evaluation of these limits is warranted. Such an evaluation was a primary objective of this work, which was expected to result in alternative design requirements for the Service II limit state.
Cost	\$56,343
How DelDOT has benefited from the project:	This project can provide experimental data on service stresses versus deflection/permanent set and experimental data on service stresses at various levels of moment redistribution. The construction methods, testing procedures, numeric data analysis, and the graphical display of data/results presented in this research are an adequate and efficient method for evaluation.
How the project was implemented:	PM stated problems arose with research (failed equipment/test beam). Additional research needed.

Historic Bridges Study-Defining & Projecting Delaware's Historic Bridges

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Glen Lovelace Bridge Design, DeDOT Phone: (302)-760-2321 E-mail: Glen.Lovelace@state.de.us
Principal Investigator	David L. Ames Director, Center for Historic Architecture and Design Professor of Public Policy and Administration, Geography, and Material Culture Studies 331 Alison Hall University of Delaware, Newark, DE 19716 Phone: 302-831-1050 E-mail:davames@udel.edu
Start date/ End Date	7/1/2005 -6/30/2006
Project Abstract	This project focuses on a number of issues associated with reevaluating the State's historic bridge list, including determining what constitutes a historic bridge, differentiating between old and historic bridges, developing life-cycle cost strategies for historic bridges, and investigating mobility and congestion problems associated with keeping older structures in service.
Cost	\$ 48,273
How DeDOT has benefited from the project:	This project provided in-depth information about the historic bridge survey, including its methodology, criteria for evaluation, and individual bridge evaluations.
How the project was implemented:	This project provided an overview of the history of roads and transportation in Delaware from the seventeenth century to the present day. The published report provided historical background to the events surrounding its development. Among historians and preservationists, this background information is referred to as "historic context," which serves as the framework for the different significant time periods of history and important themes or trends specific to each period.

Assessing the Fatigue Life of Delaware's Steel Bridges

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Doug Robb, P.E. Delaware DOT 800 Bay Road Dover, DE 19903 Phone:302 760-2312 E-mail: douglass.robbs@state.de.us
Principal Investigator	Dennis Mertz Professor Department of Civil and Environmental Engineering University of Delaware 358B DuPont Hall Newark, DE 19716, USA Phone: (302) 831-2735 E-mail: mertz@udel.edu
Start date/ End Date	7/1/2004 – 6/30/2006
Project Abstract	This project is aimed at assessing the fatigue life of Delaware's steel bridges.
Cost	\$57,888
How DeIDOT has benefited from the project:	This project enable identification and implementation of appropriate repair and retrofit techniques, thereby preventing fatigue cracks, which require costly road closures and repairs.
How the project was implemented:	The fatigue life of Delaware's steel bridges was thoroughly evaluated. No repair needed at the moment unless there are cracks.

Development of State-Specific Truck Weights

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Douglas Finney, P.E. Bridge Management Engineer Delaware DOT Phone: (302) 760-2314 E-mail: Doug.Finney@state.de.us
Principal Investigator	Dennis Mertz Professor Department of Civil and Environmental Engineering University of Delaware 358B DuPont Hall Newark, DE 19716, USA Phone: (302) 831-2735 E-mail: mertz@udel.edu
Start date/ End Date	7/1/2004 – 6/30/2006
Project Abstract	The load ratings that result from the numerical analysis are often more conservative than they would be if they were based on actual bridge response data. Adding a quantitative aspect to the bridge inspection process would be helpful in more precisely indicating the capacity of a bridge.
Cost	\$54,300
How DeIDOT has benefited from the project:	This research project found that some bridges with high LFR design load Rating Factors produced very low reliability index values.
How the project was implemented:	The results have been incorporated into Load Rating program.

Field Testing and Evaluation of the I-95 Bridge over the Brandywine River

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	<p>Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us</p>	
Principal Investigators	<p>Dennis Mertz Professor Department of Civil and Environmental Engineering University of Delaware 358B DuPont Hall Newark, DE 19716, USA Phone: (302) 831-2735 E-mail: mertz@udel.edu</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/ End Date	8/15/2003 – 12/31/2004	
Project Abstract	<p>A significant crack was recently discovered on an I-95 bridge over the Brandywine River in Delaware. The steel girder bridge carries six lanes of traffic just north of downtown Wilmington. The crack was located on the fascia girder at midspan of the bridge's main span. The entire bottom flange was found to be fractured, with the crack extending upwards to within 0.3 meters of the upper flange. This project will review the circumstances leading up to the crack, discuss the cause of the crack, review the repair strategy, and summarize the results of load tests performed prior to and during the repair.</p>	
Cost	\$27,372	
How DelDOT has benefited from the project:	<p>The University of Delaware conducted a series of diagnostic load tests on both the north- and southbound bridges. The data obtained from the load tests aided the assessment of the safety of the bridge.</p>	
How the project was implemented:	<p>Fully Implemented. Additional diagnostic load tests were performed during the repair process.</p>	

Cracking of Overhead Sign Structures and Their Repair using Composite Fabric as a Wrap

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jason Arndt Delaware DOT 800 Bay Road Dover, DE 19903 E-mail: jason.arndt@state.de.us
Principal Investigator	Joe Bhattacharya Assistant Professor Department of Civil and Environmental Engineering University of Delaware Email: baidurya@ce.udel.edu
Start date/ End Date	7/1/2002 – 8/1/2005
Project Abstract	Delaware, like several other states, has encountered cracking of overhead sign structures (OSS). This project seeks to investigate a method of repair, namely the use of composite fiber wraps. New York State Department of Transportation (NYSDOT) has apparently used this technique successfully, and the Delaware Department of Transportation (DelDOT) is looking for a summary of the technology and a how-to document that can be used by technicians in the field. The primary focus of this work is the repair of cracked secondary sign members.
Cost	\$10,954
How DelDOT has benefited from the project:	The AASHTO TIG offers demonstrations of each method to DOT's that PI would recommend DelDOT take a look at. This would be a good way to determine which system is more comfortable for DelDOT workers to use.
How the project was implemented:	DelDOT has made the decision not to use fabric wrap as a repair option. DelDOT would rather take the structure down and replace or repair (re-weld or retrofit with a mechanical connection if possible). The main reason for this decision was due to the fact that if a structure is starting to experience cracking, then it has reached or is reaching the end of its fatigue life.

Load Rating of Bridges without Plans

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Ping Jiang Division of Bridge Management, DeIDOT 800 Bay Road Dover, DE 19903 E-mail: Ping.Jiang@state.de.us	
Principal Investigators	<p>Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/ End Date	9/1/2002 – 8/31/2004	
Project Abstract	<p>Load rating bridges without plans is a difficult problem that bridge engineers and owners have to face, especially for concrete bridges without plans. The Steel area method (SAM) and the simplified method (SM), which incorporate the results of a diagnostic load test, have been developed to solve this problem. In this work, SAM was extended and then verified through laboratory tests. A procedure for load rating bridges without plans based on SAM was proposed. The procedure was verified using a field test of a concrete slab bridge (Bridge 2-063), for which plans are available. In addition, load rating of bridges without plans using the simplified method (SM) was also illustrated.</p>	
Cost	\$38,672	
How DeIDOT has benefited from the project:	A procedure for load rating bridges without plans using SAM was proposed and verified using the field test of concrete slab Bridge 2-063.	
How the project was implemented:	A few bridges have implemented the findings of the research, but DeIDOT expects additional implementation as they continue the routine load rating for all bridges over the next 5-6 years.	

Load Testing and Post-Repair Evaluation of CFRP Repaired Bridge 1-026

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Percy McNeil, Bridge Management, DelDOT	
Principal Investigators	<p>Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 E-mail: shenton@udel.edu Phone: 302-831-3640</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/ End Date	11/1/2001 – 10/31/2003	
Project Abstract	<p>In flexible pipe, such as HDPE or PVC, considerable strength is obtained in shell compression; however, bending (flexural) resistance is low. As a result, the ability of such pipes to support vertical loads is derived from lateral passive pressure mobilized in reaction to outward movement of sides against the surrounding soil. That is, the pipe assumes an oval shape under load and thus must “push” against the confining soil mobilizing its strength indirectly reacting to the vertical load.</p>	
Cost	\$28,653	
How DelDOT has benefited from the project:	<p>Corrugation stiffens the pipe section, increases its resistance to buckling, and allows for less material to be used. The end product is low in initial cost and light weight. Handling of HDPE pipes is easy, joining pipes together is quick, their flow regime is good, and they can be durable.</p>	
How the project was implemented:	<p>The performance of flexible pipes was thoroughly evaluated.</p>	

MMFX Rebar Evaluation for I-95 Service Road Bridge 1-712-B

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jason Hastings Division of Bridge Design, DelDOT
Principal Investigator	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	9/1/2002 – 8/31/2004
Project Abstract	The goal of this research was to study an innovative application of new materials in the reconstruction of Bridge 1-712B, Ramp J located in the I-95 service area in Newark, Delaware. Originally constructed in 1963, Bridge 1-712B is a single-span concrete structure. The bridge is approximately 30 feet long and 28 feet wide. Biannual inspections of the original bridge showed that it was deficient due to insufficient moment capacity of the beams. DelDOT decided to upgrade the bridge by replacing the beams and deck using an innovative design with non-corrosive reinforcement. The original design called for using carbon fiber-reinforced polymer (CFRP) rebar and epoxy-coated rebar, but DelDOT changed the plan after the introduction of MMFX steel, a new type of steel designed to be highly resistant to corrosion. The CFRP design was retained as an alternative to the MMFX. Since both designs used new forms of non-corrosive rebar, a testing program was established by the University of Delaware to validate the use of MMFX and CFRP in the new design, and a field testing program on the completed bridge was also developed.
Cost	\$99,287
How DelDOT has benefited from the project:	To validate the design methods and the performance of MMFX and CFRP rebar a laboratory and field study was conducted. DelDOT chose to utilize MMFX and CFRP rebar in their design and alternative design for the reconstruction of bridge 1-712B.
How the project was implemented:	PM replaced, DelDOT not using MMFX Rebar.

Review of Available Design Criteria for using Composite Materials as Superstructures, Reinforcement, or Strengthening

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	Jason Hastings Division of Bridge Design, DelDOT	
Principal Investigators	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>	<p>Dennis Mertz Professor Department of Civil and Environmental Engineering University of Delaware 358B DuPont Hall Newark, DE 19716, USA Phone: (302) 831-2735 E-mail: mertz@udel.edu</p>
Start date/ End Date	9/1/2002 – 8/31/2003	
Project Abstract	<p>Several laboratory studies conducted at the University of Delaware have shown that carbonfiber-reinforced polymer (CFRP) plates can be used to effectively strengthen steel bridge girders. Initial studies focused on many issues including force transfer and development, fatigue durability of the CFRP/steel bond, long-term durability of the CFRP/steel bond under sustained load, and methods for preventing corrosion between the CFRP plate and the steel. Once the feasibility of the strengthening method had been thoroughly examined, two field demonstration projects were initiated in Delaware. The first field application was performed in 2000 on a concrete slab-on-steel girder bridge located on Interstate 95. The second field application was performed in 2002 on a typical through-girder bridge (Bridge 1-119). The baseline behavior of the second bridge was determined from a diagnostic pre-test, and a posttest was used to quantify the effect of the rehabilitation. This project presents details of the second field application, including a comparison of the pre- and post-rehabilitation test results. Finally, the post-rehabilitation response of the bridge is compared to theoretical predictions.</p>	
Cost	\$9,487	
How DelDOT has benefited from the project:	The rehabilitation of steel bridges using advanced composite materials offers a short-term retrofit or long-term solution for bridge owners faced with deficient structures.	
How the project was implemented:	Composite materials in selected applications based on this research and others have been used.	

CFRP Rehab Evaluation for Bridge 1-119

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Jiten K. Soneji P.E. Bridge Design Engineer Delaware Department of Transportation 800 Bay Road, Route 113 P.O. Box 778 Dover, DE 19903-0778 Phone:(302) 760-2299 E-mail: jiten.soneji@state.de.us
Principal Investigator	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	9/1/2002 – 8/31/2004
Project Abstract	Bridge 1-119, also known as the Ashland Bridge, carries State Route 82 over Red Clay Creek in Delaware. The steel through girder bridge with a 100-foot (30.5 m) simple span has a concrete deck supported on 19 floor beams that are spaced 6 feet (1.83 m) on center and span 27 feet (8.23 m) between through girders. DelDOT determined that the concrete deck and floor beams showed significant deterioration and deemed the bridge structurally deficient. Prior to rehabilitation in June of 2002, UD conducted load tests to document the baseline behavior of the bridge. Two floor beams were retrofitted with CFRP plates on the bottom of the tension flange, and the concrete deck was replaced in two sections on November 25 and December 2. CFRP plates were bonded to the floor beams after the concrete deck was removed and before a new deck was cast. As such, the CFRP plates help the floor beams resist both dead and live loads.
Cost	\$59,140
How DelDOT has benefited from the project:	UD performed a posttest to evaluate the effectiveness of the rehabilitation specifically.
How the project was implemented:	Complete Research results were applied on an as needed basis. Repair has been incorporated into the load rating for the bridge.

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

Sponsor Organization	Delaware Transportation Institute and the National Concrete Masonry Association
Project Category	Structures and Bridges
Project Manager	Dennis O'Shea, Division of Pre-Construction, DeIDOT
Principal Investigator	Dov Leshchinsky Professor University of Delaware Department of Civil and Environmental Engineering Phone : (302) 831-2446 FAX: (302) 831-3640 E-mail: dov@ce.udel.edu
Start date/ End Date	9/1/2002 – 8/31/2004
Project Abstract	Design guideline for multi-tiered MSE walls is lacking. This study presents the results of parametric studies conducted in parallel using two independent types of analysis: one is based on limiting equilibrium (LE) and one on continuum mechanics.
Cost	\$200,000
How DeIDOT has benefited from the project:	This project characterized the stability of multi-tiered walls by quantifying the effects of offset distance, fill quality, foundation soil, reinforcement length and stiffness, water, surcharge and number of tiers.
How the project was implemented:	The LE approach was extended to the analysis of multi-tiered walls.

Development of Delaware's First "Smart" Bridge

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Barry Benton, Division of Bridge Design, DelDOT
Principal Investigator	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	7/1/2001 – 6/30/2003
Project Abstract	<p>Bridges are vital links in transportation systems, and represent a tremendous economic investment for their owners. Therefore, it is necessary to have a reliable process for maintaining them and ensuring their reliability. The Federal Highway Administration (FHWA) awarded a contract to the University of Delaware's Center for Innovative Bridge Engineering (CIBrE) to develop specifications for a long-term bridge performance program (LTBPP). The LTBPP is intended to create a quantitative database of bridge condition and performance that can be used to understand why bridges deteriorate. The program will use structural health monitoring (SHM) technologies to collect some of the desired data. These SHM technologies will be implemented on hundreds of permanently instrumented bridges throughout the country. The research describes Delaware's first permanently instrumented bridge, a potential prototype for the LTBPP. The SHM system used on this bridge will also serve as a prototype for a more extensive SHM system that is being planned for the 1,000 foot Indian River Inlet Bridge.</p> <p>The SHM system developed consists of sixty one sensors and was installed on a three-span continuous slab on girder composite bridge on I-495 in New Castle County, Delaware. The project presents the planning that led up to the actual instrumentation, including diagnostic static and dynamic tests used to establish baseline behavior, design details of the SHM system, and programming aspects related to the data acquisition system. An extensive finite element model of the bridge was also created and calibrated based on the diagnostic test data. Detailed cost and labor summaries associated with the instrumentation are also discussed. Finally, recommendations for remaining work are presented.</p>
Cost	\$78,306
How DelDOT has benefited from the project:	Continuous monitoring of bridges will provide valuable information on a bridge's health and integrity. Continuous monitoring may also help to refine design criteria, provide data to allow the determination of accurate deterioration rates, and more efficient bridge maintenance programs.
How the project was implemented:	As of April 2007, all sixty one gages have been installed on the bridge and all fifty six gages that were chosen to initially be connected into the system are wired in. The planning and installation took 18 months to complete. All accelerometers and strain gages have the necessary gage protection and have been protected from the environment with RTV. All work completed in this portion of the first permanent instrumented Delaware bridge can be replicated and used on future long term instrumented bridges.

Structural Health Monitoring of Delaware's Transportation Infrastructure

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Joe Vogel, Division of Pre-Construction, DeIDOT
Principal Investigator	Harry Shenton Professor University of Delaware Department of Civil and Environmental Engineering 301 DuPont Hall, Newark, DE 19716 Phone: 302-831-3640 E-mail:shenton@udel.edu
Start date/ End Date	7/1/2001 – 6/30/2003
Project Abstract	A permanent long-term monitoring system is currently being installed on a typical three-span continuous, slab-on-steel girder bridge in New Castle County, Delaware. The bridge carries Interstate 495 around Wilmington, Delaware, and has a relatively high volume of truck traffic. The system will automatically measure strain, displacement, rotation, acceleration, and temperature at key locations on the bridge. Two types of data will be collected: “event” data, when heavy vehicles cross the bridge, and periodic “monitor” data. The purpose of the monitoring system is to provide near real-time, and long-term, data on the performance of this typical bridge. The system will also be used as a test bed for new sensors and sensor systems for bridge monitoring as they become available in the future. Presented in the project is a brief overview of the design, installation, and operation of the monitoring system, and a discussion of some preliminary test results from the bridge.
Cost	\$25,047
How DeIDOT has benefited from the project:	The project is able to 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 DeIDOT engineers. Also, to review and evaluate Delaware’s ITMS as a potential network for structural health monitoring of the State’s transportation infrastructure.
How the project was implemented:	Two diagnostic tests were conducted on Bridge 1-821 as part of the planning for the permanent monitoring system. A static test was conducted in the summer of 2004 and an ambient vibration survey was conducted in the summer of 2006.

Application of Load Resistance Factor Rating using Site Specific Data

Sponsor Organization	Delaware Department of Transportation
Project Category	Structures and Bridges
Project Manager	Dennis O'Shea, Division of Pre-Construction, DeIDOT
Principal Investigator	Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Telephone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu
Start date/ End Date	7/1/2000 – 6/30/2002
Project Abstract	Bridge load rating has become an integral part of bridge management in the United States. Ratings are used as a means to characterize the load carrying capacity of bridges, to allocate funding for the repair and rehabilitation of bridges, and to approve permit vehicles and superload crossings. Most load ratings are calculated using simple analytical models that are based on information obtained from the structural plans for the bridge; however, for some bridges, particularly for many smaller, older bridges, structural plans may no longer be available. This project will develop a method for load rating bridges using site specific response data and probabilistic methods which will enhance DeIDOT'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.
Cost	\$47,828
How DeIDOT has benefited from the project:	This project developed a method for load rating bridges using site specific response data and probabilistic methods which will enhance DeIDOT'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.
How the project was implemented:	Two methods were developed for loading concrete slab bridges without design plans. Both methods were used for load rating Delaware Bridge 1-450.

Detecting Corrosion in Existing Structures using Time Domain Reflectometry

Sponsor Organization	Delaware Department of Transportation	
Project Category	Structures and Bridges	
Project Manager	N/A	
Principal Investigators	<p>Robert Hunsperger Professor of Electrical & Computer Engineering 214 Evans Hall University of Delaware Newark, DE 19716 Phone: (302) 831-8031 FAX: (302) 831-4316 E-mail: hunsperg@eecis.udel.edu</p>	<p>Michael J. Chajes Professor Department of Civil and Environmental Engineering University of Delaware Newark, DE 19716 Phone: (302) 831-2442 FAX: (302) 831-3640 E-mail: chajes@ce.udel.edu</p>
Start date/End Date	7/1/2002 – 1/31/2003	
Project Abstract	<p>The effectiveness of corrosion evaluation of steel strands using time domain reflectometry (TDR) has been established both theoretically and experimentally in previous work. A two-wire transmission line model has been established. The relationship between model geometry and impedance has been under thorough investigation and corresponding experimental results have been obtained. The results have proved its feasibility. TDR instrumentation has been successfully installed in a newly built bridge and periodic data are being collected and studied. It has been proved that for a new structure, if a sensor wire is applied along side the strand/rebar in the process of construction, the future corrosion that could occur on the strand/rebar can be effectively detected and the damage to the strand can be estimated. However detecting corrosion in existing structures in which sensor wires were not applied when the structures were built, is more difficult. External detection methods must be employed instead of internal methods. The theory of time domain reflectometry still applies, but factors such as the non-existence of built-in sensor wires, the presence of concrete layers (which are strong dielectrics and contain non-uniformities) and the distance from the strand to the sensor wire must be considered. They begin to exert strong influence on the TDR results and methods of distinguishing and evaluating their effects have to be found. This project is directed at solving this problem.</p>	
Cost	\$49,824	
How DelDOT has benefited from the project:	<p>TDR can be effective in identifying the existence of voids in grouted ducts. The most effective application of TDR has been when the detection system is installed during construction. Possible geometries that can be applied to externally detect steel strand corrosion and factors that influence signal returns from corrosion have been thoroughly studied during the project period.</p>	
How the project was implemented:	<p>The research team has successfully installed TDR sensors in a high performance bridge (8F in Frederica, DE), and in full-scale pre-cast beams similar to those used for bridge 712B.</p>	

Part 5 Traffic and ITS

Study and Calculation of Travel Time Reliability Measures

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Gene Donaldson Operations Manager Traffic Management Center Delaware Department of Transportation 169 Brick Store Landing Road Smyrna, DE 19977 Phone: 302-659-4601 FAX:(302)659-6128 Gene.Donaldson@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	9/1/2010 – 8/31/2012
Project Abstract	Travel speeds and their corresponding travel times on Delaware’s road network provide valuable performance measures of interest to transportation planners and operators. Of related interest is the variability of expected travel times, since lower variability implies greater predictability of travel conditions, and hence greater reliability. Delaware’s Department of Transportation (DelDOT) provided funding to use the GPS coordinates of state fleet vehicles to explore roadway reliability measures.
Cost	\$58,514
How DelDOT has benefited from the project:	State Fleet Vehicle GPS data is a valuable statewide resource to estimate and monitor travel times, average speeds, and travel time reliability for various times of day, days of week, and seasons. The data could support many applications, including the study of traffic flows at intersections, vehicle routing support, research into the relationship of volume, capacity and speed, and an examination of the relationship between land use and transportation system improvement.
How the project was implemented:	This project successfully generated travel time and reliability measures for two corridors in New Castle County. A method of synthetically generating trips based on small segment chains was also developed and provides a method for calculating travel time and variability where less occurrences of a specific trip of interest are available within the source data. These steps were a starting point which can be improved and automated in the future.

Effective Countermeasures for Crash Reduction at Unsignalized Intersections for Two-Lane Undivided Roadways

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Adam Weiser Safety Programs Engineer Delaware Department of Transportation 169 Brick Store Landing Road Smyrna, DE 19977 Phone: (302) 659-4073 E-mail: Adam.Weiser@state.de.us
Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831 – 1446 FAX: (302) 831 – 0674 E-mail: Faghri@udel.edu
Start date/ End Date	9/1/2011 – 8/31/2012
Project Abstract	Delaware Department of Transportation (DeIDOT) has identified five unsignalized intersections in rural areas of Delaware as locations with higher than average crash rates over the past three years. These intersections are Delaware 10 & Delaware 15, Delaware 15 & Barratts Chapel Road, Delaware 15 & Andrews Lake Road, Delaware 30 & Mount Joy Road, and Delaware 30 & Zoar Road. While none of these intersections meet the requirements for signalization, the purpose of this study is to identify countermeasures that can be used to improve safety at these intersections. The methodology used in this study begins with identifying what types of crashes are occurring at each intersection and why the crashes are occurring through review and statistical analysis of crash reports as well as intersection site visits. Through completing a comprehensive literature review of other studies of rural unsignalized intersection and following the methods dictated in the American Association of State Highway and Transportation Officials' (AASHTO) Highway Safety Manual, countermeasures were identified to address the unique safety concerns of each intersection. To compare the expected effectiveness of each countermeasure, cost-benefit ratios were calculated for each countermeasure based on the estimated construction cost for the countermeasure and the projected crash reduction potential over ten years.
Cost	\$42,632
How DeIDOT has benefited from the project:	This project provided DeIDOT with a clear comparison of potential options for safety improvement at these intersections.
How the project was implemented:	In February 2012, DeIDOT converted Delaware 30 & Mount Joy Road and Delaware 30 & Zoar Road to four-way stops. Since these intersections had a problem with inadequate gap acceptance crashes, the analysis of these intersections suggests that the four-way stop conversion will be beneficial.

DE Transportation Operations Management Plan – NCC

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Gene Donaldson Operations Manager Traffic Management Center Delaware Department of Transportation 169 Brick Store Landing Road Smyrna, DE 19977 Phone: 302-659-4601 FAX:(302)659-6128 E-mail: Gene.Donaldson@state.de.us
Principal Investigator	Earl Lee Assistant Professor Director, T2 / LTAP Center Department of Civil and Environmental Engineering University of Delaware 355A Dupont Hall Newark, DE 19716 Phone: (302) 831-6241 E-mail: elee@udel.edu
Start date/ End Date	9/1/2009 – 3/31/2013
Project Abstract	New Castle County is the most populous county in the state of Delaware, with a diverse landscape from the largest city in the state, Wilmington, to numerous small towns and communities, historic estates and farmlands. The county hosts several major employment generators ranging from the University of Delaware’s main campus in Newark to major financial institutions, pharmaceutical companies, and headquarters of many other major companies. These characteristics generate a significant amount of traffic, loading the county’s transportation network with a variety of users including commuters, shoppers, and tourists. Thus, as the county experiences a lot of traffic with significant potential and evidence of recurring congestion, the Delaware Department of Transportation (DelDOT) initiated an effort in 2001 to establish baseline transportation data associated with New Castle County’s transportation network.
Cost	\$64,216
How DelDOT has benefited from the project:	This project was able to allow DelDOT to examine the County’s transportation issues as a system and to consider effects of various transportation initiatives as a whole.
How the project was implemented:	This inventory of Delaware roadway segment and intersection analyses is expected to be utilized as a tool for identifying areas of the roadway network that can/should be improved.

Enhanced Pedestrian Crossings

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Mark Luszcz, P.E., PTOE Delaware Department of Transportation, Traffic Section Chief Traffic Engineer 169 Brick Store Landing Road Smyrna, DE 19977 Phone:(302) 659-4091 E-mail: Mark.Luszcz@state.de.us
Principal Investigator	Earl Lee Assistant Professor Director, T2 / LTAP Center Department of Civil and Environmental Engineering University of Delaware 355A Dupont Hall Newark, DE 19716 Phone: (302) 831-6241 E-mail: elee@udel.edu
Start date/ End Date	9/1/2009 – 8/31/2011
Project Abstract	The countdown pedestrian signal (CPS) provides additional information to pedestrians when compared to the older displays which only use the Walking Person – Flashing Hand – Upraised Hand signal. This study was done to evaluate if there is a safety concern in allowing the pedestrian change interval to terminate at the end of the concurrent vehicular yellow interval using countdown pedestrian indications, as is allowed for non-countdown pedestrian indications. Part of the concern is that the “early” termination of the pedestrian change interval is providing too long of a buffer between the designated time when a pedestrian is notified that they should be out of harm’s way, and the actual time when conflicting vehicles will be given a green indication. The hypothesis is that by “lying” to the pedestrian, we are actually breeding contempt for the pedestrian signal indications. A before and after methodology was employed at sixteen different intersections in Newark, Delaware.
Cost	\$47,213
How DelDOT has benefited from the project:	Two of the listed observed behaviors were considered to be significant for pedestrian safety, late arrival and late departures / late arrivals.
How the project was implemented:	The project team recommends that FHWA consider one of two options for the next version of the MUTCD related to the termination of the pedestrian change interval: either to allow the pedestrian change interval to extend through the concurrent vehicular yellow phase, or to reduce the required “buffer” time from three seconds to two.

Delaware Signal Timing Enhancement Partnership (DSTEP)

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
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Principal Investigator	Earl Lee Assistant Professor Director, T2 / LTAP Center Department of Civil and Environmental Engineering University of Delaware 355A Dupont Hall Newark, DE 19716 Phone: (302) 831-6241 E-mail: elee@udel.edu
Start date/ End Date	9/1/2009 – 12/31/2012
Project Abstract	The Delaware Signal Timing Enhancement Partnership (DSTEP) is a cooperative effort between the University of Delaware, DelDOT, and private consultants to involve students in the evaluation of signal timing and coordination of corridors.
Cost	\$133,682
How DelDOT has benefited from the project:	This project improved corridor selection, data collection, simulation, and implementation.
How the project was implemented:	The results have been used for improving corridor selection and simulation.

GPS Travel Time and Delay Data Collection and Analysis

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Mark Eastburn Planner, DeIDOT DeIDOT Statewide & Regional Planning Phone: (302)760-2138 E-mail: Mark.Eastburn@state.de.us
Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831- 1446 FAX: (302) 831-0674 E-mail: Faghri@udel.edu
Start date/ End Date	7/1/2001 – 8/31/2012
Project Abstract	This phase of the project follows what has been accomplished during previous years. That is during the months of September, October and November, peak travel time data on all the roadway segments will be automatically collected. This year uses two cars each equipped with a Global Positioning System (GPS) receiver. Each roadway segment was traveled at least four times (twice in the AM and twice in the PM) for an accuracy of +/-2mph with a 95% confidence level. Also for Summer, travel data from all major roads that are used by summer travelers were collected. Data was collected on only Fridays, Saturdays and Sundays. This research gives a data summary sheet and Geographic information System (GIS) database.
Cost	\$1,161,552
How DeIDOT has benefited from the project:	Traffic congestion is a growing problem in many jurisdictions across the country. In order to quantify the severity of congestion, Global Positioning System (GPS) applications have been utilized to collect travel time and delay data for many of Delaware's principal and minor arterials, collectors, and freeways. Since 1996, the Delaware Department of Transportation (DeIDOT), with the help of the Civil and Environmental Engineering Department at the University of Delaware, has been using GPS technology for this purpose.
How the project was implemented:	Travel time runs are important to determine the average speed along the corridor. This information has been used to calibrate the existing model of the corridor, used for preparing both the Time-Space Diagrams and the Synchro model.

Use of Roundabouts as Alternatives to All-Way-Stop Controls

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Dan Lacombe Research Coordinator Delaware Department of Transportation P.O. Box 778 800 Bay Road, Dover DE 19901 Phone:302-326-4488 Fax:302-326-4489 E-mail: daniel.lacombe@state.de.us
Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831-1446 FAX: (302) 831-0674 E-mail: Faghri@udel.edu
Start date/ End Date	7/1/2008 – 12/31/2009
Project Abstract	This project evaluates the performance of modern roundabouts in Delaware. Delaware Department of Transportation is planning to install modern roundabouts to replace some other types of intersection control. The primary purpose of this project is to obtain Delaware-specific parameters for design of the modern roundabout such as the critical headway and follow-up headway. Three modern roundabouts in Delaware and two in Maryland were the basis of this study. Computer simulations were used to assess the capacity (v/c ratios), delay, and queue lengths. The simulations were based on HCM, aaSIDRA, and the NCHRP approach described in Report 572. Preliminary results indicated that the roundabouts are performing at an acceptable level of service. The capacity at Rehoboth however is exceeded leading to long queue lengths and delays from the simulation. This is the result based on the volumes generated with Delaware Department of Transportation (DelDOT) Peninsula Model. No significant delays or queuing were observed at the site during data collection. Crash analysis was conducted based on incidents reported before construction of the roundabout and after construction where appropriate. Sufficient data is not available to make sound conclusions on safety. It appears there is a push to make this provision mandatory and future roundabouts may have to provide APS. These observations from this research will enhance the planning and design of roundabouts in Delaware. Continued research will enable a more complete and reliable assessment of modern roundabouts in the state.
Cost	\$19,982
How DelDOT has benefited from the project:	Delaware Department of Transportation is planning to install modern roundabouts to replace some other types of intersection control. This project evaluated the performance of modern roundabouts in Delaware.
How the project was implemented:	Periodic monitoring of the new and existing roundabouts in the state was implemented. Further field experiments should be carried out to capture additional data on critical headway and follow-up headway.

Rating of 4-way Stop Intersections for Conversion to Roundabouts

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	Dan Lacombe Research Coordinator Delaware Department of Transportation P.O. Box 778 800 Bay Road, Dover DE 19901 Phone:302-326-4488 Fax:302-326-4489 E-mail: daniel.lacombe@state.de.us
Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director, Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831- 1446 FAX: (302) 831-0674 E-mail: Faghri@udel.edu
Start date/ End Date	7/1/2005 - 6/30/2007
Project Abstract	This project is the second phase of work aimed at assessing the use of roundabouts as a safer, cleaner alternative to four-way stops, with Phase II addressing the rating of four-way stop intersections for conversion to roundabouts to improve traffic flow and safety.
Cost	\$66,015
How DeDOT has benefited from the project:	In this project, a knowledge-based expert system is calibrated for Delaware conditions using drive gap acceptance characteristics.
How the project was implemented:	Results from this project were used in developing the rules of the expert system. The rating system also provided advice on a variety of issue associated with the new intersection type and references for further guidance.

A Study of the Traffic Monitoring and Data Program in Delaware

Sponsor Organization	Delaware Department of Transportation (DD/SPR)
Project Category	Traffic and ITS
Project Manager	Tyrone Crittenden Division of Planning, DeIDOT Phone: (302) 760-2162 E-mail: Tyrone.Crittenden@state.de.us
Principal Investigator	Arde Faghri Professor, Department of Civil & Environmental Engineering Director Delaware Center for Transportation (DCT) University of Delaware Newark, DE 19716 Phone: (302) 831-1446 FAX: (302) 831-0674 E-mail: Faghri@udel.edu
Start date/ End Date	4/2/2004 – 9/30/2005
Project Abstract	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. The program was undertaken to review, establish, and implement effective statistical and procedural methods. The second phase of a two phase project, which implements the methodologies that were derived in the first phase, is presented. Existing field data from Delaware's current ATR locations allowed for a statistical determination of the necessary number and road-type group distribution for the ATR sites. The absence of field data for AVC and WIM sites, however, necessitated alternative methods for determining the number and location of the traffic monitoring devices. As a result, a combination of statistical analysis and engineering judgment must be used for the establishment of any statewide traffic monitoring system.
Cost	\$79,695
How DeIDOT has benefited from the project:	The program comprises automatic traffic recorder (ATR), automatic vehicle classification (AVC), and weigh-in-motion (WIM) sites for the state of Delaware.
How the project was implemented:	Data was collected into an annual file which is then periodically used to update travel demand model. Using descriptive analysis and seasonal grouping, the number and location of sites needed for each of the three types of traffic monitoring devices were determined.

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

Sponsor Organization	Delaware Department of Transportation
Project Category	Traffic and ITS
Project Manager	William Brockenbrough Division of Project Development, DeIDOT Phone: (302) 760-2109 E-mail: Thomas.Brockenbrough@state.de.us
Principal Investigator	Shinya Kikuchi Professor, Department of Civil and Environmental Engineering Director, Intelligent Transportation Systems Laboratory University of Delaware Newark, DE 19716 Phone: (302) 831-2657 E-mail: kikuchi@ce.udel.edu
Start date/ End Date	7/1/2002 – 6/30/2004
Project Abstract	This project presents the trip attraction rates of the shopping centers in Northern New Castle County in Delaware. The study aims to provide an alternative to ITE Trip Generation Manual (1997) for computing the trip attraction of shopping centers in Delaware. As part of this study, a total of eighteen shopping centers were surveyed, for which the number of vehicles entering and leaving the shopping center in every fifteen minutes interval and the number of people visiting each store in the shopping center along with their movement patterns were measured. Based on the surveyed data and the aerial photographs, two approaches, microscopic and macroscopic, are developed to compute the trip attraction rate. The microscopic approach deals with the relationship between the trip attraction rates of individual stores and the shopping center as a whole. The macroscopic approach relates the trip attraction of the shopping center as a function of the physical features of the shopping center, e.g. total parking spaces, total floor area, and the number of stores in the shopping center.
Cost	\$83,713
How DeIDOT has benefited from the project:	Travel demand forecasting is essential for the design of transportation facilities and services, and also for planning, investment, and policy development. Trip generation is the first step of the traditional four-step travel demand forecasting process. It is critical that this step produces an accurate value as these values form the basis for the subsequent steps and the errors in this step can propagate in the entire estimation process. The purpose of this study is to collect data about the number of people coming to SCs in northern New Castle County in Delaware, and develop models for estimating the TAR of the SCs.
How the project was implemented:	The models have been used for planning and design of SCs for the geometric design and traffic control schemes on the roadways near the SCs.

Examination and Application TRANSIMS

Sponsor Organization	Delaware Department of Transportation (DD/SPR)
Project Category	Traffic and ITS
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	Shinya Kikuchi Professor, Department of Civil and Environmental Engineering Director, Intelligent Transportation Systems Laboratory University of Delaware Newark, DE 19716 Phone: (302) 831-2657 E-mail: kikuchi@ce.udel.edu
Start date/ End Date	12/1/2001 – 5/31/2004
Project Abstract	This project describes TRANSIMS for its programming architecture and functions, and evaluates its performance and application feasibility in Delaware. We test two cases, one for a small network but defined to a high detail (Newark study), and two, an extensive network but defined to a low detail (New Castle County study).
Cost	\$47,970
How DelDOT has benefited from the project:	This project developed new TRANSIMS model of Delaware.
How the project was implemented:	The developed new TRANSIMS model of Delaware is suitable to metropolitan areas, where information on congestion and emissions is highly critical for making operating and strategic decisions. In Delaware, the application is suitable for greater Wilmington areas and Dover.

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

Sponsor Organization	Delaware Department of Transportation (DD/SPR)
Project Category	Traffic and ITS
Project Manager	Gene Donaldson Operations Manager Traffic Management Center Delaware Department of Transportation 169 Brick Store Landing Road Smyrna, DE 19977 Phone: 302-659-4601 FAX:(302)659-6128 Gene.Donaldson@state.de.us
Principal Investigator	Shinya Kikuchi Professor, Department of Civil and Environmental Engineering Director, Intelligent Transportation Systems Laboratory University of Delaware Newark, DE 19716 Phone: (302) 831-2657 E-mail: kikuchi@ce.udel.edu
Start date/ End Date	12/1/2001-11/30/2003
Project Abstract	This project will devise a system that provides the travel time in the network using AVL on the DART buses and evaluate the effects of this system with respect to the overall performance of DelTrac.
Cost	\$143,259
How DelDOT has benefited from the project:	This project measured and analyzed the accuracy of travel time.
How the project was implemented:	The algorithms developed can translate the measurements to information useful to auto users as well as transit users.

Part 6 Transit

Optimizing Accessible Taxi Service to Augment Traditional Public Transit Services in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Catherine C. Smith Delaware Transit Corporation 119 Lower Beech Street / Suite 100 Wilmington, DE 19805 E-mail: catherine.smith@state.de.us
Principal Investigator	Douglas Tuttle Policy Scientist, IPA School of Public Policy and Administration University of Delaware 177C Graham Hall Newark, Delaware 19716-7380 Phone: 302-831-0718 FAX: 302-831-0450 E-mail:dougt@udel.edu
Start date/ End Date	7/1/2008 – 12/31/2009
Project Abstract	As one of the most rapidly “graying” states in the nation, Delaware soon will be faced with significant growth in the demand for public transportation services that meet the needs of an increasingly older population. The purpose of this project is to explore the efficacy of raising Delaware’s taxi industry from its current balkanized status to a level of accessibility and performance that will permit it to augment the state’s traditional public transit services. Current accessible taxi service may be a myth, but that also means no current investment strategies need to be abandoned. Accessible taxi service in Delaware truly is a blank slate. In terms of vehicle choices, the time during which this report has been in production has seen more than one prospect appear to present a path forward, only to drift away. Clearly, the best path forward is to embrace the philosophy of Universal Design, in which the removal of barriers for one segment of society does not simultaneously raise barriers for another. Some possible strategies are suggested.
Cost	\$58,000
How DelDOT has benefited from the project:	This project explored the efficacy of raising Delaware’s taxi industry from its current balkanized status to a level of accessibility and performance that will permit it to augment the state’s traditional public transit services.
How the project was implemented:	The first step along that path considered the merits of Universal Design, as opposed to specialization. True optimization of accessible taxi service in Delaware would require a new service model, as well as new vehicles.

A Feasibility Study of Bus Rapid Transit (BRT) in Delaware

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Catherine C. Smith Delaware Transit Corporation 119 Lower Beech Street / Suite 100 Wilmington, DE 19805 E-mail: catherine.smith@state.de.us
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Start date/ End Date	7/1/2007 – 6/30/2009
Project Abstract	Is bus rapid transit (BRT) a viable transit option in Delaware? The original title of this research study, funded by the Delaware Center for Transportation, was “A Feasibility Study of Bus Rapid Transit (BRT) in Delaware.” The initial research done by the University of Delaware Institute for Public Administration (IPA) consisted of a review of BRT literature, functioning BRT systems, local demographic information, transit data, and commuting patterns. Based on the analysis of these data and subsequent meetings with local transportation officials, the scope of work evolved from examining the feasibility of deployment of BRT in Delaware to exploring the viability of a regional BRT system.
Cost	\$72,577
How DelDOT has benefited from the project:	The State of Delaware like most states in the Mid-Atlantic region is experiencing increasing volumes of traffic and traffic congestion. Delaware is also experiencing an increasing proportion of its aging population (60+) and as a coastal state, an increasing influx of retirees seeking residence in the state. These changes in demographics and traffic volumes will produce greater demands and needs for transportation services and programs. They also suggest the need to explore alternative means to meet the anticipated transportation demands.
How the project was implemented:	The feasibility of BRT in the Mid-Atlantic region immediately adjacent to Delaware’s I-95 corridor was thoroughly evaluated.

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

Sponsor Organization	Delaware Department of Transportation(DD/FTA)
Project Category	Transit
Project Manager	Cathy Dennis Delaware Transit Corporation DeIDOT
Principal Investigator	Michael Gamel-McCormick Director, Center for Disabilities Studies College of Human Services, Education, and Public Policy University of Delaware 461 Wyoming Road Newark, DE 19716 Phone: (302) 831-6974 Fax: (302) 831-4690 E-mail: mgm@udel.edu
Start date/ End Date	7/1/2005 -9/30/2006
Project Abstract	In the State of Delaware, the Delaware Transit Corporation (DTC), operating under the auspices of DART First State and DART First State Paratransit, is the provider of fixed route and paratransit services. Paratransit is a demand-responsive, door-to-door service provided to eligible riders who make trip requests in advance. The cost of a paratransit trip in Delaware is about 10 times greater than the cost of a fixed route bus trip. Since the passage of the ADA, eligibility applications for paratransit have increased at a steady rate, as seen in the trends reported for increased levels of service. All indicators point to even greater demand for paratransit in the future. Therefore, one logical way to limit these costs is to objectively establish an eligibility determination process so that only those who truly need paratransit get it. The model used in this research refines the eligibility-determination process by comparing the mobility characteristics and the environmental characteristics of an individual for a specific trip. The model, which builds upon and extends our prior research on ADA paratransit eligibility, compares the mobility attributes of a person with a disability with the environmental attributes associated with the use of a fixed route bus system. The mobility characteristics of an individual, the measured value, and the environmental characteristics (the reference or set value), provide the critical and objective input data to the model. The mobility attributes include such things as the ability to ambulate, climb steps, stand, wait, see, hear, and communicate. (The way these attributes are functionally identified can vary.) The environmental characteristics are fixed points and include the features of pathways and distances between bus stop locations at the origination and destination points, direction of traffic, speed limits, sidewalks, curb cuts, intersections, communication systems, and vehicle accessibility.
Cost	\$79,796
How DeIDOT has benefited from the project:	This project demonstrated how our model comparator can be implemented at DART First State.
How the project was implemented:	The successful implementation of this model changed the eligibility paradigm for transit systems.

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

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Dave Gula Delaware Transit Corporation, DelDOT 400 South Madison Street Wilmington, Delaware 19801 E-mail: dave.gula@state.de.us
Principal Investigator	Shinya Kikuchi Professor, Department of Civil and Environmental Engineering Director, Intelligent Transportation Systems Laboratory University of Delaware Newark, DE 19716 Phone: (302) 831-2657 E-mail: kikuchi@ce.udel.edu
Start date/ End Date	7/1/2004 - 6/30/2005
Project Abstract	This project is to collect data about the desires and concerns of the existing and potential bus passengers, and to analyze the survey results and organize the findings into information, which is to be used for detailed planning of the operation of the new concept.
Cost	\$65,999
How DelDOT has benefited from the project:	This project provided revealing insights into the early planning of the operation.
How the project was implemented:	The finding has been used for the planning of the operation.

Transit Accident Study

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Charles Hacket Delaware Transit Corporation, DeIDOT
Principal Investigator	Douglas Tuttle Policy Scientist, IPA School of Public Policy and Administration University of Delaware 177C Graham Hall Newark, Delaware 19716-7380 Phone: 302-831-0718 FAX: 302-831-0450 E-mail:dougt@udel.edu
Start date/ End Date	7/1/2004 - 6/30/2005
Project Abstract	This study involves an examination of the occurrence of traffic accidents experienced by the operators of the vehicles utilized by Delaware's statewide transit service, DART First State. Specifically, transit accident frequencies during FY 2003 and FY 2004 were studied in relationship to operators' length of time on duty pre-collision on the date of the accident and their numbers of hours off duty between consecutive shifts. Generally, the data available for review indicated that motor vehicle accidents were distributed rather evenly across the work day. Of the 588 accidents for which sufficient data was available for analysis, 434 accidents - or 74% - occurred sometime during the first nine hours of the involved drivers' shifts for those days. This would not be unexpected, as the majority of DART First State's operators' shifts are of nine or fewer hours' duration. However, a noticeable deviation in the characteristics that were the focus of this study was observed among drivers who had accidents after being on duty for nine or more hours. Higher-than-average hours worked during their previous shifts and lower-than-average rest time between shifts characterized this subset of accident-involved DART drivers. DART First State's policies and procedures related to operator fatigue were also reviewed in comparison to the pertinent findings of the American Public Transportation Association's Analysis of the Survey to Determine Status of the Transit Industry with Regard to Fatigue published in 2002 and a survey of contemporary practices in comparable transit organizations.
Cost	\$23,460
How DeIDOT has benefited from the project:	This project identified a range of policy options that have been implemented by various transit operators to address the issue of driver fatigue.
How the project was implemented:	The lack of readily available accident data for prior years limited the scope of the data analysis conducted for this project. DART First State has since revised their accident report form to capture more data, including the variables we examined. For future research, DART First State's accident data for fiscal year 2005 and beyond could be collected and examined to determine long-term trend and the possible impact of any policy changes that may be implemented following this study.

Estimating Current Modal Splits

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Michael DuRoss Delaware Department of Transportation P.O. Box 778 Dover, DE 19903 Phone: 302-760-2110 Fax: 302-739-2251 E-mail: Michael.DuRoss@state.de.us
Principal Investigator	David Racca Policy Scientist Center for Applied Demography and Survey Research 284 Graham Hall, University of Delaware Phone:302 831-1698 E-mail: dracca@udel.edu
Start date/ End Date	7/1/2002 - 6/30/2004
Project Abstract	This project is the second part in a two part modeling effort. In previous work, mode choice was modeled by examining characteristics of individuals and the trips they make. A study of the choices of individuals is necessary for a fundamental understanding of travel mode choice. Models were built to estimate mode split at the State and County level. Where transit or walk trips often account for only 1 to 5% of all trips, the main problem in modeling the use of other choices of travel besides the personal auto is that there is very little data available. The modeling difficulty becomes greater as estimates of mode split are desired for smaller levels of geography, such as for a traffic zone, rather than a County. For use in travel demand forecasting and examination of transit markets, almost all mode choice models used by transportation agencies are developed using aggregate level data, typically at the level of a traffic zone, such as population totals, mean incomes, average household characteristics, and other summary data. The reason for this is that aggregate data, such as provided by the U.S. Census, is typically more available. For the most part, estimates of travel mode split used in travel demand models are not very sophisticated and often consist of an estimate based on fixed percentage of trips (e.g., 1% of trips in a zone will be accomplished by using transit) rather than a model considering a number of factors. This project starts with models based on individual data developed at the county level and investigates the applicability of these models at smaller levels of geography where aggregate estimates of the factors are available.
Cost	\$30,000
How DelDOT has benefited from the project:	This project investigated how travel mode split can be modeled using aggregate data at smaller levels of geography like traffic zones for use in route planning and travel demand forecasting.
How the project was implemented:	Completed successfully. Alternative models have been proposed. Further research shall be encouraged to compare the proposed models with existing traditional model.

Paratransit Services Study

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
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Principal Investigator	Douglas Tuttle Policy Scientist, IPA School of Public Policy and Administration University of Delaware 177C Graham Hall Newark, Delaware 19716-7380 Phone: 302-831-0718 FAX: 302-831-0450 E-mail:dougt@udel.edu
Start date/ End Date	7/1/2002 - 6/30/2003
Project Abstract	This study involved an examination of the scope and character of Delaware's statewide ADA paratransit service, as currently provided by DART First State, and the county-by-county variations within service categories. Projections of service needs developed from Delaware population estimates that reflect the proportion of persons, by age, expected to have disabilities that will affect their capacity to travel without assistance – indicate that these county-by-county disparities will become more significant in the future. Delaware's paratransit policies and procedures were reviewed in the context of the requirements of the ADA and the typical range of paratransit services provided in other jurisdictions. Cost estimates were developed to illustrate the policy implications associated with the continuation of the status quo, and the potentially disparate impact (by county) of program modification options which may be considered as service demand outpaces available resources. The option of adopting a policy model incorporating aspects of the "Seattle Plan" which has been implemented by King County Metro Transit in the state of Washington was examined in detail.
Cost	\$29,500
How DeDOT has benefited from the project:	This study involved a detailed assessment of current DART First State paratransit policies and operating procedures. Policy options are discussed with the goal of maintaining the inclusive nature of Delaware's paratransit service while exploring alternative demand management and cost recovery strategies.
How the project was implemented:	Completed successfully. The implementation of a more comprehensive eligibility review protocol was undertaken in 2002, which, along with the acquisition of new vehicles during that year which made DART First State's entire fixed route fleet accessible, is expected to mitigate the growing demand for additional complementary paratransit service. A follow up research has just started in 2007.

Factors that Affect and/or can Alter Mode Choice

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Dan Lacombe Research Coordinator Delaware Department of Transportation P.O. Box 778 800 Bay Road, Dover DE 19901 Phone:302-326-4488 Fax:302-326-4489 E-mail: daniel.lacombe@state.de.us
Principal Investigator	Edward Ratledge Associate Professor, School of Public Policy & Administration Director, Center for Applied Demography and Survey Research University of Delaware Newark, Delaware 19716 Phone: (302) 831-1684 E-mail: ratledge@udel.edu
Start date/ End Date	7/1/2001 - 6/30/2002
Project Abstract	This project uses data about individuals, their characteristics, the trips they make, and the costs and benefits of travel modes, to identify factors that can be used in models for travel mode choice. In Delaware, for the past eight years, the Delaware Department of Transportation (DelDOT) has sponsored the DelDOT Household Survey. Approximately 200 people of the age of 16 or older are called on the telephone and asked to describe the trips they have taken in the previous day. A particular level of service of transit is necessary to have people choose to use transit over a car when they have the choice. Factors that reflect the transit level of service are necessary in any model, and level of service factors certainly significantly influence mode choice. A review of the literature indicates many types of service factors that have been used in mode choice models. Level of service is often very difficult to quantify. This project employed road network models and optimum routing algorithms as available in geographical information systems to estimate travel times and service factors for trips taken by individuals. This project is the first part in a two part modeling effort. Once mode choice is modeled at the individual and trip level, a study will be done on how travel mode split can be modeled at the smaller levels of geography like traffic zones for use in route planning and travel demand forecasting.
Cost	\$35,600
How DelDOT has benefited from the project:	The factors identified in this project can be used in models for travel mode choice and transit planning.
How the project was implemented:	This project has been implemented. The quality of service as measured in this project was a significant factor in mode choice models though overshadowed by the dominance of vehicle availability and trips to or from the Central Business District in the data.

Process Control ADA Eligibility Model for DART First State Paratransit

Sponsor Organization	Delaware Department of Transportation
Project Category	Transit
Project Manager	Bonnie Hitch Delaware Transit Corporation 900 Public Safety Blvd Dover, DE 19901 Phone: 302-760-2809 Fax: 302-760-2932 E-mail: Bonnie.Hitch@state.de.us
Principal Investigator	Carol Denson Associate Professor, Department of Consumer Studies College of Human Services, Education and Public Policy University of Delaware Newark, DE 19716 Phone: (302) 831-8537 E-mail: crdenson@udel.edu.
Start date/ End Date	7/1/2001 - 6/30/2002
Project Abstract	The Americans with Disabilities Act of 1990 (ADA) paratransit eligibility process control model developed from previous work is described in this project. The model was developed from a method based on the ADA categories for eligibility. It provides the microstructure of mobility characteristics and the microstructure of the environmental characteristics, thereby allowing for the eligibility analysis of a given individual for a given trip. This approach provides a framework to create a rational solution when determining paratransit eligibility. The model was tested by using a sample of 233 eligible paratransit riders on Delaware Transit Corporation, New Castle County. From that sample, 53 people with disabilities completed in-person interviews. The physical environments associated with the fixed route trip that respondents indicated they would take most frequently were also assessed.
Cost	\$55,500
How DelDOT has benefited from the project:	The project presented a way to objectively determine an ADA paratransit eligibility method for the State of Delaware.
How the project was implemented:	The data were successfully used in the process control model both to determine ADA paratransit eligibility and to analyze fixed routes for overall accessibility and compliance with the regulatory standards.

Treatment of Data for Transit Operations and Planning Decisions

Sponsor Organization	Delaware Department of Transportation (DTI/FHA)
Project Category	Transit
Project Manager	Dave Gula Delaware Transit Corporation, DeIDOT 400 South Madison Street Wilmington, Delaware 19801 E-mail: dave.gula@state.de.us
Principal Investigator	Shinya Kikuchi Professor, Department of Civil and Environmental Engineering Director, Intelligent Transportation Systems Laboratory University of Delaware Newark, DE 19716 Phone: (302) 831-2657 E-mail: kikuchi@ce.udel.edu
Start date/ End Date	1/1/2001 - 6/30/2005
Project Abstract	The urban public transportation systems of world cities are confronted by various challenges in the face of expanding motorization, suburbanization, fiscal constraints, politics, many policy objectives to achieve, and changing needs for mobility. At the same time, many cities are responding to the challenges by various innovative schemes of planning, operations, marketing, and technologies. The objective of this project is to promote a greater level of innovation in research and practice regarding transit preferential treatment.
Cost	\$65,000
How DeIDOT has benefited from the project:	This project examined how innovative policy making can be introduced and determines if the presence of a policy entrepreneur is a necessary and sufficient condition. The decision-making models from this project allow transit agencies to implement preferential treatment.
How the project was implemented:	Preferential treatment policies were evolved in the planning process.