Fiscal Year 2010

Virginia Tech
Transportation
Institute

Message from the Director

Throughout FY 2010, the Virginia Tech Transportation Institute (VTTI) has strategically navigated the tumultuous economic conditions and positioned itself for the new economy. VTTI has embarked on a new era of strategic growth and reorganization, deliberate investment and innovation, intentional collaboration and alliances, and conscious commercialization.

Strategic Growth and Reorganization

As new research initiatives have emerged VTTI has reorganized to capitalize on these opportunities. In reorganizing VTTI is able to more nimbly respond to emerging research areas and focus strategically on capturing research projects. The Institute has spun off a new center called the Center for Smart Infrastructure and Sensing Technology (CSIST). The CSIST, led by Dr. Linbing Wang, will focus on the application of pavement mechanics, applied sensing technologies, and transportation geotechnical engineering. The CSIST has recently received an award of more than $1,000,000.

Our Lighting and Infrastructure Technology Group has "graduated" to center status with the award of a large Federal Highway Administration Indefinite Quantity Contract and continued growth in areas related to infrastructure safety. This activity is now the Center for Infrastructure Based Safety Systems (CIBSS) and is being led by Dr. Ron Gibbons. The CIBSS specializes in research dealing with safety issues involving vehicle-infrastructure cooperative safety systems, roadway delineations, and roadway and vehicle lighting.

Deliberate Investment and Innovation

VTTI has become the leading expert in *in situ*, real-world transportation data collection. Our crew of technology experts has transformed VTTI's data acquisition systems into highly capable modular data collection systems that can be modified for almost any research application. These systems are easy to install and robust enough to capture many months of naturalistic driving data in real-world settings. Our engineers are working on developing a miniaturized data acquisition system that will enable data collection on motorcycles and bicycles that due to size, weight and power requirements has been impossible to date.

To manage the tremendous volume of data generated by our naturalistic driving and other activities, VTTI continues to invest in the International Center for Naturalistic Driving Data Analysis (ICNDDA) at Virginia Tech. Due in large part to expanded data capacity requirements at VTTI the ICNDDA has grown from merely 40 terabytes to more than 1 petabyte. Along with the tremendous capacity expansion, the Center will serve a much broader clientele, including national and international researchers and the general public.

Intentional Collaboration and Alliances

In keeping with the spirit of growth and partnership, VTTI has intentionally developed associations with active and budding research ventures. The Center for Injury Biomechanics-Transportation (CIB-T) continues to exceed expectations. In 2009, the CIB-T brought on-line the crash-sled laboratory, which has led to multi-million dollar research projects, bringing its research awards to nearly $5 million.

Two new and promising ventures came into being in FY 2010. The Virginia Green Highway Initiative (VGHI) is a partnership with VTTI, the Institute for Critical Technology and Applied Science, the College of Engineering, the Office of Research, and the Virginia Department of Transportation. The VGHI was developed to capture the growing emphasis on green transportation solutions. The mission of the VGHI within the realm of ground transportation is to increase energy efficiency, reduce carbon emissions, and explore strategies to minimize the impacts on Virginia's ecosystems. This initiative seeks to propel Virginia to the forefront of the green energy revolution in the field of transportation.

VTTI is collaborating with the Department of Mechanical Engineering, the College of Engineering, and the Institute for Advanced Learning and Research and leveraging resources from the General Motors Company to develop the National Tire Research Center (NTRC) in Southside Virginia. Though this initiative is in its infancy, it is anticipated that the NTRC, an innovative public-private partnership, will lead to more than $12 million in testing and research within five years and create up to 183 new jobs in the Southside Virginia area.

Conscious Commercialization

Since early 2008, VTTI has actively developed several of its research technologies to bring them to the point at which they can be commercialized. VTTI has overcome many hurdles and through the work of the Center for Product Development has facilitated the documentation and filing of five intellectual property disclosures. These disclosures defined key VTTI-developed technologies that made up a comprehensive safety system offering driver monitoring, forward collision warning and roadway departure functionality. An external license has been granted to Transecurity, a VTTI spin-off company, and the product launch is imminent.

Looking to the Future

VTTI has managed to weather the economic down turn. The Institute has:

- Substantially diversified its research sponsor portfolio;
- Built a successful and self-sustaining surface transportation safety stakeholders group called the National Surface Transportation Safety Center for Excellence;
- Embarked on newly emerging transportation research areas;
- Capitalized on economic development opportunities such as commercializing products and building a National Tire Research Center.

The future looks bright.

Mission and Background

Mission

The Virginia Tech Transportation Institute (VTTI) saves lives, saves money, and saves time in the transportation field by developing and using state-of-the-art tools, techniques, and technologies to solve transportation challenges.

VTTI conducts applied research using a multidisciplinary core of researchers and educates students in the latest transportation technologies through hands-on research and experience. VTTI uses a breadth of tools to explore transportation problems, including facilities such as the Virginia Smart Road and VTTI's internally developed data acquisition system (DAS).

VTTI has an elite team of engineers that develops new techniques and technologies to study transportation challenges from any perspective: vehicle, driver, infrastructure, and environment. These capabilities earn VTTI a unique standing in the transportation research field making VTTI truly a one-stop shop for transportation research, evaluation, analysis, and development.

Background

In 1996, the Institute was designated as one of three Federal Highway Administration/Federal Transit Administration Intelligent Transportation Systems (FHWA/FTA ITS) Research Centers of Excellence.

Since then, VTTI has grown tremendously and has garnered a reputation as one of the leading transportation research institutions in the nation. Its cutting-edge research is effecting significant change in public policies in the transportation domain on both the state and national levels. In 2005, due to VTTI's continued research leadership, the Institute was designated the National Surface Transportation Safety Center for Excellence (NSTSCE).

Table of Contents

Sponsors, Clients, Partners

The Institute's continued success is due in large part to its sponsors, clients, and partners. VTTI would like to acknowledge the contributions and support of the following organizations:

- 3M
- AAA Foundation for Traffic Safety
- ACF
- American Association of Motor Vehicle Administrators
- American Transportation Research Institute
- Amoco
- Arlington County, VA
- Atlantic Construction Fabric
- ATRI
- Attention Technologies, Inc.
- Battelle
- Beam Brothers
- Bedford County, VA
- Bekaert
- Bishop Consulting
- Booz Allen Hamilton
- DLA Piper
- California DOT
- Calspan
- Cambridge Systematics
- Collision Avoidance Metrics Partnership
- Carnegie Mellon Robotics Institute
- CARPI USA
- Center for Innovative Technology
- Cisco Systems
- Clean Air Tech International
- Corning Cable Systems
- Crack Sealant Consortium
- Delaware Technical & Community College
- Delaware Department of Motor Vehicles
- Dunlap and Associates, Inc.
- Dynamic Research, Inc.
- Ergonomic Analysis, Inc.
- Fairfax County, VA
- Federal Highway Administration
- Federal Motor Carrier Safety Administration
- Fluor, VA
- Ford Motor Company
- Foundation for Outdoor Advertising Research and Education
- General Motors
- General Motors OnStar Division
- George Mason University
- Georgia DOT
- Guard Rail of Roanoke, Inc.
- Howard/Stein-Hudson Associates, Inc.
- Hubbell Lighting, Inc.
- Human Factors North
- ICTAS
- IDEA Programs
- Interactive Design and Development, Inc.
- Jacobs, Edwards, and Kelcey, Inc.
- Johns Hopkins University
- Last Resource
- Lisboa, Inc.
- Litton Network Access Systems
- Lord Corporation
- Maccaferri
- MaineWay Services
- Michelin
- Minnesota DOT
- Mississippi DOT
- ModComp
- Monterey Technologies, Inc.
- Montana State University – Western Transportation Institute
- Motor Coach Industries
- Motorcycle Safety Foundation
- National Academy of Sciences
- National Cooperative Highway Research Program
- National Institutes of Health
- National Parks
- National Highway Traffic Safety Administration
- National Private Truck Council
- National Science Foundation
- National Transit Institute
- Navteq
- New River Valley Planning District Commission
- Nissan
- Norfolk Southern Railroad
- Oilcom
- Omni Weight Corporation
- Osram/Sylvania
- Outdoor Advertising Association of America
- Pacific-Sierra Research
- Parsons Brinkerhoff
- PB Farradyne, Inc.
- PB World
- PACCAR, Inc.
- Penn State University
- Pennsylvania DOT
- Performance Fuels System
- Philips Lighting
- Pitt Ohio
- Professional Truck Driving Institute
- PSMJ Resources, Inc.
- Realtime Technologies, Inc.
- REI Safety Services, Inc.
- ROHO Inc.
- Research & Special Programs Administration
- RGS Associates, Inc.
- Rowan University
- Rutgers University
- SAE International
- Schneider
- Science Applications International Corporation
- Science Museum of Western Virginia
- Scientex
- Shenandoah Telephone
- Shentel Service Company
- Siecor/Corning
- Siemens
- Snow Economics
- Software Technology, Inc.
- South Carolina DOT
- Systems Technology, Inc.
- Texas Transportation Institute
- Texas DOT
- TNO Defense, Security and Safety
- Tom Tom
- Toyota
- Transanalytics
- Transportation Research Board
- Travelers
- U.S. Air Force
- United Defense, L.P.
- University of Calgary
- University of Central Florida
- University of Iowa
- University of Maryland
- University of Massachusetts/ Amherst
- University of Michigan Transportation Research Institute
- University of Minnesota
- University of North Carolina-Chapel Hill
- University of Pennsylvania
- University of South Dakota
- Virginia Department of Conservation and Recreation
- Virginia Department of Environmental Quality
- Virginia Department of Rail and Public Transportation
- Virginia DOT
- Virginia Rail Policy Institute
- Virginia Tech Parking Auxiliary
- Virginia Transportation Research Council
- Virginia Transpiration Research Council/VDOT Operations and Security Division
- Veridian
- Virginia Tourism Commission
- Visteon Corporation
- Volvo Trucks North America
- WESTAT
- Weigh-In-Motion
- Western Research Institute
- Windwalker Corporation

Facilities and Equipment

Overview

VTTI's traditional laboratories are housed in two buildings totaling more than 52,000 square feet. Building I is 30,000 square feet with office, laboratory, and garage facilities. Low-service laboratories include facilities dedicated to driver interface development, eyeglance data reduction, lighting research, accident analysis, accident database analysis, pavement research, and traffic simulation. The National Surface Transportation Safety Center for Excellence (NSTSCE) building added 22,000 square feet of office and laboratory space and was occupied in July 2006. VTTI also has approximately 3,200 square feet of "flex" space in The Moss Building at the Virginia Tech Corporate Research Center (CRC).

To supplement and support the focused transportation research of the Institute, the facility holds a fully staffed garage and machine shop to instrument experimental vehicles. Technicians and engineers use full-scale machine and welding shops, electronics laboratories, and garage facilities to customize transportation hardware and software in the effort of collecting large amounts of data. These facilities are also used to support the maintenance and expansion of the Virginia Smart Road's systems and capabilities. Additionally, VTTI occupies an adjacent four-bay, 7,200-square-foot garage. This facility stores VTTI's instrumented vehicle fleet and the equipment necessary for VTTI research and Smart Road operations.

Laboratories

VTTI houses the Smart Road Control Room designed to schedule and oversee on-road research. The Control Room also acts as the 511 Virginia Data QA/QC Center. Dispatchers located in the Control Room have the ability to manipulate the lighting and the all-weather test-

ing system on the road and can control access to the facility itself. VTTI has several laboratories to aid in research objectives. These research labs include driver interface development, eyeglance data reduction, lighting research, accident analysis, accident database analysis, pavement research, and traffic simulation.

Vehicle Fleet

VTTI's vehicle fleet includes 32 vehicles and tractor trailers, many of them uniquely instrumented for specific experiments. The table below outlines each vehicle or trailer's year, model, make, and color. Researchers utilize the vehicle fleet for Smart Road tests and experimental test vehicles for developing new instrumentation packages. Several of the vehicles are long-term loaners from vehicle manufacturers, VDOT, and other partnering organizations.

All vehicles are carefully maintained in-house when possible with VTTI's fully functional garages and machine shop. Loaned vehicles are maintained in cooperation with the organization that provided the vehicle.

Year	Make	Model	Date of Acquisition	Color
1997	Volvo	Tractor Trailer	Nov-96	Green
1994	Peterbilt	Tractor Trailer	Sep-98	White/Blue
1995	Oldsmobile	Aurora	Apr-96	White
1997	Ford	Tauras	Dec-96	White
1999	Chevrolet	Van (15 Passenger)	Dec-98	White
1999	Ford	Explorer XLT	Mar-99	White
1999	Ford	Crown Victoria	Apr-99	White
1999	Ford	Contour	Apr-99	White
2000	Ford	Explorer XLS	Jan-00	White
2000	Chevrolet	C-K 2500	Jun-00	White
2002	Chevrolet	Silverado 2500	2-May	White
2002	Ford	News Van	2-Feb	White
2002	Cadillac	Escalade	2-Aug	Pewter/Gold
2002	Cadillac	Seville	3-Aug	Red
2001	Saab	504-ASR	3-Nov	Midnight Blue
2006	Cadillac	STS	6-Oct	White
2006	Cadillac	STS	6-Oct	White
1999	Dodge	Ram-Pickup	6-Nov	Green
2007	Ram Lin	Trailer-Wind Machine	7-Oct	Maroon
2003	Chevrolet	Malibu	8-Jan	White
1997	Wasbash	Trailer	7-Jun	Orange
2007	Utility	Trailer	7-Jun	White
N/A	Mitsubushi	Mighty Mitz	6-Dec	Silver
1990	Hyster	Forklift	4-Jul	
2008	Chevrolet	Tahoe	8-May	Grey
2008	Chevrolet	Tahoe	8-May	Blue
2008	Chevrolet	Tahoe	8-May	Gold
2008	Chevrolet	Tahoe	8-May	Red
2008	Chevrolet	Tahoe	8-May	Blue
2008	Chevrolet	Tahoe	8-May	White
2003	Chevrolet	Malibu	8-Sep	White
2008	Kawasaki	LE650-A	9-Jan	Red

The Virginia Smart Road

Overview

The Smart Road is a unique, state-of-the-art, full-scale, closed test-bed research facility managed by VTTI and owned and maintained by the Virginia Department of Transportation (VDOT). The Smart Road continued to play an important role in VTTI's research and overall success during Fiscal Year 2010. Since its inception, more than 12,000 hours of research have been completed on the road. The Smart Road features weather-making capabilities, a variable lighting test bed, pavement markings, an onsite data acquisition system (DAS), road weather information systems, a differential global positioning system (GPS), road access and surveillance, and a signalized intersection.

Smart Road Intersection

The intersection is useful for a variety of projects and Smart Road testing. The placement of the intersection offers the advantage of extra wide shoulders. While this provides a safety benefit during subject testing, it also provides the potential for a left-turn lane to be marked on the original portion of the Smart Road as needed for future research. Likewise, the signal mast arms are long enough to provide extra signal heads for dedicated left-turn signals. VTTI's project personnel collaborate with VDOT traffic engineers on the design features of the intersection, including approach lengths, signals, controllers, and other pertinent information. Special consideration is given to Smart Road water, electricity, and computer wire conduits, taking into account the aforementioned studies and future research efforts.

Smart Road Enhancements

During the year, the following facility enhancements and additions were made to improve the capabilities of the Smart Road:

New lighting

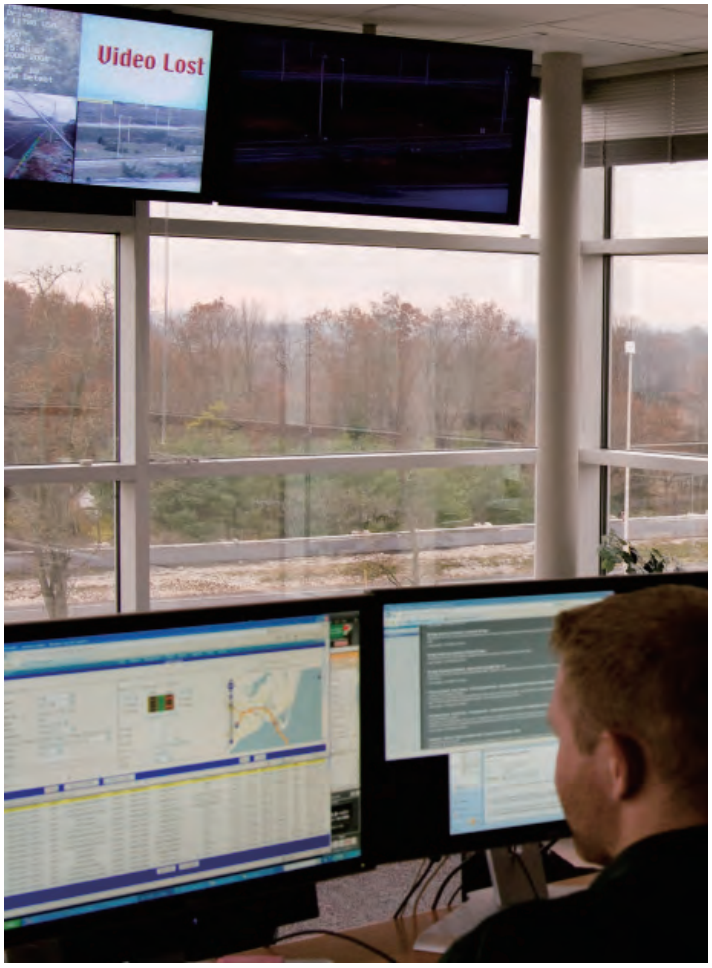
New light-emitting diode (LED) and fluorescent overhead lighting were installed.

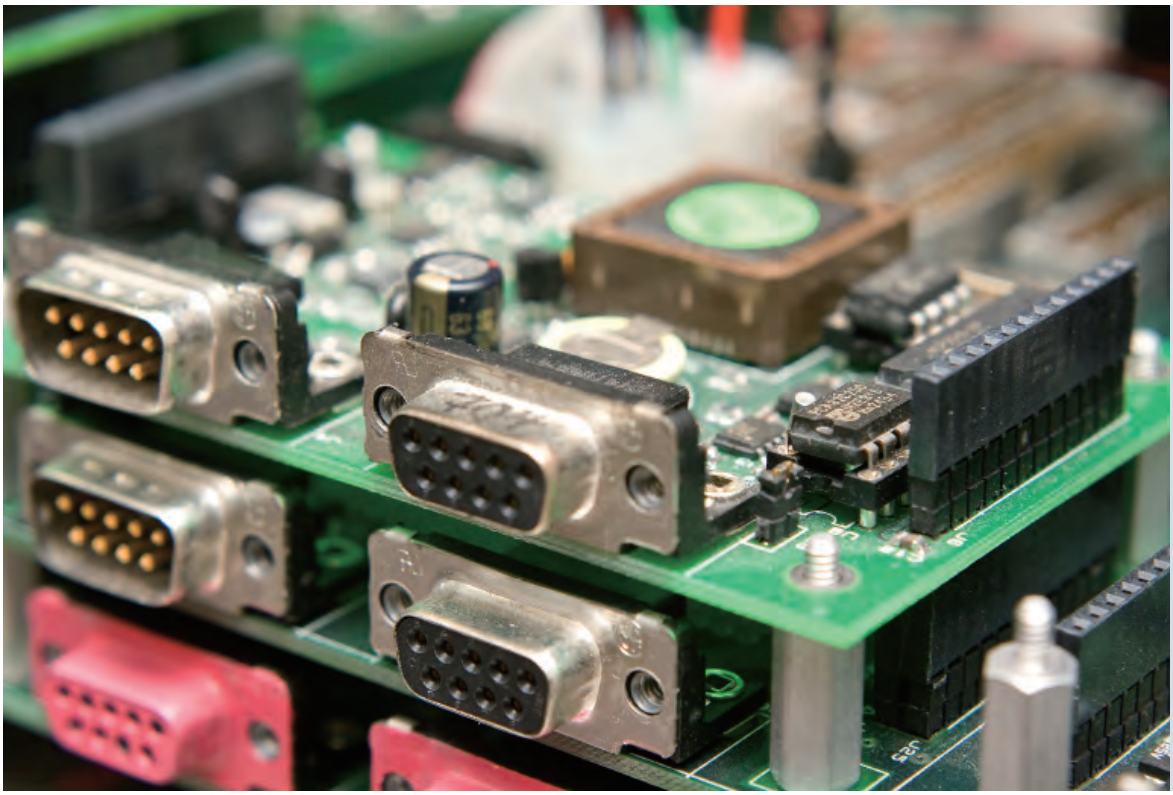
The Virginia Smart Road

The 511 Virginia Project

VTTI serves as the main quality controller for VDOT's 511 Virginia project, which includes VDOT's software, "VA Traffic." The 511 website covers most roads in Virginia, and the 511 phone system continues to cover close to 400 roads (all interstates and most primaries).

The 511 system continues to be a solid tool that assists travelers in working around congested areas or road and lane closures, as well as negotiating dangerous roadways due to inclement weather conditions.





International Center for Naturalistic Driving Data Analysis at Virginia Tech (formerly Smart Data Center)

The Smart Data Center is undergoing significant expansion in capacity and scope. VTTI was awarded the S06 contract for the Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving Study. Initially, the data center capacity requirements were 40 terabytes (TB) but grew to 100 TB. Because of the SHRP 2 contract award and additional new projects, the requirements grew to approximately 1.5 petabytes (PB). Along with this phenomenal growth, the Smart Data Center will service a much broader clientele, including national and international researchers, as well as the general public. With this increased visibility, the Smart Data Center was renamed the International Center for Naturalistic Driving Data Analysis at Virginia Tech, befitting its role as an international resource.

Building a data center at this scale required two sites: the primary (active) site (located at VTTI and Virginia Tech's Corporate Research Center) and a secondary (backup/failover/disaster recovery) site. VTTI, with the aid of Virginia Tech's initiative to provide enhanced support research computing, will fund the cost of the new data center. Several revenue models are under consideration that would allow VTTI to enhance data storage, data analysis and data management on a continuing basis.

Training and Education for VTTI Employees

The human resources staff at VTTI, in cooperation with research associates from several centers at the Institute, provided a variety of training and education opportunities for faculty and staff throughout the fiscal year. Opportunities for this fiscal year included Leave Report Training for faculty and staff and a brownbag luncheon to discuss the infrastructure for the Next Generation Data Acquisition System.

Tours and Open Houses

Tours and Open Houses

The staff at VTTI, in partnership with VDOT, hosts one public open house, two school day events, and multiple tours each year.

Open Houses

The open house was held in September 2009, and attendance was in the 300-person range. Attendees saw a presentation about the construction and capabilities of the Smart Road, toured the Smart Road Control Room, looked at some of VTTI's instrumented vehicles, and took a ride on the Smart Road through a simulated rain shower created by specialized weather towers on the road.

School Day Events

School Day events were held in October 2009. Students in attendance included first graders to college students as well as public, private and home-school groups from various regions of the Commonwealth. All students were given a presentation about the construction and capabilities of the Smart Road, toured the Smart Road Control Room, looked at some of VTTI's instrumented vehicles, and took a ride on the Smart Road through a simulated rain shower created by specialized weather towers on the road.

Community Tours

In order to increase general public education and awareness about the Smart Road and the types of research conducted at VTTI, community tours are given throughout the year. Research hours on the Smart Road always take precedence, but we make every effort to have as many groups as possible tour the Smart Road and our facilities at VTTI.

Tour groups included potential sponsors; civil and mechanical engineering students from Virginia Tech; peer institutes; various police department safety units throughout the Commonwealth; driver's education instructors; driver training programs; various international university officials; Virginia Tech reunion group attendees; and conference groups, including the American Trucking Association, the Virginia Trucking Association, fleet safety managers, the U.S. Department of Transportation management and research staff, and attendees from VTTI-sponsored conferences.

Media Coverage

*ABC World News Tonight
Ann Arbor News
*Associated Press
Australia 60 Minutes
Bermuda Sun
Boston Globe
Burlington Free Press
*Business Week
Calgary Sun
*CBS News Tonight
*CNN
Cape Cod Online
*Collegiate Times
*Chicago Daily Herald
Daily Herald Tribune
*Dallas News
*Detroit News
Distraction.gov
FastLane (official blog of Ray LaHood)
Forbes
*FOX News
Galveston County Daily News
Good Housekeeping
*IIHS.org
JAMA
KSLA News 12 (Shreveport, LA)
Kentucky Educational TV
Koco.com, Oklahoma City
*KTVU (Oakland, CA)
La Canada Valley Sun
*Landline
Liberty Mutual
*Los Angeles Examiner
*Los Angeles Times
*MSN
*MSNBC
MarketWatch
Men's Health
*Miami Herald
Milwaukee-Journal Sentinel
Morning Journal
Motorcycle USA
Nationwide.com (Nationwide Insurance)
*NBC Nightly News
NBC-12, Richmond, VA
*New York Times
Nola.com (New Orleans)
OnlineAthens, GA
Oprah.com
*Orlando Sentinel
Overdrive
*Ozarks First
PCWorld
*Philly.com
*PilotOnline.com
*Richmond Times-Dispatch
*Reuters
*Roanoke Times
San Fernando Sun
Sarasota Herald-Tribune
Seattle Times
South Carolina News
Sun Herald
Sunshine State News
Sun Times
Sydney Morning Herald, Australia
The August Chronicle
*The Auto Channel
*The Chronicle of Higher Education

The Coloradoan
The Gainesville Sun
The Indianapolis Star
The Journal Gazette
The Journal Record
The Ledger
*The Trucker
*Time Magazine
*Time Online
Toronto Sun
*Trucking Info
USA Today
Virginia Business
Virginia Tech News
Virginian-Pilot
*Washington Post
*Washington Times
*WDBJ-7, Roanoke, VA
WGRZ-TV, Buffalo, NY
WHEC-TV, Rochester, NY
WHNT.com (Huntsville/Decatur, GA)
WHSV-3, Shenandoah Valley, VA
*WSLS-10, Roanoke, VA
*WSET-13, Lynchburg, VA
*Ward's Auto
Women's Health
*XM/Sirius radio

*Multiple mentions

National Surface Transportation Safety Center for Excellence

The mission of the National Surface Transportation Safety Center for Excellence (NSTSCE) is defined as using state-of-the-art facilities, including the Smart Road, to develop and test transportation devices and techniques that enhance driver performance, examine advanced roadway delineation and lighting systems, address age-related driving issues, and address fatigued-driver issues.

The National Surface Transportation Safety Center for Excellence (NSTSCE) at the Virginia Tech Transportation Institute (VTTI) was established by the Federal Public Transportation Act of 2005 to develop and disseminate advanced transportation safety techniques and innovations in rural and urban communities.

NSTSCE's vision is to become recognized as The National Center for Surface Transportation Safety, make a significant impact in improving surface transportation safety, and leverage partner and sponsor relationships to disseminate results.

NSTSCE has formed a stakeholders' committee comprising organizations that share the vision for improving road user safety locally and across the nation. The Stakeholders' Committee members represent the Federal Highway Administration (FHWA), General Motors Corporation (GM), the Virginia Department of Transportation (VDOT), the Virginia Transportation Research Council (VTRC), and VTTI. In 2009, VTTI welcomed the Federal Motor Carrier Safety Administration (FMCSA) and Travelers as new stakeholders.

New Projects

STSCE Bay

The objective of this project is to develop Bayesian models for risk assessment using naturalistic driving data. Specifically, the project will focus on the following two aspects: 1) Developing Bayesian models for the case-crossover approach, a widely used method for assessing the safety impacts of driver behavior; and 2) Developing and implementing Bayesian hierarchical models for several existing naturalistic driving data, including 100-Car and truck naturalistic driving data. This project will contribute to the methodology issues for analyzing naturalistic driving data.

Mask Post-Processing

VTTI's proprietary Mask software offers an ideal opportunity to use machine-vision technology to automatically scan a naturalistic driving video database to quantify the extent of a driver's head turn from its nominal forward position and perhaps much more. The intent of the current project is to develop the necessary middleware to allow the Mask to scan a video database (or any specified subset thereof) as a batch process. Previously, the mask had to be applied in a basis that was fairly labor-intensive (i.e., one complete trip file at a time). Metrics derived from the mask may be particularly relevant and provide insight into maneuvers such as left turns across traffic. This research capability has now been successfully applied in a related NSTSCE project, *Age-Related Driver Difficulties at Intersections*, which is designed to compare the visual scanning behaviors of senior, middle-aged, and teen drivers, particularly during maneuvers such as left turns. In the future, this technology will be applied to other video libraries, including those of the large-scale Second Strategic Highway Research Program (SHRP 2) and the 250 Truck Naturalistic Driving Study (NDS).

OLAP Cube

VTTI maintains naturalistic databases relevant to many driving safety research efforts. Online analytical processing (OLAP) cubes are data structures that allow fast analysis of data and represent one possible method for providing timely access to large quantities of data. These data structures can be thought of as an extension to the array layout of spreadsheet applications in which numeric facts, called measures, are categorized by dimensions. For example, dimensions of interest to driving safety researchers might include driver age groups, road type and weather conditions while measures might include deceleration, headway and speed. There are two primary objectives for this project: design and develop an OLAP cube with naturalistic driving data (e.g., the older driver data set) and determine the feasibility of OLAP cubes for general use with naturalistic driving data.

Commercial Driver Health and Well-Being, Phase II

The purpose of this project is to provide an outreach website for commercial motor vehicle (CMV) drivers, providing them with information about maintaining a healthy lifestyle as a driver. Studies have indicated that a substantial portion of CMV drivers have an unhealthy body weight. The NSTSCE Commercial Motor Vehicle Health and Fatigue study (Wiegand, Hanowski, and McDonald, 2009) examined the body mass index (BMI) and driving performance of 103 CMV drivers. Results of this study found that 28 percent of CMV drivers were overweight, and 53 percent were obese. These drivers were found to have a significantly greater risk of driving while fatigued, not wearing a seatbelt, and being involved in a safety-critical event. However, many CMV drivers' jobs present barriers to maintaining a healthy body weight and overall good health. The NSTSCE Driver Health Tips Website will serve as a single-source information portal for CMV drivers, allowing them to gain information and the support needed for maintaining a healthy lifestyle as a CMV driver. This will serve as a critical outreach vehicle for the NSTSCE, partners, and potential stakeholders.

The NSTSCE Driver Health Tips Website project began in October 2009, and work progressed in several main areas. The VTTI research team has contacted stakeholders and has determined the support for a CMV driver-oriented health outreach website and social networking out-

reach website. The results of this process have helped determine the best course of action for providing information to CMV drivers so as to make the largest impact on CMV driver health. The research team has begun assembling information for the site and outlining the construction of the social networking outreach methods to be used.

Additionally, VTTI has submitted a summary of the project as a proposal to a Transportation Research Board (TRB)-sponsored, international scope conference focused on CMV driver health and wellness that will bring additional attention to the project. Notification of acceptance is pending.

Case Study on the Impact of Treating Sleep Apnea in CMV Drivers

This project will assess the overall effectiveness of Schneider National's sleep apnea program and will document two different sleep apnea programs being implemented by truck carriers (Schneider National, Inc., and J.B. Hunt). A sleep apnea implementation manual to include a set of best practices for a successful obstructive sleep apnea (OSA) treatment program will be developed, which may serve as a guide for trucking fleets wishing to implement a sleep apnea treatment program to improve the health of drivers, reduce crashes and fatigue-related traffic incidents, and reduce health- and safety-related costs. The intent is to distribute this manual to other trucking fleets; VTTI has enlisted the assistance of several other agencies, including the National Institute for Occupational Safety and Health (NIOSH), the Federal Transit Administration (FTA), the National Sleep Foundation (NSF), the American Transportation Research Institute (ATRI), and the American Sleep Apnea Association (ASAA). The manual produced in this study is expected to be beneficial to other transportation modalities and industries. Specifically, VTTI will:

1. Evaluate the efficacy of OSA treatment, including automatic positive air pressure (APAP), while CMV drivers are on the job;

2. Assess the safety and health benefits in treating OSA (e.g., reduced crashes and improved health profile);

3. Evaluate the overall return-on-investment (in terms of reduced heath care premiums, lower crash rates, and increased driver retention compared to the costs of treatment);

4. Develop models to predict beneficial health and safety outcomes (e.g., compliance rates, age, gender, etc.); and

5. Develop a set of best practices for implementing and maintaining a successful OSA program for the trucking industry.

Focus group research will also be conducted with drivers and staff involved in the Schneider National, Inc., and J.B. Hunt programs. The purpose of the focus group research will be to assess participants' perceptions and opinions about the program and to gain insight firsthand from those who participated as to what worked, suggested improvements, etc. Findings from this study will provide recommendations as to why carriers should implement a sleep apnea program and how they can do so in an effective and efficient manner.

STSCE Object Color

There is some evidence for the potential to lower or change the required lighting level based on the light source used. Evidence gathered from site testing shows that a benefit in visual performance might not be related to blue light but more so from seeing the proper rendition of color in the visual environment from a broad spectrum light source. Possible project results may include recommendations to lower light levels based on using a broad spectrum source.

STSCE Color Camera

This project focuses on the development of a camera system that accurately defines color in a driver's environment and allows for color analysis during projects. The camera allows for the capture of a succession of images at a rate of approximately 4 frames per second and will be used in conjunction with the already developed luminance camera system. A calibration technique is being developed that will allow the color camera to be incorporated into other ongoing projects and the Roadway Lighting Mobile Measurement System (RLMMS).

Ongoing Projects

STSCE Crash/Near-Crash Algorithm

In the 100-Car Study, trigger algorithms for extracting near-crashes and crashes were not optimized. Because the hit-miss ratio for obtaining crashes and near-crashes needs to be improved, NSTSCE researchers are testing methods to improve the trigger algorithms for use in future research.

Several statistical classification methods are being evaluated. These methods will be tested using valid and invalid events from the original 100-Car Study analysis as a gold standard to judge algorithm performance. Once the methods are evaluated with a 100-Car Study analysis, the algorithms will be tested on other data sets to estimate robustness.

STSCE Distraction Index

A number of surrogate measures of distraction exist, but their contribution to the overall construct has not been quantified. The goal of this research is to establish a framework for the creation and, to the extent possible, validation of a distraction index that combines the effects of the most important surrogate indicators of distraction. The concept would be similar to that of the widely used (in the musculoskeletal arena) NIOSH Lifting Index and would result in a published research guideline that could be used as a common measure across studies.

In order to determine the feasibility of this effort, researchers will start with select crash and near-crash surrogates and overlay this with naturalistic data. A literature review and re-analysis of existing data would be required (no additional data collection needed).

Publication Analysis

VTTI maintains the largest repository of naturalistic driving data in existence: more than 100 terabytes (TB) and counting. The goal of this project is to develop a comprehensive and cohesive data-mining, analysis, and publication plan for this ever-growing data set in a manner that synergistically addresses the foundational concerns of NSTSCE: age-related driving issues, fatigue, lighting and infrastructure, and driver performance. While all publications reflect VTTI's safety studies, the current focus is on those featuring naturalistic data.

STSCE Roadway Lighting Design and Safety

This is a continuation project for the luminance camera system project. The goal of this research effort is to validate the luminance camera through field testing and to analyze a variety of real-world sites in addition to short-term Smart Road testing. The outcome will be analyzed in terms of potential crash causes and possible mitigation techniques.

Visual Information Modeling

Analysis of a driver's nighttime visual environment requires consideration of multiple interrelated variables, including human factors and roadway features and lighting. A driver's field of view contains such features as the roadway, the hood of the vehicle, the instrument panel, off-roadway facilities and roadway fixtures (e.g., signs, traffic signals, and pavement markings), as well as the activities of other road users. From this environment, a driver must continuously draw information about the presence of potential hazards in the roadway, navigate using roadway signage and delineation, and maintain control of the vehicle. Drivers must attend to and select which objects present important information and determine those that are superfluous. Reviewing

and identifying, where possible, what attracts a driver's gaze towards an object while driving at night can provide insight into visual behavior.

The research project has progressed through a number of tasks that included completing a literature review incorporating a number of elements such as previous models, eye tracking behavior, and photometric components. The key elements were broken down into specific aspects of the overall topics. These elements were then used in the creation of the experimental and analysis methodology for the project.

An experimental design was constructed to collect data both in a controlled environment on the Smart Road and on a public roadway drive. A total of 24 Smart Road participants and 8 public road participants took part in the research. The data types included the suite of variables collected on the VTTI data acquisition system (DAS; e.g., distance, global positioning system [GPS], speed, etc.), data from the VTTI-developed luminance camera (e.g., luminance levels), and the eye movement information from the eye tracking unit (e.g., number of glances, fixation duration, etc.). When data collection was complete the data were reduced and cleaned.

Data from the eye tracker and the luminance camera were also processed during the data reduction effort. Using a VTTI-specific approach developed in MATLAB, the frame number from the luminance camera was matched to the corresponding frame number from the eye tracker. Sections of time before and after a specific target were also examined to identify eye gaze information and to have the ability to match corresponding luminance data.

As part of the overall project and collaboration effort, VTTI aided with the development and review of the experimental tasks being partially duplicated at the Texas Transportation Institute (TTI) facilities. For example, both VTTI and TTI participated in a luminance camera calibration review at the National Institute of Standards and Technology (NIST). A calibrated light source and a photometer were employed in order to determine the spectral sensitivity of the luminance camera system. Image data were recorded at the NIST.

Data from both facilities will be combined and analyzed in an effort to produce a preliminary visibility model for nighttime driving. The research will assess and provide a new foundation for the development of a predictive model that incorporates the dynamic relationship of driver performance with the safety of the total roadway environment. Once this relationship is defined, safety modification factors can then be developed that relate the quality of the design to driver safety.

STSCE Public Access

VTTI maintains naturalistic databases relevant to many driving safety research efforts. The ability to make portions of these data sets publicly available needs to be developed. There are two primary objectives for this project: 1) Develop the tools and procedures necessary to provide timely access to data sets and 2) Allow VTTI personnel to gain experience in providing appropriate levels of service to external researchers.

Driver Coach: Bedford/Montgomery Virginia Evaluation Project

The purpose of this project is to forward the concept of teen driver coaching and monitoring to eliminate behaviors that can lead to fatal and injurious crashes. Teen drivers are three times more likely to get into a fatal crash than their adult counterparts. The causes of teen crashes include excessive speed, alcohol use, distraction, and failure to recognize hazards. VTTI has been independently approached by two Virginia counties—Bedford and Montgomery—to help design a program to mitigate what they believe is a tragic and growing problem in their communities. VTTI has recommended a "three-pronged" approach to help reduce teen deaths and injuries: 1) Parent-teen contracts with elements of an enhanced graduated driver's licensing (GDL) program; 2) Training of specific skills at a specially designed training facility; and 3) A teen driver monitoring and coaching program using advanced in-vehicle technology. This project will support these three parts, with

special emphasis on the driver monitoring and coaching program.

Roadway Lighting Mobile Measurement System (RLMMS)

The RLMMS will allow the research team to collect lighting data dynamically and to incorporate a number of previous NSTSCE project features into the data collection process. The RLMMS captures illuminance, luminance, and GPS information in an effort to monitor lighting levels. This information can then be synchronized to the DAS currently in use at VTTI. The overall system provides valuable data that incorporate illuminance, luminance, and a number of vehicle variables such as speed, acceleration, and steering behavior. The integration of illuminance and luminance information adds another valuable data source for understanding the quality of lighting and potential safety impacts within the nighttime driving environment.

STSCE Rural Intersection Lighting

Recent research has shown that lighting may have an impact on driver safety at rural intersections. Research results showed that the ratio of night-to-day and total night crashes were lower at lighted intersections compared to unlighted intersections. However, this research only used lighting as a strictly binary measure during analysis, meaning that the lighting was either present or absent according to the database. These results suggest that lighting enhances driver safety; however, the data do not account for the quality or level of light at intersections.

During the current research effort the research team identified a number of Virginia intersections based on the crash database provided by the Virginia Department of Transportation (VDOT). Rural intersections of interest were those that had high and low crash rates, both lit and unlit, and that had reasonable equal representation based on type (e.g., T-intersection, crossroads, etc.). When the list was finalized a data collection effort was made using the VTTI-created RLMMS to measure lighting levels at the intersections of interest.

Following the data collection effort the data were cleaned and reduced based on parameters selected during the intersection identification phase. The data were loaded into a geographical information system (GIS) software package, and a perimeter around each intersection was created that included the illuminance measurements of interest from the data collection effort. The data also included the corresponding luminance image from the luminance camera deployed as part of the data collection effort.

The project is currently reviewing the data in order to be integrated into a Bayesian model framework in an effort to identify the effect of lighting levels and crash rates. The project may identify the safety benefits of lighting at a representative sample of rural intersection locations. These data can also be used for establishing warranting information for lighting at rural intersection locations.

STSCE Data Center

The purpose of this project is to integrate Virginia Tech's petabyte-scale, high-performance data storage system into VTTI's data infrastructure. Once completed, data from multiple naturalistic driving studies will be migrated to this infrastructure. These data will be analyzed using high performance computational systems in order to perform more complex computational algorithms and data mining.

100-Car Re-Analysis

The 100-Car NDS (released in 2006) was able to provide new levels of detail about naturalistic driving research with a database of nearly 7 TB of information. The data continue to be a wealth of information for transportation research, providing many opportunities for the re-analysis of new discoveries about driver behavior. However, in order to conduct subsequent analyses for more than 42,000 hours of driving data, new information must be obtained.

The objective of the 100-Car Study re-analysis project is to obtain information that was not readily available about each data file in the 100-Car data set but that would be useful to research-

ers in subsequent data analyses. Specifically, the project is designed to provide information for all 100-Car data files about who was driving the vehicle, whether the driver wore a seat belt, whether the driving occurred during the day or night and which, if any, video views were missing. This project has also allowed researchers to assign identification numbers to new secondary drivers. This supplemental information will strengthen many of the secondary analyses of this data and allow for accurate estimates of exposure and risk.

Naturalistic Observation of Motorcycle Riders

The Virginia Tech Foundation (VTF)-STSCE Motorcycle project is intended to support naturalistic research of motorcycle crash causation by identifying and developing applicable sensor strategies and analysis methods. The project has been run in parallel with a National Highway Traffic Safety Administration (NHTSA)-funded project exploring the feasibility of instrumenting motorcycles for naturalistic study and independently after that study was completed. The project has provided targeted instrumentation and DAS specification through an online and paper survey of more than 400 motorcyclists exploring motorcycle use and rider needs. The project has also covered the development of instrumentation for brake lever/pedal force, engine rpm, and manifold absolute pressure. Each of these new technologies has been developed and tested on a VTF-STSCE motorcycle, which also provides a platform on which clients can review instrumentation options. The areas of focus for this project have been successful in building VTTI's competencies in motorcycle research and in initiating the first large-scale naturalistic research project in motorcycle crash causation. VTTI just began a project funded by the Motorcycle Safety Foundation (MSF) to instrument approximately 100 motorcycles for one year. The MSF is a private, not-for-profit organization sponsored by BMW, BRP, Ducati, Harley-Davidson, Honda, Kawasaki, KTM, Piaggio, Suzuki, Triumph, Victory and Yamaha.

Completed Projects

Motorcycle Feasibility

This project applied techniques and study procedures used for light- and heavy-vehicle studies that were adapted for use in answering motorcycle-related questions. Three motorcyclists rode for a total of more than 3,100 miles while instrumentation recorded acceleration in three axes, yaw, pitch and roll, geographic location, rear-wheel speed, position in lane, turn-signal use, braking, range and closing speed to forward objects, and five video views. Analyses were conducted to illustrate possible uses of the data and to confirm the effectiveness of the adapted instrumentation. An independent evaluator reviewed the project, including the technical approach, instrumentation, data and questionnaires. The project successfully demonstrated the feasibility of equipment and procedures for investigating motorcycle rider and crash-related research questions.

Driver Performance While Text Messaging Using Handheld and In-Vehicle Systems

In this study, driver performance while

texting using a handheld mobile telephone was compared to a driver's performance while texting using an integrated vehicle system with a voice interface. The study was conducted in parallel with privately funded work investigating manual versus voice control of other typically manual-controlled technologies. The texting portion of the study investigated driver performance while sending and receiving text messages on the Smart Road test track using personal handheld phones and the vehicle system. It was found that handheld text message sending resulted in longer task times, higher mental demand ratings, more frequent and longer glances away from the forward roadway, and degraded steering and speed control than baseline driving. Handheld receiving showed less decrement in some areas but still had worse performance than the baseline on a number of measures. The vehicle system showed improvement over handheld use for both sending and receiving text messages, although sending messages using the system resulted in higher workload and longer time spent looking inside the car than the baseline. Finally, older drivers exhibited more performance decrements than younger drivers for nearly all measures. A final paper draft was submitted for publication consideration in a peer-reviewed journal.

STSCE Rural Roads II

The emergence of naturalistic driving data provided a new opportunity for exploring the rural crash problem. In contrast with crash report-based data sources, naturalistic data provided extremely rich information from many video views and data streams describing what occurs instant-by-instant in non-crash situations and during actual crashes and near-crashes. Within these data, epochs of driving in rural areas were located and further analyzed to identify the characteristics of driving in rural areas, the factors contributing to these crashes, countermeasures that will reduce the frequency and severity of these crashes, and, in some cases, tested the effectiveness of proposed countermeasures.

Naturalistic driving data sets were expected to be large. To prepare for investigations into the rural crash problem using this type and quantity of data, an automated method was developed to determine when participants were driving on rural roads. A review of previous work on rural road driving was undertaken to find a standard definition of a rural road. While there are some variations in the definitions of a rural road, a definition was selected that is comparable with the determinations most common in rural roads literature. By employing the functionality of a GIS, code was written that allows for an automated process to compare the GPS data recorded in the naturalistic driving data with geographic map data from the U.S. Census Bureau and road data from various sources such as state departments of transportation (e.g., VDOT) or other providers. Points recorded in the naturalistic driving data that fell outside the boundaries of the Census Bureau's urbanized areas or urban clusters were determined to be rural. The points were further evaluated to determine whether or not the vehicle was being driven on an interstate highway. Points that were determined to be rural and not on interstate highways were segments of interest in addressing the rural road crash problem.

Data Mining of the Independence by Franklin Intersection

This project focused on ascertaining factors contributing to red light violations identified during the Cooperative Intersection Collision Avoidance System for Violations (CICAS-V)

data collection effort at three intersections in the New River Valley, Virginia. Particular emphasis was placed on determining why a larger proportion of violations occur at the intersection of Independence by Franklin.

Developing Bayesian Models for a Naturalistic Driving Study

The current mainstream analysis tool for NDSs is a classical statistical paradigm, which lacks the ability to incorporate information from previous studies or expert opinions. The Bayesian method had advantages of ease of interpretation, flexibility to accommodate spatial/temporal correlation, ability to incorporate prior/expert-opinion information, and natural hierarchical structure in modeling multi-center/group studies.

The overall objective of this study was to develop Bayesian analysis methods for NDSs. The specific goals of this study included: 1) Development of the general framework of the Bayesian approach for analyzing naturalistic driving data; 2) Investigation of alternative priors, which was the key to the Bayesian approach; specifically, two types of priors were investigated: objective prior, in which no external information was used in the modeling, and informative prior, where information from expert or previous studies was used to improve estimation; and 3) Investigation of hierarchical Bayesian models in conducting combined analysis using data from separate naturalistic driving studies.

Older Driver Data Collection

The high-level goals associated with this research project were to better understand older drivers' behaviors and driving performances, as well as the functional impairments, situations, and contributing factors that lead to crashes. We instrumented 20 vehicles of older drivers with highly capable yet unobtrusive DASs. Incorporated within the DAS were four camera views, forward radar, accelerometers in three dimensions, yaw rate, GPS, machine-based lane tracking, and select vehicle network data. In this research paradigm, participants simply drove without restriction while the video and time series data were gathered continuously for one year. We also assessed participants along a variety of functional performance dimensions relevant to driving, including: physical, psychomotor, visual, cognitive, and health and well-being. The goal of collecting these assessment data was to correlate functional impairment profiles to driving behaviors and safety outcomes observed in the naturalistic driving data and, ultimately, to develop validated fitness-to-drive models. These results could have implications for older driver training programs, technological countermeasures, and licensing/restriction/cessation protocols. Some aspects of the collected data have already been analyzed in several VTTI projects. In the end, more than 4,600 hours of driving data were collected during more than 29,000 trip files. Also, the driving participants were assessed along a broad array of assessments, as were a cohort of seniors who had recently given up driving.

The Impact of Privacy on Emerging Technology on Transportation Safety Applications

With funding from the Virginia Transportation Research Council (VTRC) and NSTSCE, the Transportation Policy Group (TPG) examined the technology of transportation safety and various types of emerging technology and transportation applications. Privacy concerns have been raised about most technology that collects and processes personal information. This study examined the nature of the informa-

tion usage, ways personal data were processed, possible misuse of personal data, and ways to mitigate concerns for privacy. The team included two subcontractors well versed in the legislative and legal implications. The project was helped by the addition of the Intelligent Transportation Society of America as a team member.

Device Survey

The purpose of this project was to gather self-reported data regarding portable consumer electronic devices that are sometimes used while driving, including cell phones, MP3 players, and hand-held navigation devices. It was devised to facilitate the comparison of the responses of drivers who hold commercial driver's licenses (CDLs) with those who do not on these same dimensions. To this end, the survey was administered to two samples associated with Virginia Tech: 1) Faculty, staff, graduate and undergraduate students and 2) Blacksburg Transit drivers, all of whom held CDLs.

The objectives of this effort were multiple:

- Learn about consumer behavior in terms of the purchase and acquisition of such portable devices and their use by individuals while driving.

- Compare CDL holders with those who only hold standard licenses on these same dimensions. Note that the CDL holders were administered the same questionnaire as the other participants and were asked to respond per their personal, non-work-related habits.

This project entailed the following: a questionnaire about device use and buying behavior was designed and Institutional Review Board (IRB) approval was sought and attained. In addition, Virginia Tech's Center for Survey Research implemented the questionnaire as an internally branching, computer-based survey that was distributed via email. Data were successfully acquired from 1,429 individuals with regular driving privileges and 72 from those individuals who also held CDLs.

Age-Related Driver Difficulties at Intersections

This project, sponsored by the NSTSCE, utilized naturalistic techniques to examine the glance-related behaviors of drivers making left turns at intersections with an emphasis on comparing older driver behaviors to younger and middle-aged drivers passing through the same intersections along the same pathway. Aging drivers have historically been over-represented in crashes resulting from turns across traffic at intersections and have a higher rate of fatality than younger drivers. For example, Staplin et al. (2001) reported that drivers aged 80+ were involved in fatal intersection crashes at more than twice the rate for drivers under the age of 50.

Of particular interest was whether older drivers showed narrowed visual scanning as they prepared for and initiated their turns (both in terms of the spatial extent of their eye movements and in terms of head rotation). Such patterns have been reported in prior simulator and experimental work but have not yet been confirmed in the real world via naturalistic driving research.

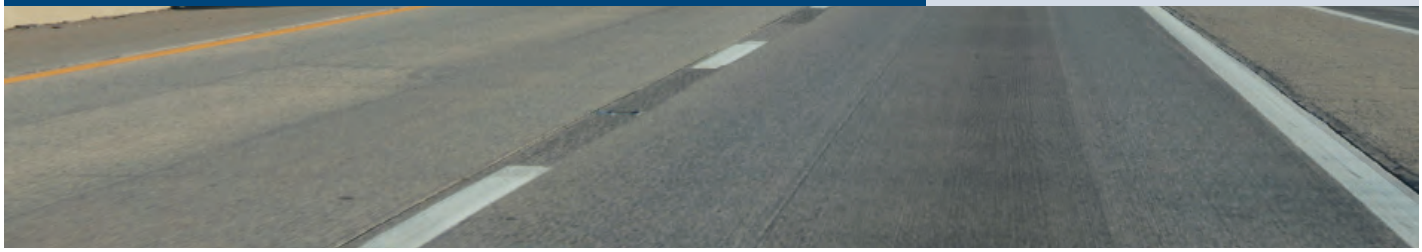
Results varied across intersections, phase of turn, and age group. This shows that not all left-turns-across-traffic are the same and that a complex set of factors must be considered together when determining the age-related differences in negotiating such potentially risky traffic situations.

Center for Automotive Safety Research

The Center for Automotive Safety Research (CASR) specializes in researching the causes of automobile crashes and ways to prevent them.

The center comprises two research groups: The Advanced Product Testing and Evaluation (APTE) group tests in-vehicle systems for industry, while the Light Vehicle Safety (LiVeS) group conducts federally funded research projects to advance safety on the nation's roadways.

The mission of the Center for Automotive Safety Research (CASR) is to conduct research and development efforts to advance knowledge in the light-vehicle domain and provide solutions to real-world situations.



New Projects

Human Factors Limited-Ability Autonomous Driving Systems (HFLAADS)

VTTI is working with General Motors (GM) in cooperation with the U.S. Department of Transportation (DOT) Federal Highway Administration (FHWA) to study the human factors aspects of Limited-Ability Autonomous Driving Systems (LAADS) . The goal of the project is to understand the factors that impact the effectiveness of alternative concepts of operation (human-machine interfaces and control transition strategies) for vehicles with LAADS features (specifically, an adaptive cruise control and lane centering capable of autonomously following a single lane on freeways). The program addresses concerns such as the possibility of drivers becoming overly reliant upon the systems, operating the systems outside of design parameters, or being unaware as to when the systems are not operating as intended. Data from a series of simulators and test tracks studied will be used to design and refine various interaction concepts intended to help drivers stay engaged in the driving task.

General Motors Blanket Agreement

VTTI currently has 13 active GM-sponsored projects under the $4.8 million GM Blanket Agreement. The projects span a range of interface and system design issues related to the advancement of vehicle safety and convenience systems. These are applied projects generally focusing on driver acceptance, use, and reliance on advanced vehicle systems, as well as driver comprehension and understanding of alternative interface designs. Ongoing work includes controlled test track and extended naturalistic driving studies (NDSs) using instrumented vehicles to capture and document driver interactions with systems.

DAS Procurement

The goal of the Data Acquisition System (DAS) Procurement project (under the Second Strategic Highway Research Program [SHRP 2] S12a) is to obtain all DASs and related warranties needed to support the SHRP 2 NDS (S06 and S07 projects) within budget and within a timeframe to support project scheduling constraints. The strategy focuses on finding a contract manufacturer (CM) with the capacity to provide a full turn-key product, including the services, while recognizing that some parts may be obtained in separate procurements or purchase orders. The plan includes ordering production prototypes from two to three CMs.

A selection committee has been formed, including VTTI and SHRP 2 nominated personnel. The selection committee reviews and approves all procurement processes, documentation, request for information (RFI)/request for proposal (RFP) vendor responses, and has made the selection of the winning bidder from among several competitors. Vendor responses were primarily evaluated for cost, services offered and delivery schedule. Acceptance testing of the winning bidder's prototype DAS units is ongoing.

Identifying Countermeasure Strategies Targeting Older Pedestrians

This project was awarded by the National Highway Traffic Safety Administration (NHTSA) through Westat, which is serving as the prime contractor. The objective of this effort is to determine best practices related to enhancing safety for older pedestrians who are at greater risk than other age groups for being in, and being severely injured or killed by, a pedestrian crash. This project also has a focus on determining the best

ways to enhance safety for senior pedestrians within minority and/or immigrant populations and communities.

Activities include the review and comparison of past NHTSA-sponsored pedestrian safety program implementations and conducting structured interviews with experts in the field of senior pedestrian and transportation safety. From these activities, best practices will be determined in terms of engineering solutions, enforcement practices, and public information and education programs. These solutions will be explored and evaluated by focus groups consisting of minority as well as non-minority seniors.

In general, this project is founded on the notion that the topic of transportation safety for seniors must look not only towards enhancing safety related to older drivers, but it must also focus on other key modes of transportation for this growing segment of our population.

Occasional Seatbelt Users: An Analysis of the 100-Car Data

This project was awarded by the NHTSA through the National Safety Council, which is serving as the prime contractor. Despite progressively increasing seatbelt use rates, there remains a subset of the driving population that fails to wear a seatbelt for a significant amount of the time that they drive. The factors that weigh into these drivers' decisions are not clear, and targeting safety campaigns to these drivers is difficult without understanding their decision processes.

This project mines the 100-Car NDS and a subsequent re-analysis/inventory of that data that included recording seatbelt usage and driver ID for every file in the data set. The first objective of this new project is to examine differences in driver demographics, personalities, driving histories, and driving performance metrics between three identified seatbelt user groups: infrequent, occasional, and consistent seatbelt users. The second objective is to closely examine the occasional seatbelt users in order to identify situational factors that may weigh into these drivers' decisions to wear or not wear a seatbelt during any given driving trip. Metrics to be examined in this second step include trip length (miles, minutes), road type (e.g., interstate vs. non-interstate), and maximum driving speed. We also plan to begin exploring the trip purpose based on the type of destination as a factor in seatbelt usage decisions.

Rating Consumer Info

This project, sponsored by the NHTSA, was initially focused on the development of a consumer metric for device distraction that would provide information to consumers about the visual and cognitive demands that electronic systems (such as phones, navigation systems, MP3 players, etc.) can impose on drivers. This metric could be used to help consumers distinguish between devices that are potentially less risky when used while driving. However, after the successful conclusion of Task 1, the project was put on hold in light of NHTSA's larger, agency-wide focus on distraction-related concerns. Since then, the project has been re-imagined as a way to produce still and video images of examples of distracted driving and its consequences. This could then be used to support the NHTSA distraction.gov website and its efforts to reduce the dangers associated with distracted driving.

Motorcycle Safety Foundation Naturalistic Study of Motorcyclists

The number of motorcyclists killed and injured while riding on the nation's highways has been

consistently increasing for more than a decade. During the same period the number of fatalities and injuries has been decreasing for other road users. A number of factors could be contributing to this trend; however, insufficient data are available for capturing the entire breadth of causal factors precipitating motorcycle crashes in a multi-phase study. With the objective of understanding natural riding, the causes of crashes, and subsequently identifying strategies for avoiding crashes, the Motorcycle Safety Foundation (MSF) has contracted VTTI to conduct a naturalistic study of approximately 100 motorcyclists in three locations (Virginia, Florida, and California). This study will be conducted during the next three and a half years.

Ongoing Projects

Technical Coordination and Quality Control for the SHRP 2 NDS

The Transportation Research Board (TRB) of the National Academy of Sciences (NAS) is administering the SHRP 2. VTTI is playing an important role in helping the TRB achieve its goals in the safety arena via its leadership role in the SHRP 2 NDS, the largest NDS undertaken to date and the model for similar efforts being pursued internationally. VTTI will work closely with SHRP 2 staff and the S07 site contractors, who are staffing each of the six data collection sites across the U.S.

The overall goal of the S06 effort is ensure that all study data are collected accurately and stored securely while maintaining all human subject protections, all within the constraints of the provided budget and schedule. The S06 responsibilities include: design and acceptance testing of the DAS; overseeing procedures for protection of participants; coordinating study protocols; developing approved consent forms and related supplemental materials; facilitating successful Institutional Review Board (IRB) submissions across all IRBs involved; training of S07 project personnel in terms of driver assessment, DAS installation, and data handling; attending S07 project kickoff meetings; conducting S07 project site readiness inspections; overseeing participant recruitment; adhering to the sampling plan; managing the triage response to all remote DAS self "health" check and automated collision notification messages; monitoring the progress of hard drive removals and data uploads to the VTTI data center; maintaining the data collection schedule; and processing, storing, and providing access to study data for ongoing and subsequent research projects.

CWIM Phase II

The goal of this project is to develop human factors test protocols and related metrics to evaluate driver-vehicle interfaces (DVI) related to advanced crash warning systems (ACWS). With the flood of new vehicle features coming to market it is important to understand the need for consistency and standardization across these systems. For example, drivers accustomed to a particular system in their personal vehicle should not be confused by, or react inappropriately to, alerts issued by that same system in a different vehicle with a different DVI. Empirical evidence is needed to determine which aspects, if any, should be considered for standardization. This project will initially focus on two ACWS functions: forward collision warning and lane departure warning.

Center for Automotive Safety Research

Preventing Motor Vehicle Crashes among Young Drivers: Research on Driving Risk among Novice Teen Drivers

Motor vehicle crash rates are highest among novice teen drivers, especially during the first six months and 1,000 miles of independent licensed driving. Crash rates decline with driving experience; however, no research has demonstrated learning effects on performance due to independent driving experience. Additionally, the extent and variability in driving performance among novice drivers have not been established.

The purpose of this study, funded by the NHTSA and the National Institute of Child Health and Human Development (NICHD), is to assess the effect of driving experience on driving performance. This study, which was awarded in 2005, is collecting continuous naturalistic driving data and controlled experimental data on the Smart Road. Forty-two newly licensed teen drivers and their parents are participating in this study. All teens plus one parent each have been tested twice on the Smart Road, once at the beginning of the study and 12 months later. Continuous naturalistic driving data are also being collected for the same teens, along with some parents, for a period of 18 months. The vehicles were instrumented within three weeks of licensure to ensure that driving data were captured during the earliest possible period of independent driving. Data collection began in June 2006 and continued through September 2008. The resulting data analyses will assess how teen driving performance changes over time for a variety of complex driving scenarios. Analyses will also assess the sequence of events prior to teen crashes and near-crashes as well as the key contributing factors to better understand the underlying risk factors involved in teen crashes and near-crashes.

Naturalistic Teenage Driving Study

This project, funded by the NICHD, is an optional add-on to the 40-Teen Study. The study will be an observational study of the nine months of the learner's permit (practice driving) phase followed by the first six months of independent driving. The study will be conducted using the center's naturalistic data collection method and continuous data recording. Data will only be collected when the teen participant is driving.

Learners and their supervisors will not be instructed to practice in any particular way; however, the amount and variety of practice provided by the parent and compliance with the state laws (45 hours, 15 of which must be at night) will be analyzed. The first nine months of practice will then be compared with the driving outcomes during the first six months of independent driving. Data collection for this study is scheduled to begin in the fall of 2010.

Follow-on FOARE

This research, sponsored by the Foundation for Outdoor Advertising Research and Education (FOARE), was undertaken to further disseminate the results of two previous studies examining whether there is any change in driving behavior in the presence or absence of billboards. Activities undertaken during the current reporting year include monitoring and analysis of ongoing efforts in this field, including an FHWA-sponsored international scan tour and an FHWA field study replicating previous studies conducted by VTTI. Publication(s) will result.

Completed Projects

Motorcycle Feasibility

This project applied techniques and study procedures used for light- and heavy-vehicle studies that were adapted for use in answering motorcycle-related questions. Three motorcyclists rode for a total of more than 3,100 miles while instrumentation recorded acceleration in three axes, yaw, pitch and roll, geographic location, rear-wheel speed, position in lane, turn-signal use, braking, range and closing speed to forward objects, and five video views. Analyses were conducted to illustrate possible uses of the data and to confirm the effectiveness of the adapted instrumentation. An independent evaluator reviewed the project, including the technical approach, instrumentation, data and questionnaires. The project successfully demonstrated the feasibility of equipment and procedures for investigating motorcycle rider and crash-related research questions.

Evaluation of Enhanced Brake Lights Using Surrogate Safety Metrics

Rear-end crashes are the most frequently occurring type of collision, accounting for approximately 29 percent of all crashes, which result in a substantial number of injuries and fatalities each year. The vast majority of rear-end crashes involve a distracted driver who is not looking forward at the onset of lead vehicle braking or situations where an otherwise attentive driver fails to recognize a hard deceleration event or stopped lead vehicle. A signal designed to capture and re-focus the driver's attention to the forward roadway and/or increase the saliency of the braking event has the potential to address this problem and reduce crash risk. The NHTSA contracted with VTTI to conduct a series of tests resulting in recommendations for enhanced rear lighting and signaling systems. This multi-year effort involved testing and evaluating various rear signaling systems that would warn drivers of hard lead-vehicle deceleration events and/or stopped lead vehicles. The work included evaluating efficiency and implementing several prototype brake light systems on a small fleet of vehicles in preparation for a larger-scale field operational test (FOT).

International Vehicle Safety

VTTI administered this project conducted by Battelle in a comparative analysis of vehicle safety standards for developing global technical regulations.

National Advanced Driving Simulator (NADS) Lane Change

A study was conducted at the National Advanced Driving Simulator (NADS) where drivers experienced five types of collision avoidance systems (CAS) in the simulator. Lane-change CASs were designed to prevent crashes in lane-change maneuvers by alerting the driver to hazards relating to adjacent vehicles. This project examined the approach, interpretation, and results of this study and refined the analyses.

Advanced Collision Avoidance Technologies

The main goal of the Advanced Collision Avoidance Technologies project, funded by the NHTSA and an original equipment manufacturer (OEM), was to estimate the potential safety benefits that may emerge from the deployment of backing crash warning systems. These countermeasures alerted the driver when there were obstacles present in the vehicle's travel path as it completed a backing maneuver. Efforts under the project included the documentation of these objective test procedures for future use in testing similar systems and results for future use as a benchmark. Finalization and testing of the software tool that estimates the potential safety benefits were also conducted.

Center for Injury Biomechanics

The Center for Injury Biomechanics (CIB) combines experimental testing of dummy and human surrogates and computational modeling in order to develop human impact injury criteria.

The Center for Injury Biomechanics (CIB) performs research investigating human tolerance to impact loading. The application of this research includes automobile safety, military restraints, and sports biomechanics. As a member of the Mechanical Engineering Department and the School of Biomedical Engineering and Sciences at Virginia Tech, the CIB offers an excellent opportunity for graduate student education through a wide variety of biomechanics courses and research experience. In addition, the CIB features numerous collaborative projects with the Wake Forest University School of Medicine and the Edward Via School of Osteopathic Medicine.

New Projects

New Eye for Blast Injury

In combat, the rate of eye injuries has dramatically increased during the past 90 years from approximately 2 percent during World War I and World War II to nearly 13 percent during Operation Desert Storm. One reason for the increase in eye injuries in modern day military conflicts is a lack of modernization of protective goggles and face shields to keep up with advances in weaponry. Therefore, the purpose of this project is to develop a new FOCUS eye that can provide design engineers a tool to create and evaluate eye goggles. In order to develop a FOCUS eye with more sensitivity to a range of loading conditions, this proposed research plan will create a new fluid-filled synthetic eye to replace the current solid eye. Specifically, this project will satisfy two key objectives: 1) Develop a biofidelity fluid-filled eye for the FOCUS headform that can predict eye injury risk for a range of blunt impact scenarios; and 2) Validate the fluid-filled FOCUS eye for blast loading conditions with corresponding injury criteria.

Lateral Facial Fractures

Because of the protective characteristics of the facial bones, the reduction in structural failures of the facial bones is of extreme importance and can lead to a reduction in injuries to both the brain and the eye. Based on the types of injuries sustained in military situations, countermeasures such as helmets, goggles and facemasks can be designed to effectively distribute loads to reduce the incidence of injuries. In order to design the protective equipment, the local injury thresholds for the facial bones must be developed. A useful tool to measure the effectiveness of the current countermeasures is the FOCUS headform, but injury criteria are needed to correlate injury risk from lateral impact to the measured response of the advanced headform. Facial fracture experimental impact testing is needed to better characterize facial fracture injury risk. Therefore, the purpose of this study is to perform tests with post-mortem human subjects (PMHSs) to determine facial fracture injury risk functions for lateral impacts to the zygoma, mandible and nasal bones for the 50th percentile male.

Head and Thoracic Injury

In the automotive safety field, finite element (FE) models are commonly used to predict and ultimately mitigate injuries to human occupants. However, there currently are limited data that can be used to validate the kinematics and inertial response of internal organs due to applied loading. Therefore, the injury pattern of restrained occupants will be reconstructed on PMHSs under controlled loading conditions using impact tests that simulate injury mechanisms seen in field accidents. The project has two goals: 1) Simulate field accident internal organ injury mechanisms through local impact testing; and 2) Quantify the three-dimensional (3D) motion of internal organs due to isolated thoracic impacts. In order to accomplish these goals, radiopaque markers will be implanted in various thoracic structures. A high-speed, biplane x-ray system will be used to visualize the motion of the markers.

Roadside Data

Each year more than 10,000 motorists are fatally injured in road departure crashes in the United States. The reasons why road departure crashes often lead to fatality or injury, despite the installation of thousands of miles of advanced countermeasures, are complex and not completely understood. This study will conduct in-depth investigations of 1,000 road departure crashes at 24 sites across the United States. The study promises to provide fundamental new insights into the crash conditions associated with road departures (e.g., impact speed, impact angles, vehicle road departure orientations, encroachment frequencies, and roadside topography) to reduce the severity and frequency of roadside crashes. The study will couple these crash causation factors with complete injury information for each of the crash victims to identify the influence of infrastructure design on injury outcomes.

Automated Collision Notification

The Center for Disease Control (CDC) has recommended that triage decisions in vehicle crashes should take advantage of electronic data collected in a crash. This has become particularly important as automated collision notification systems. Event Data Recorders (EDRs) provide a unique source of electronic data about the crash which can assist in improved triage decisions when data are transmitted through automated collision notification systems. In the event of a crash, EDRs in current production passenger vehicles store data elements that

describe the vehicle and occupant restraint response to impact. These EDR data elements can be used to dramatically improve the prediction of impact injury incidence and severity for field triage decisions. This research program will use EDR data to investigate the feasibility of using EDR data to improve algorithms for field triage decisions.

Ongoing Projects

Motorcycle Barrier Crashes

The goal of the proposed research program is to determine the characteristics of serious injury and fatal motorcycle crashes into traffic barriers through in-depth accident investigations. The long-term goal is to recommend injury mitigating strategies for motorcyclists that continue to protect passenger vehicle occupants. The scope of the research program will include collisions with all forms of traffic barriers, including guardrail barriers, concrete barriers, bridge rails, crash cushions, and end terminals.

Review and Programming Update of the WinSmash Crash Reconstruction Program

This research program is developing engineering enhancements to the WinSmash Crash Reconstruction Program used by the National Highway Traffic Safety Administration (NHTSA) in the National Automotive Sampling System (NASS), the Crash Injury Research Engineering Network (CIREN), and Special Crash Investigations (SCI). The research program has recently released updates to the integrated and standalone versions of WinSmash as WinSmash 2008.

The project rewrote the code in C#, implemented the vehicle specific stiffness database and stiffness selection procedure, validated the vehicle-specific stiffness algorithm, provided continuing programming support for WinSmash, and updated the vehicle stiffness library. Enhancements have been made to the damage-only calculation, missing vehicle calculation, collision deformation classification-only calculations, and the vehicle trajectory calculations.

Military Biomechanics

The U.S. military is faced with a number of significant biomechanical questions for the nearly three million active duty and reserve personnel who fight in this nation's conflicts. Injuries to the head, neck, and chest can be seriously debilitating or fatal and will dramatically reduce the combat effectiveness of the American soldier. This project establishes a cooperative agreement between VTTI (Virginia Tech – Wake Forest, CIB) and the U.S. Army for the purpose of reducing the incidence of head, neck, and chest injuries in military personnel. This project presents a three-phase plan that utilizes analyses from published case data, experiments using dummy surrogates, and computational human body modeling to enhance head, neck, and chest protection for soldiers.

Each phase incorporates sub-tasks for all three anatomical regions. Within Phase 1, the primary goal of Task 1 is to analyze head injury biomechanics to aid in head protection design. Task 2 focuses on improving neck protection through an analysis of current models and human head-supported mass testing to develop head-supported mass criteria. Chest protection is the goal of Task 3, which will utilize thorax injury models to evaluate advanced restraints. The primary deliverables of the full research program will be countermeasure design analysis for head protection, head-supported mass criteria for neck protection, and advanced injury criteria and restraint evaluation for chest protection.

Evaluation of Implementation Readiness of Biofidelic Abdominal Insert for the Hybrid III Six-Year-Old Dummy

A new abdominal insert has been implemented for the Hybrid III six-year-old dummy. This was an extension of recent work to improve the design and performance of the original 50th percentile male abdominal insert, which was developed by Rouhana et al (2001). This work developed a viable instrumentation approach for the measurement of abdominal penetration. The performance of the six-year-old abdomen requires refinement. This involves comparing the mechanical response of the current insert design to scaled response data for the Hybrid III 50th percentile abdominal insert and the human cadaver for rigid-bar and seatbelt loading and comparing the response to porcine data reported by Kent et al (2006) for seatbelt loading. Further, the geometry of the current six-year-old insert was compared to the seated child anthropometry data of Arbogast (2006) and subsequently modified. A revised pelvis is being developed by the University of Michigan Transportation Research Institute (UMTRI).

Adjustments to the insert design were made accordingly, and two to three new versions were produced. An instrumentation system was implemented. Additional seatbelt and rigid-bar testing will be conducted. HyGe-style sled testing will also be included. General kinematics as well as abdominal and thoracic penetration will be measured to observe the influence of the insert on dummy motion, chest compression, and belt loading, as well as the response of the revised insert. Multiple copies of the final versions will be fabricated and made ready for round robin testing. Similar improvements will be made to the 50th percentile insert and measurement system, and similar tests will be performed. The new abdomen and pelvis for the six-year-old crash dummy will provide better biofidelity and will be able to assess the potential for submarining for child occupants restrained in booster seats.

New Jersey Graduated Driver's License (GDL)

Teen crash fatalities occur for a number of reasons, from driver inexperience to a lack of proper training to a propensity for excessive risk taking among some teens. These tragic events continue to occur at the rate of approximately 100 deaths per year in New Jersey despite the implementation of graduated driver's licensing in the state in 2001. The goal of this research program is to develop a comprehensive teen driver monitoring method and program for New Jersey that utilizes current and future data sources. This system will be used to determine the effectiveness of New Jersey's Graduated Driver's License (GDL) law in reducing motor vehicle crashes, injuries, fatalities, and property damage for novice drivers who are typically 16 to 25 years of age. The resulting system will be designed to allow evaluation of the current New Jersey GDL law and proposed enhancements to the law.

Specifically, this research program will: 1) Develop a comprehensive teen driver monitoring method and program for New Jersey that utilizes current and future data sources; 2) Evaluate crash data to determine if teen driver crashes and fatalities in New Jersey have significantly declined since enactment of a GDL law in 2001; 3) Conduct a study that compares the driving experience of teens who had 50 hours of practice driving coupled with formal driver training versus those who had 100 hours of practice driving without formal driver training in terms of future crash involvement, traffic violations, and other factors; 4) Conduct a study that compares the driving experience of teens who held their driving permit for six months versus those who held their permit for 12 months in terms of future crash involvement, traffic violations, and other factors; 5) Evaluate the effectiveness of the September 2008 directive banning plea bargains for drivers with a GDL; and 6) Develop a detailed plan for a pilot study of in-vehicle observation of teen driving behavior.

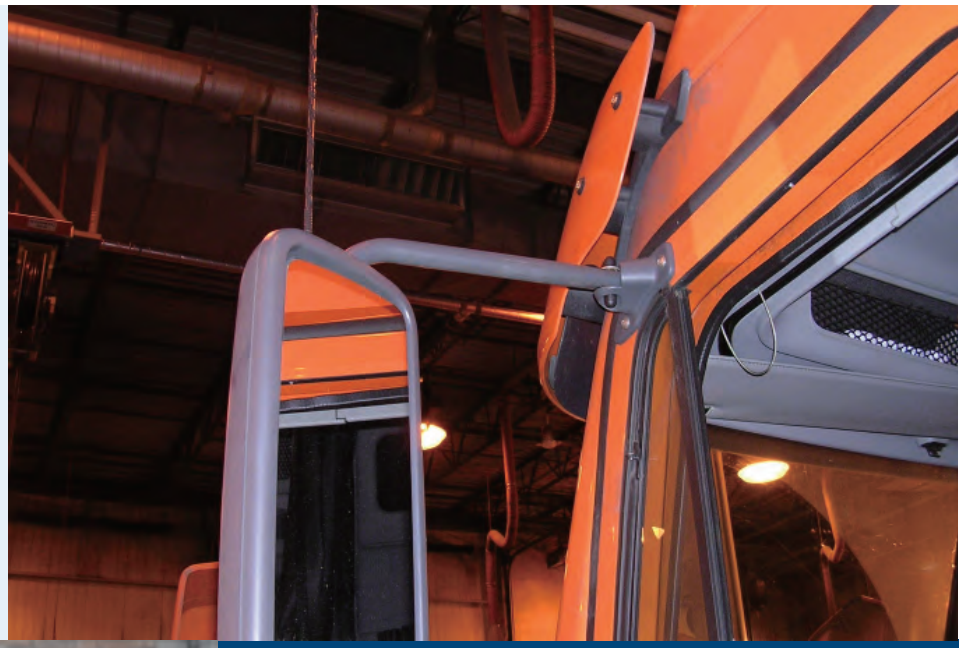
Human Abdomen Model Center of Expertise

This research is being conducted for the Global Human Body Models Consortium (GHBMC). This is a multi-year, multimillion dollar project coordinated by the GHBMC, which is a consortium of the world's largest automobile manufacturers and suppliers. The effort is designed to develop and validate the most advanced FE models of the human body. Regional models are separated for development into five centers of expertise with the full-body center performing integration of the regions. The models will be highly anatomically detailed and will possess the most accurate tissue representations possible, particularly in terms of mechanical response and failure characteristics. The models are being designed to predict relevant crash-induced injuries. Individuals are being modeled to cover the maximum range of normal sizes in the world population. A fifth and 50th percentile female and a 50th and 95th percentile male model are being developed. Scalable models will be developed to represent other shapes and sizes. Subsequent models will represent children and the elderly.

The CIB is participating in the GHBMC effort as the Abdomen Model Center of Expertise. The CIB is collaborating with Dr. Philippe Beillas of the French National Institute for Transport and Safety Research (INRETS) in Lyon-Bron and Dr. Philippe Vezin, the head of the Laboratory of Biomechanics and Impact Mechanics (LBMC). The research approach involves empirical and numerical components at multiple scales. For the development of an improved FE tool for the evaluation of local abdominal injury, material properties, tolerance of tissues and systems, and the local structural responses during impact are needed and will be obtained throughout the course of this project. The CIB is conducting the majority of the empirical work, and INRETS is conducting the majority of the numerical work for the abdomen Center of Expertise.

Center for Truck and Bus Safety

The Center for Truck and Bus Safety (CTBS) conducts research and development efforts to advance the state of knowledge in the truck and bus safety domain and provides pragmatic solutions to real-world problems.



The Center for Truck and Bus Safety (CTBS) specializes in providing high quality education and research focusing on a variety of safety issues involving heavy truck and bus operations.

Recent projects have been directed at driver and vehicle safety regulations, including the Hours-of-Service Regulations for Commercial Vehicle Drivers and the Federal Motor Vehicle Safety Standards (FMVSS). The center also strives to provide practical recommendations and guidelines based on the results of its studies that can be used by government and industry to improve safety.

New Projects

Consolidated Security Credentials for Persons Who Transport Hazardous Materials

This study, awarded by the Transportation Research Board (TRB), began in February 2010. The study centers on workers in the hazardous materials (HM) transportation sector who face multiple security credentialing requirements. In some cases these workers also have to undergo government-mandated, pre-employment security threat assessments for each credential. This study seeks to identify the burden of HM transportation workers with regards to security credentialing. This study will also evaluate the feasibility of consolidating credentials to lessen the burden and reduce or eliminate redundancies.

Distraction in Commercial Trucks and Buses: Assessing Prevalence and Risk in Conjunction with Crashes and Near-Crashes

The purpose of this Federal Motor Carrier Safety Administration (FMCSA)-funded research is to conduct an analysis of naturalistic data collected by DriveCam during a consecutive one-year period. Commercial trucks (three-axle and tractor trailer/tanker) and buses (transit and motor coaches) are the target vehicles in the analyses. These data will provide the FMCSA with descriptive data about the adverse consequences of cell phone use and other distractions while driving a commercial truck or bus. DriveCam re-reviewed all cell phone safety-critical events from 90 days (i.e., June 6, 2009, to September 5, 2009) to determine the frequency of the following cell phone sub-tasks: dial cell phone, reach for cell phone, reach for Bluetooth/headset/earpiece, talk/listen on hands-free cell phone, talk/listen on handheld cell phone, and text/email/surf web on cell phone. The results of these analyses provide information about the scope of cell phone use and other distractions during safety-critical events (including crashes, near-crashes, and crash-relevant conflicts) in two data sets during a one-year period (first 275 days data set and last 90 days data set).

Onboard Monitoring System (OBMS) Field Operational Test (FOT)

This project was awarded by the FMCSA. The objective of this project is to determine whether an onboard monitoring system (OBMS) will reduce at-risk behavior among commercial drivers and improve driver safety performance. Specifically, the project will determine if recording and reporting of safety-critical events followed by coaching the driver (by safety managers) using these safety events as feedback will enhance safe driving behavior. This system will also contain an electronic onboard recorder (EOBR) that will be evaluated.

Operator monitoring and feedback can be characterized as a behavior-based safety method. Safe behavior is rewarded and unsafe behavior is coached, thereby proactively improving overall safety. The OBMS to be used in this study will record (through snippets of video and other performance/kinematic measures) unsafe driving behaviors and provide real-time feedback to drivers. Recorded driver problems (e.g., hard braking) will then be transmitted to and reviewed by the driver's fleet safety manager. Depending on the judgment of the fleet safety manager, the recorded incident can then be shown to the driver in a coaching session with the goal of pinpointing the problematic behavior and providing instruction about how to avoid that problem in the future. Corrected action and improved behavior are expected as results of drivers viewing their recorded errors alongside their safety manager and instructed as to the nature of the problematic behavior.

Conceptually, the prospect of improving driver behavior and reducing safety-critical events fits well within the FMCSA mission. Hypothetically, successful implementation of the OBMS program may significantly reduce the number and severity of crashes involving commercial motor vehicles (CMVs).

Motor Carrier Practices Phase II

This project, awarded by the FMCSA, is a subaward conducted by the Washington State University Sleep and Performance Research Center.

Phase 1 studied the effectiveness of the current 34-hour restart provision that was evaluated using a best case/worst case design. The objective of Phase II is to determine whether a restart period involving the time of sleep for two biological nights would be more effective in restoring performance in individuals working nights under the hours of service (HOS) regulations governing property-carrying CMV drivers than the current 34-hour restart provision. The study will also focus on nocturnal duty periods, and a restart period of 58 hours will be added to the best case/worst case in-laboratory experimental study that was conducted in Phase I.

Development of Performance Requirements for Commercial Vehicle Safety Applications

This seven-month project was awarded in May 2010 and is funded by the National Highway Traffic Safety Administration (NHTSA). The NHTSA, FMCSA, Federal Highway Administration (FHWA), and Research and Innovative Technology Administration (RITA) have a great interest in accelerating the widespread vehicle-to-vehicle (V2V)-equipped commercial vehicles (e.g., trucks, buses, transit). The widespread deployment of V2V safety is dependent on understanding the effectiveness of safety applications. The objective of this task is to determine the performance requirements for potential V2V safety applications that are appropriate for heavy commercial vehicles. To accomplish this objective the research team will: 1) Review the literature currently available for heavy commercial vehicles covering collision avoidance systems; 2) Interview representatives from the heavy vehicle manufacturers, suppliers, and fleet operators to determine suitable crash avoidance technologies for the V2V communication; and 3) Identify and develop performance requirements for the selected applications.

Pulsar's Data

This project was funded by the FMCSA and began in June 2010. The purpose of the project is for VTTI to provide de-identified data such as actigraphy data and safety-critical event data collected during the Naturalistic Truck Driving Study (NTDS) to Pulsar Informatics, Inc., for use in one of its projects.

Work Hours HOS

This study, awarded by the FMCSA, began in June 2010. The purpose of this task is to provide support for the FMCSA development of a new HOS rule for the CMV industry. This task will provide a literature review of research that has been conducted about driver fatigue and health and a peer review of four documents. This task also includes analyses using the VTTI NTDS. This analysis will focus on the following three research areas: 1) Safety-critical events as a function of driving hour, 2) Safety-critical events as a function of work hour (both driving and non-driving), and 3) Safety-critical events as a function of both driving hour and work hour.

Ongoing Projects

Speed Limiter

This study, awarded by the FMCSA, began in February 2009. A number of motor carrier research studies have shown that the use of speed limiters in commercial vehicle operations may improve safety. The FMCSA has determined that it is important to go beyond these studies and a soon-to-be-published synthesis study of the safety impacts of speed limiters to provide

a better understanding of speed limiter implementation effects, both from safety (reduction in crash numbers and severity) and economic (increased fuel economy and reduced maintenance) points of view. Quantitative and qualitative data will be collected to evaluate the impacts of speed limiters.

SimVal II

The Simulator Validation (SimVal) study will test the effectiveness of a driver training simulator for purposes of commercial (large-truck) driver training and testing. The scope of the training under consideration will include basic vehicle operation, safe operating practices, and advanced capabilities (e.g., extreme driving conditions, emergency maneuvering). The study will also assess the potential applicability of simulators to commercial driver's licensing and the overall value of formal training for commercial drivers. This project is being performed in support of the commercial driver safety program of the FMCSA.

Phase I of the project was performed by VTTI in collaboration with the Commercial Driving Program of the Delaware Technical and Community College (DTCC). FAAC Incorporated was selected as the simulator vendor. Phase I developed all instructional and testing units required for the full-scale SimVal experiment, which will be conducted under a separate contract. Some of these instructional and testing units include simulator driving scenarios and a simulator commercial driver's license (CDL) course that are representative of the driving routes used by the driving program at the DTCC. All scenarios were designed and pilot tested to meet the needs of the driving school. Phase I was completed on September 30, 2005. Phase II, which is the empirical study, is currently underway.

Motorcoach Fatigue

This project, awarded by the FMCSA, is a subaward being conducted by the Washington State University Sleep and Performance Research Center. This study will focus on the current HOS regulations for motorcoach drivers. The regulations were implemented long before there was clear scientific understanding of fatigue causal factors, e.g. time of day, amount and timing of sleep, time awake, and time on task that includes extended work days. Field studies of motorcoach driver fatigue, sleep, and performance will be conducted using 50 drivers in a real-world driving environment, examining 25 on a fixed route and 25 demand responsive services.

Objective measures of sleep (actigraph) and performance (Palm Pilot Psychomotor Vigilance Test) will be used to test the factors that are causing increased fatigue and impaired performance affecting drivers and general public safety and well being. The data collected during this and other research endeavors will help guide scheduling practices in the motorcoach industry.

Split Sleep

This project, awarded by the FMCSA, is a subaward being conducted by the Washington State University Sleep and Performance Research Center. The study will focus on investigating and providing direction about the effects of various split sleep/driving schedules on driver health and safe driving performance. The study will take into account the primary schedule characteristics (e.g., time of day, split schedules, structure of principle driving and sleep periods, and individual driver differences).

A laboratory study will be conducted with a two-by-two design of the effects of consolidated/split

and normal/restricted sleep performance and acute health outcomes that, over time, lead to chronic illness. The data collected and conclusions drawn will inform the optimum use and effective regulation of sleeper berth use in commercial trucking operations and will take into consideration performance and health.

Indirect Visibility System (IVS)

The NHTSA and FMCSA are collaboratively funding Task Order #23, "Field Demonstration of an Advanced Heavy Vehicle Indirect Visibility System (IVS)." The purpose of this project is to evaluate whether the concept of providing drivers with enhanced vision information results in improved situational awareness and leads to a reduction in safety-critical events caused by poor visibility (e.g., vehicles in blind spots, vehicles obscured by poor weather conditions, and vehicles obscured by poor lighting). A commercially available camera/video imaging system (C/VIS) and an advanced C/VIS that meets the performance specifications developed by previous VTTI research are currently being installed on trucks that operate in a revenue-producing environment. Drivers' involvement in safety-critical events, as well as their lane-change behaviors, will be measured during the course of four months each. The safety benefits these C/VISs stand to offer will be assessed by investigating whether drivers' safety-critical event involvement and lane-change behaviors improve when a C/VIS is available compared to when it is deactivated. This project has a $2.4 million budget and will be completed by February 2011. This research is expected to assist the NHTSA and FMCSA in policy development.

Large Truck Crash Causation Study (LTCCS)

This study, funded by the FMCSA, began in September 2008. This project will analyze large-truck crash investigation data from the Large Truck Crash Causation Study (LTCCS), two large-truck naturalistic driving (ND) data sets (the Drowsy Driver Warning System Field Operational Test [DDWS FOT] and the NTDS) and the General Estimates System (GES). This project shall include a generalized comparative analysis of the four data sets (i.e., LTCCS, GES, NTDS, and DDWS FOT) and will then focus on four specific analyses using only three data sets (LTCCS, NTDS, and DDWS FOT): 1) One selected crash/incident type; 2) Two selected contributing factors and 3) One selected environmental condition of occurrence; and 4) One complex, multi-element event scenario. Each analysis will involve unique comparisons, and each should serve as a prototype for other analyses of similar nature within that dimension:

- Generalized comparative analysis of LTCCS, GES, NTDS, and DDWS FOT
- Event type:
  - » Rear-end, truck striking
- Contributing factors:
  - » Truck driver fatigue
  - » Truck driver excessive speed
- Condition of occurrence:
  - » High-traffic density
- Complex scenario "crash trifecta":
  - » Pre-event speeding, tailgating, or other unsafe behavior
  - » Transient driver inattention
  - » Unexpected traffic event

HOS and Driver Fatigue – Driver Characteristics Research

This project, awarded by the FMCSA, is a subaward being conducted by Penn State University. The study will focus on updating the previous study, the LTCCS, using a larger and more diverse sample of crashes. While the LTCCS investigated a large number of serious truck crashes, this research effort will focus on evaluating a large number of crashes from a specific set of carriers. Crash and non-crash events will be compared and will provide more detailed demographics and workforce variables primarily related to driver HOS. The study will provide a more sophisticated, reliable model of the effects on crashes of various operational measures (hours driving, hours of rest, multi-day driving pattern) and workforce/demographic measures (age, experience with the firm). The

combination of the two research projects should provide the FMCSA with a detailed understanding of the various physical and human contributors to large-truck crashes.

Truck Rear Signaling

This project, awarded by the FMCSA, began in September 2008. The enhanced rear signaling (ERS) for the heavy trucks project is directed at investigating methods of reducing or mitigating those crashes where a heavy truck has been struck in the rear by another vehicle. These crashes occur with such sufficient frequency that they are a cause of concern within regulatory agencies. As part of FMCSA's goal of reducing the overall number of truck crashes, this crash configuration is one that is important to the agency. This particular collision type results in higher than usual rates of fatalities and injuries compared to types of rear-end accidents in which the lead vehicle is a light vehicle. There were approximately 15,000 rear-end crashes involving heavy trucks per year from 1997 to 2001, which resulted in an average of 150 fatalities and 1,200 incapacitating injuries per year.

Thus far, two phases of work have been completed on this project. Phase 1 entailed crash data analysis performed by General Dynamics to determine causal factors of these crashes and the development or identification of countermeasures to aid in reducing them. Phase II entailed the development of a prototype system by Freese Enterprises, Inc., that included the countermeasures from Phase I. Each element of the prototype was evaluated by a jury and by limited field testing (approximately 100 hours on the road). In Phase II, it was found that there appear to be potential benefits of using these countermeasures.

The next step, Phase III, focuses closely on exploring the benefits of the countermeasures developed in Phases I and II. Phase III also focuses on the development of a plan for a large-scale FOT. Because there were multiple countermeasures developed in Phases I and II, a plan has been developed to assess the value of multiple countermeasures individually and in combination with one another. In addition, Phase III will utilize what has been learned in the rear-end crash avoidance work on light vehicles that is being conducted by the NHTSA with VTTI serving as the primary research organization.

Nurse Tank

This project, awarded by the FMCSA, is a subaward being conducted by Iowa State University. Nationally, it is estimated that there are approximately 200,000 cargo tanks used in the agricultural industry. These tanks are commonly referred to as "nurse tanks." Because they are not required to be removed from service at a given age, many nurse tanks that have received no effective safety inspections for several decades likely remain in use on farms and at filling facilities. The purpose of this research is to determine the service life limitations of nurse tanks that are used for transporting/applying anhydrous ammonia and to make recommendations as to the periodic testing and maintenance of these types of cargo tanks.

Onboard Safety Systems (OBSS)

This project, awarded by the FMCSA, began in April 2009. Working with the truck industry, the FMCSA envisions a future of smart technologies that support the expanding role of the trucking industry to safely, securely, and efficiently transport the nation's goods and products. One way to save lives and reduce the number of injuries on the nation's highways is through the expanded use of onboard safety systems (OBSS)

such as: 1) Lane departure warning (LDW) systems; 2) Electronic stability control (ESC) systems; and 3) Forward collision warning (FCW) systems. Information from motor carriers about the effectiveness of these systems in improving safety will be valuable in advancing further use in the trucking industry. The purpose of this FMCSA-funded project is to conduct an OBSS effectiveness evaluation of these three technologies through the use of data collected directly from motor carriers.

Motorcoach Distraction

This 12-month project was awarded in February 2009 and is funded by the FMCSA. The objectives of this task order are twofold. The first is to synthesize findings relating to cell phone use in automobiles and any research findings and conclusions relating to commercial vehicle operations. Second, the project will identify current practices of truck and bus fleet managers to assess the impact of these practices, including limitations on the use of personal digital assistants (PDAs), on overall driving safety. Consideration will be given to the applicability of findings that relate to car drivers and truck and bus driving environments, as well as to the rationale and driving factors that have led fleet managers to restrict or manage cell phone and/or PDA use.

The goal of this project is to accelerate efforts to provide a foundational body of knowledge of the risks of the use of cell phones and PDAs in commercial truck and bus operations. This knowledge base is critical for consideration of potential regulations relating to restriction or limitation of the use of these devices and related accessories. Such regulations would have the objective of enhancing and promoting safe operations and protecting passengers and all highway users.

Completed Projects

Low-Cost Driving Behavior Management System (DBMS)

The FMCSA funded this project to provide an independent evaluation of a commercially available low-cost DBMS. Participating drivers drove an instrumented vehicle for 17 consecutive weeks while they made their normal, revenue-producing deliveries. During the four-week baseline phase, the event recorder documented safety-related events; however, the feedback light on the event recorder was disabled, and safety managers did not have access to the recorded safety-related events to provide feedback to drivers. During the 13-week intervention phase, the feedback light on the event recorder was activated, and safety managers had access to the recorded safety-related events and followed the coaching protocol with drivers when necessary. Carrier A significantly reduced the mean rate of recorded safety-related events/10,000 miles from baseline to intervention by 37 percent ($p = 0.046$), while Carrier B significantly reduced the mean rate of recorded safety-related events/10,000 miles from baseline to intervention by 52.2 percent ($p= 0.03$). The results suggest that the combination of onboard safety monitoring and behavioral coaching were responsible for the reduction in the mean rate of safety-related events/10,000 miles at Carriers A and B.

Commercial Vehicle Operations Distraction Analysis

This 21-month project, funded by the FMCSA, began in July 2007. This analysis project used data from two recently completed large-scale naturalistic data collection studies, the DDWS FOT study and the NTDS. The purpose of this study was to analyze drowsy-related and distraction-related safety-critical events (i.e., crashes and near-crashes) collected during the DDWS FOT and NTDS, in addition to 20,000 baseline events (i.e., normal driving). Each safety-critical event and baseline event was analyzed for driver eye position prior to the event to determine the presence of driver inattention.

The analysis conducted on this data followed that of the 100-Car Study, which investigated the types and frequencies of distractions in which drivers engage, environmental conditions associated with these distractions, and the

effects of eyes-off-forward-roadway on driving performance.

Motor Carrier Practices

This project, awarded by the FMCSA, was a subaward conducted by the Washington State University Sleep and Performance Research Center. The current FMCSA HOS regulations for property-carrying CMV drivers stipulate that drivers may drive 11 hours and be on duty 14 hours after 10 consecutive hours off duty, may not drive after 60/70 hours on duty in 7/8 consecutive days, and may restart a 7/8 consecutive day period after taking 34 or more consecutive hours off duty (the 34-hour restart rule). The purpose of this study was to determine the effectiveness of the current 34-hour restart provision in the HOS regulations governing property-carrying CMV drivers in restoring performance and to evaluate alternative restart durations. This was accomplished by conducting a two-phase, in-laboratory experimental approach. Phase 1 studied the effectiveness of the current 34-hour restart provision evaluated using a best case/worst case design. Phase II will study more effective alternatives to the current 34-hour restart provision.

Aspheric Synthesis

This project, awarded by the NHTSA, began in April 2009. The aspheric mirror synthesis study summarized the past 30 years of light-vehicle, non-planar mirror research. Non-planar mirrors such as convex and aspheric mirrors have the potential to increase roadway safety by reducing the blind spots around automobiles. However, there are remaining questions regarding driver distance and speed estimation performance using non-planar mirrors. Specific issues relevant to non-planar mirror use include mirror frame size/shape, distance/motion estimation biases, radius of curvature effects, fields of view, and safety tradeoffs related to mirror combinations/configurations. This project summarized findings of research relevant to these issues, determined if the results of prior research have been consistent enough for the NHTSA to draw conclusions about whether or not to allow ECE-compliant (United Nations Economic Commission for Europe, a standards body) non-planar mirrors, and identified areas of additional needed research.

Peer Review/Scientific Information

This project, awarded by the FMCSA, began in June 2009. The FMCSA has developed an initiative identified as the Comprehensive Safety Analysis 2010 (CSA 2010) as part of its ongoing effort to improve safety in the motor carrier industry. A peer review was conducted for the following six scientific documents: "Safety Measurement System (SMS) Methodology" (April 2009), "Incorporating the Carrier Safety Measurement System Results into the Proposed Safety Fitness Determination Process" (November 2007), "Carrier Safety Measurement System (CSMS) Violation Severity Weights" (June 2008), "Critical Reason Special Study" (May 2009), "FMCSA Safety Program Effectiveness Measurement: Compliance Review Effectiveness Model, Results for Carriers with Compliance Reviews in Fiscal Year 2005" (April 2008), and "Moving Freight with Better Trucks: Improving Safety, Productivity and Sustainability" (May 2009). The focus was on exploring the compliance review program the FMCSA currently has in place and providing the FMCSA with insight into its current safety programs and effectiveness in the industry.

Center for Sustainable Mobility

The goal of the Center for Sustainable Mobility (CSM) is to establish a center that is recognized nationally and internationally for its research in the area of sustainable transportation planning with emphasis on mobility, efficiency, environmental, and safety impacts of transportation infrastructure.

The Center for Sustainable Mobility (CSM) has been awarded projects from the Federal Highway Administration (FHWA), the Second Strategic Highway Research Program (SHRP 2), and the National Highway Traffic Safety Administration (NHTSA).

New Projects

Data Mining and Gap Analysis for Weather Responsive Traffic Management Program

During the past several years, the Federal Highway Administration (FHWA) Road Weather Management Program (RWMP) has conducted a series of studies to gain a better understanding of travelers' behaviors and responses to inclement weather conditions. The FHWA envisions that effective weather responsive traffic management (WRTM) strategies will be developed and implemented based on findings and recommendations generated from the efforts of the last several years. An important lesson learned from WRTM studies conducted so far is lack of relevant and sufficient traffic and weather data available for the analysis. Efforts were devoted at the onset of previous WRTM studies to identify and obtain suitable data but yielded limited results. Hence, this project examines the issues related to "traffic and inclement weather data." Four objectives have been identified for this project: 1) Conduct a comprehensive search and documentation of traffic and weather data in the U.S. and abroad that could be used for WRTM; 2) Establish contacts with organizations that have suitable traffic data about inclement weather and determine the procedures/requirements to obtain these data; 3) Identify critical gaps in regard to the collection and processing of traffic data about inclement weather conditions; and 4) Recommend strategies and generate guidelines for gathering and processing data that will be used in WRTM studies.

Developing Eco-Routing Strategies

Dynamic traffic routing is defined as the process of dynamically selecting the sequence of roadway segments from a trip origin to a trip destination. Dynamic routing typically entails using time-dependent roadway travel times to compute this sequence of roadway segments. As with the general case of modeling human behavior, modeling driver travel behavior has always been complicated, never accurate enough, and in constant demand for further research. Among the early attempts to model human choice behavior is the economic theory of the "economic man" who in the course of being economic is also "rational" (Simon 1955). According to Simon's exact words, "actual human rationality-striving can at best be an extremely crude and simplified approximation to the kind of global rationality that is implied, for example, by game-theoretical models."

This project sponsored by NAVTEQ combines energy and emission models with navigation programs. The idea is to help consumers make "greener" choices about their routes. For example, an earlier study by the principal investigator found that choosing an artery-based route that takes about five minutes longer than a highway-

based route reduced fuel usage by 23 percent (it was shorter and had slower speeds). During the past year, that would have amounted to almost $300 in savings for a commuter. Adding real-time traffic information would help, too. For example, some research has found that mildly congested roads actually promote fuel efficiency since they slow drivers down and make for a more even flow. It is strange to think of willingly following a navigation program's directions to a more congested route but this could result in significant environmental savings. This task will investigate the potential of integrating energy and environmental measures within the traffic routing decision framework. The impact of this routing strategy on the network-wide efficiency (vehicle delay) will be quantified, and the potential for integrating system efficiency with environmental measures will be investigated. This task is divided into several subtasks, as follows: 1) Incorporate energy and emissions within current routing algorithms; 2) Investigate the impact of such routing strategies using sample networks assuming perfect knowledge of system performance; 3) Quantify the minimum number of probe vehicles required for successful implementation of the algorithms; and 4) Evaluate the routing strategies associated with different vehicle types.

Developing Eco-Driving Strategies

Numerous variables influence vehicle energy and emission rates. These variables can be classified into six broad categories, as follows: travel-related, weather-related, vehicle-related, roadway-related, traffic-related, and driver-related factors. In order to reduce fuel consumption and emissions, significant efforts are required to decrease the total trip distance and improve the vehicle technologies and road infrastructure. Several research efforts have studied the impact of aggressive driving on fuel consumption and emission rates (Nam, Gierczak et al. 2003; Nesamani and Subramanian 2006; Tzirakis, Pitsas et al. 2006). One study from Sierra Research found that aggressive driving is responsible for 15 and 14 times higher CO and HC emissions for the same trip (NRC 1995). This project is sponsored by the Mid-Atlantic Universities Transportation Center (MAUTC).

Develop Wet Surface Traffic Signal Timing Change Intervals

The study sponsored by the Virginia Department of Transportation (VDOT) will attempt to address the following objectives: 1) Determine the percentage of drivers who run the yellow light as a function of their time-to-intersection (TTI), their speed, gender, and age as a function of the roadway surface and weather conditions; 2) Address the issue of whether the dilemma zone is determined solely by the TTI or varies with vehicle speed, roadway surface condition, gender, and age of driver; 3) Compute the dilemma zone boundaries for implementation within dilemma zone control systems; 4) Design yellow and all-red timings for wet roadway conditions; and 5) Compare the inclement weather clearance times to clear condition clearance times to determine whether inclement weather timings should be implemented within traffic signal controllers.

Integrating Travel Time Reliability Measures within VDOT's Systems Operations Program

The objectives of this project sponsored by VDOT are: 1) Develop a novel multi-stage model for travel time reliability evaluation and reporting; 2) Construct a simulation test bed along a section of I-66 to investigate the impact of different factors on travel time reliability; 3) Construct a database of field loop detector and incident data for the same I-66 study section; 4) Develop a multi-stage model to quantify the impact of incidents on travel time reliability using the field and simulation test bed; and 5) Develop algorithms to use vehicle probe data to estimate dynamic roadway travel times.

Ongoing Projects

Region 3 University Transportation Center

The MAUTC has been the federally designated university transportation center (UTC) for Region 3 since the inception of the UTC Program in 1988. The CSM led the Virginia Tech team within a six-university consortium that also includes Penn State (lead university), University of Maryland, University of Virginia, and West Virginia University. The theme of the center is, "Technology for Integrated Transportation Systems Operation and Performance." The theme recognizes that, now and in the future, transportation needs to be envisioned as a set of mobility options that are fully integrated to ensure optimal system performance. For too long, transportation has been thought of as a series of modes with discrete missions, goals, customers, and problems. The nature of the obstacles that have to be faced and the complexity of the elements of the transportation system dictate that advanced technologies are to be used to formulate solutions. With innovative solutions in hand, the national strategic objectives of safety, mobility, global connectivity, environmental stewardship, and security can be dealt with effectively.

Microscopic Analysis of Traffic Flow in Inclement Weather

The CSM teamed with Cambridge Systematics, Inc., and won this FHWA-sponsored project. The project builds on previous work funded by the FHWA to help determine how weather events and associated road conditions affect driver behavior. The project will also help establish how different variables, including driver characteristics, roadway characteristics, and environmental factors influence the response to weather events. Three objectives are identified for the program: 1) Review and summarize existing research, data, and analytical procedures related to driver behavior on freeways and arterial roads during inclement weather; 2) Develop and implement for freeways and arterials a methodology designed to identify and model microscopic driver/roadway/vehicle parameters that are influenced by weather conditions; and 3) Recommend procedures for incorporating results of the study into existing traffic microsimulation models.

Feasibility of Using In-Vehicle Video Data to Explore How to Modify Driver Behavior that Causes Non-Recurring Congestion

The CSM teamed with the Science Applications International Corporation (SAIC) and won the Second Strategic Highway Research Program (SHRP 2) L10 project. The objective of this project is to determine the feasibility of using existing in-vehicle video to make inferences about driver behavior that would allow the investigation of the relationship of observable driver behavior to nonrecurring congestion in order to improve travel time reliability. The use of other data sources such as infrastructure-based video and traffic data will also be evaluated for the potential to identify ways to modify driver behavior to improve travel time reliability.

Center for Sustainable Mobility

Traffic Signal Control Enhancements under Vehicle Infrastructure Integration Systems

The CSM teamed with researchers at the University of Virginia to conduct a project designed to research and investigate the potential to utilize vehicle infrastructure integration (VII) data to characterize system operation, estimate system-wide measures of performance, and develop advanced signal timing procedures that can capitalize on VII data and enhance the operations of traffic signal system operations.

Hardware-in-the-Loop Evaluation of the Bendix ESP System for Tractor Semi-Trailer

The objective of this National Highway Traffic Safety Administration (NHTSA)-sponsored project is to evaluate the potential safety benefits of the Bendix ESP system for heavy trucks using hardware-in-the-loop (HIL) simulations. The evaluation will attempt to quantify safety benefits and provide relative safety performance between different pre-crash scenarios. The project will be limited to the application of the Bendix ESP in a predetermined five-axle tractor semi-trailer configuration. The approach used in the study will include HIL simulations using the real-time version of TruckSim (TruckSim RT). The TruckSim model will provide all necessary signals to the brake system hardware. Additional interfaces and signal conditioners will be required. Bendix will be providing support in developing the software/hardware interface.

Evaluation of Merits and Requirements of Next Generation Traffic Control Systems for Northern Regions Existing Infrastructure

The objective of this VDOT-sponsored project is to understand the limits of the existing VDOT traffic signal system under the growing traffic demands and needs and to determine when/if the existing traffic signal system should be replaced or re-used and retrofitted to a certain extent. The project initially attempts to address the challenges related to the northern region operation (NRO) systems and then apply the lessons learned to the rest of the state. The project will result in the development of functional requirements for traffic signal control and a clear understanding of the gap between these functional requirements and the existing traffic signal system capabilities.

CAREER: New Methods in Air Pollution and Education

The CSM is assisting Dr. Linsey C. Marr in Virginia Tech's Charles E. Via, Jr. Department of Civil and Environmental Engineering with a National Science Foundation (NSF)-sponsored project that will establish innovative methods to measure and quantify air pollutant emissions that endanger public health and drive global climate change. Specific objectives are to: 1) Design a mobile eddy covariance system for the measurement of air pollutant emissions; 2) Use the new mobile system to measure anthropogenic emissions in the field; 3) Link the measurements to specific sources by modeling air flow at the field sites; and 4) Relate

measured emission rates to demographic and land use characteristics.

Completed Projects

Signalized Intersection Red Light Running and Dilemma Zone Study

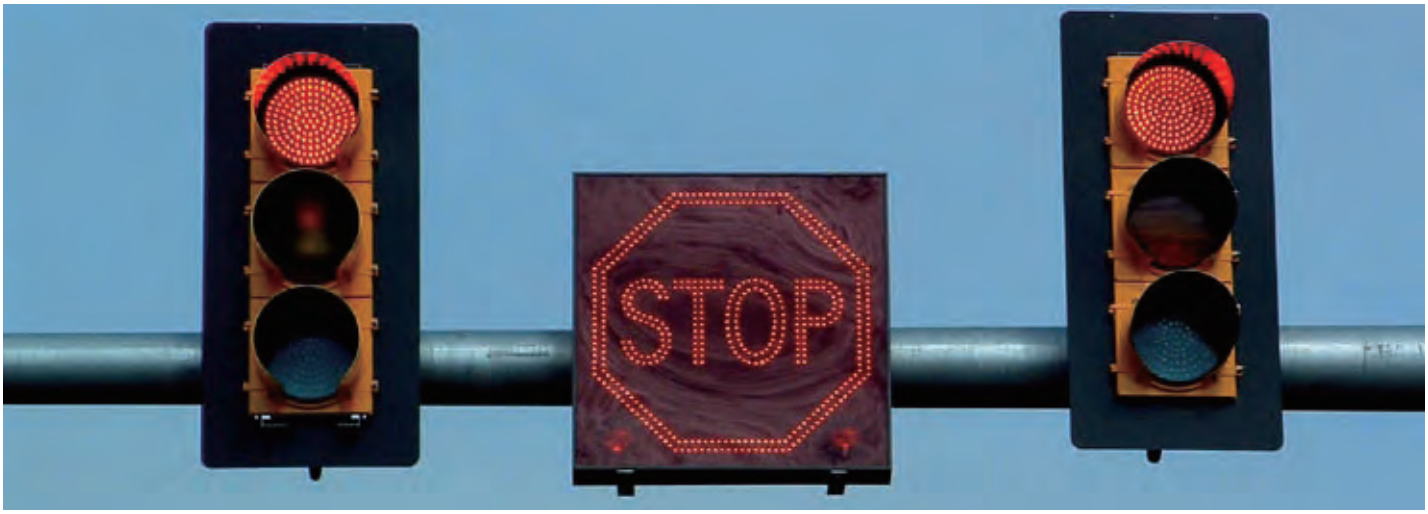
In a previous CSM study, a field data collection effort funded by the FHWA, MAUTC, and VDOT collected data about 60 subjects approaching a signalized intersection on the Smart Road. In the experiment, participants were instructed to drive the car at 72 km/h (45 mph) except in the turnarounds or when stopping at the intersection. Participants were instructed to behave normally when faced with a yellow light, making the decision whether to stop or to go as they usually would.

At the beginning of each trial run, the signal displayed a green light. As the car approached the intersection, the onboard computer decided whether or not to trigger the yellow and, if so, at what distance from the stop bar. The yellow duration was fixed at four seconds and was initiated when the front of the car was at various distances from the stop bar. Each participant faced phase changes from green to yellow four times for each TTI. These 24 trial conditions (20 yellow lights and four green lights) ran in a predetermined, randomized sequence, with a different order for each participant. This implied that the number of times a participant encountered a yellow light at a given TTI on a given grade (up or down) varied between one and three times.

In the previous study, no vehicles other than those driven by the participants were present on the Smart Road. Had the drivers in the previous studies been following other vehicles that ran the yellow light, they too might have proceeded. Furthermore, had there been vehicles following the subject drivers in the preceding studies, the drivers might have decided differently because of a perceived risk of a rear-end collision. This VDOT-sponsored research effort built on the previous study by accomplishing the following: 1) Studied the behavior of drivers while following another vehicle; 2) Studied the behavior of drivers when another vehicle followed them; and 3) Studied the behavior of drivers at different speeds.

An Investigative Analysis of the use of Road Topography Data to Enhance Truck Performance along Roadways

The goal of this NAVTEQ-funded research effort was to assess possible fuel and air quality savings associated with adaptive cruise control systems that make use of topographical information. The research effort was designed to develop vehicle engine models, develop gear shifting models that use topographical data as input, and validate the models against pilot field data. These models were tested using different truck engine and trailer characteristics. The approach combined engine modeling, gearshift optimization, and vehicle fuel consumption and emission modeling.

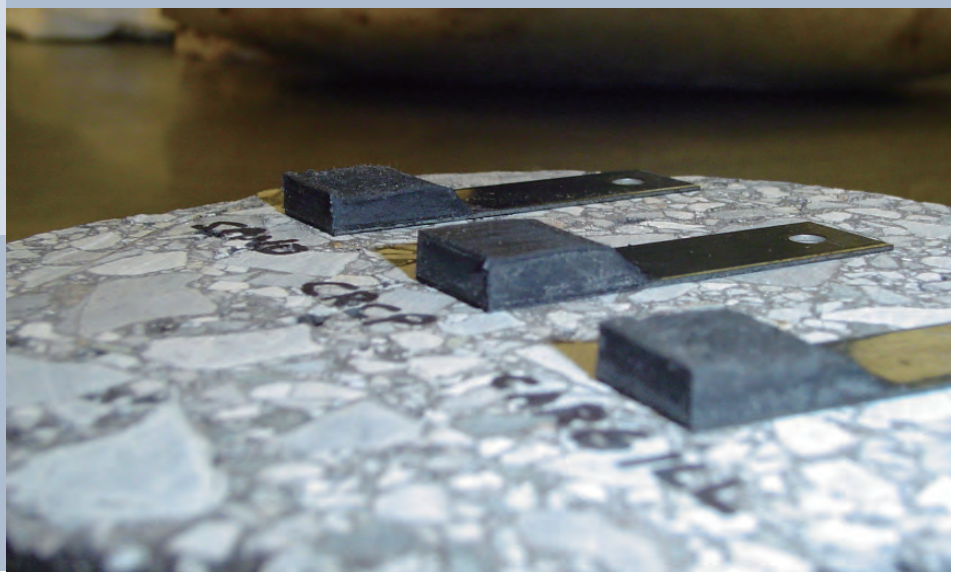


Center for Sustainable Transportation Infrastructure

The Center for Sustainable Transportation Infrastructure (CSTI) conducts innovative basic and applied research for enhancing the transportation infrastructure; is a paradigm of collaboration among governments, academia, and industries; and provides excellent resources and instruction for students to learn fundamental concepts, acquire advanced knowledge, and gain practical experience.

The CSTI has numerous projects in conjunction with multiple agencies: the Virginia Department of Transportation (VDOT), the Virginia Transportation Research Council (VTRC), the Federal Highway Administration (FHWA), and the National Academy of Sciences (NAS). The Center works in cooperation with Virginia Tech's Charles E. Via, Jr. Department of Civil and Environmental Engineering.

The Center for Sustainable Transportation Infrastructure (CSTI) focuses on the areas of asset management, road surface characterization, general pavement design and life cycle cost assessment.



New Projects

NSF Support for the International Sustainable Pavements Workshop

This grant provided funding for a workshop also sponsored by the Federal Highway Administration (FHWA) to discuss sustainability in asphalt pavements and to compare U.S. and European activities in this field. The workshop brought together the leading researchers in this field from the U.S. and Europe: 1) To compare and contrast the best practices in the U.S., Europe, and other countries; 2) To explore the vital subject of sustainable pavements; and 3) To develop a roadmap of future research needs.

The workshop concluded that "for pavements, business as usual is NOT sustainable. However, focused near-term research will provide practical, scientifically based tools and solutions to effectively guide decision makers. Strategic research in areas identified in this document will provide the scientific answers necessary to support the green economy of the future."

The resulting "Research Agenda for Sustainable Pavements" defines the main challenges that require research if pavements are to form a more sustainable part of the transportation infrastructure, a strategic approach for increasing the sustainability of our pavement materials, systems and networks, the research needs that will give short- and longer-term advances, a plan and timeline of research efforts to facilitate the provision of a more sustainable road infrastructure, and an associated communications plan. This "dynamic" document is expected to become the reference of choice for agencies and organizations developing programs for increasing the sustainability of pavement materials, systems, networks, and asset management programs.

Ongoing Projects

Splash & Spray

This project is designed to develop an assessment tool to characterize the propensity of highway sections to generate splash and spray during rainfall and for this propensity to be assessed in terms of the impact on drivers. The project will deliver a robust model to predict splash and spray generation and will consist of three components: 1) Water film model, 2) Splash/spray model, and 3) An exposure model. The final model will be practical and applicable by all highway administrations throughout the country.

Special emphasis is being placed on identifying the input parameters that are necessary for a robust model and how these should be measured. The tool, which will subsequently be developed into an appropriate software application, will contribute to ongoing efforts to improve user satisfaction with public highways. The project scope includes: 1) Evaluation of prior work in the area of splash and spray mechanisms; 2) Development of a model to predict water film thickness and splash and spray occurrence on pavement surfaces, encompassing an appropriate range of conditions; 3) Validation and refinement of the model developed; 4) Development of recommendations as to threshold criteria to classify the impact of splash and spray on highway users; and 5) Documentation of the development efforts and preparation of technology transfer materials.

Pavement Surfaces Properties Consortium

This collaborative project established a research program focused on enhancing roadway transportation system services by optimizing pavement surface texture characteristics, including friction, splash and spray, and tire-pavement noise. Other organizations participating are the FHWA and Connecticut, Georgia, Pennsylvania, South Carolina, Mississippi, and Virginia departments of transportation (DOTs).

The program is designed to evaluate equipment for measuring pavement surface properties and other emerging technologies that show promise for improving measurements as well as innovative pavement surfaces and pavement preservation treatments. The collaborative research program provides an accessible and efficient way for highway agencies and other organizations to conduct research on pavement surface texture and smoothness and helps participants verify the operation and accuracy of their equipment used for pavement evaluations and road construction quality control.

Current projects include: 1) An annual equipment "rodeo" to compare the partner's equipment for measuring pavement surface properties; 2) Seasonal monitoring of friction and macrotexture on different surfaces to investigate the need for seasonal correction factors; 3) Development of stereo vision technology for measuring macrotexture; 4) Implementation and operation of a load program for continuous friction measuring devices; 5) Evaluation of high-friction surfaces; and 6) Evaluation of the feasibility of implementing the International Friction Index in the United States.

Completed Projects

Development of an Integrated Quality Index for Accepting Hot Mix Asphalt (HMA) Materials and Construction

This project built upon the previous Virginia DOT (VDOT) work on End Result Specification for Hot Mix Asphalt (HMA). The main objectives of the project included: 1) Exploring the possibility of integrating all of the individual quality indicators and corresponding pay factors into a single value that could be used to compute aggregated pay factors and 2) Investigating other quality parameters that could be added to the procedure, including the use of mechanistically based material characterization properties such as the dynamic modulus. The work was divided into two phases. Phase I of the project included in-depth data collection and field evaluations with field inspection personnel from the Virginia Transportation Research Council (VTRC) assisting in the sample collection, field density measurements, and experimental digital imaging in conjunction with the inspection work conducted by VDOT-contracted inspection crews. The required laboratory tests were conducted by the CSTI. Phase II focused on the data analysis to try to determine quantitative specification limits that would be representative of quality construction standards for the mixes evaluated.

NCHRP Synthesis 39-01—Quality Management of Pavement Condition Data Collection

This project, funded by the National Academy of Sciences (NAS), was designed to document quality management practices employed by public road and highway agencies for automated, semi-automated, and manual pavement condition data collection and delivery. In particular, the synthesis examined: 1) The quality management techniques used in contractor selection, monitoring, and data acceptance by agencies that outsource the data collection; 2) The quality management techniques used for operations by in-house staff, including training, certification, monitoring, and data acceptance; and 3) How these practices impact the quality of the decisions made based on the data collected.

The collection of network-level pavement condition data was very important because data quality has a critical effect on the business decisions supported by the agencies' pavement management systems. If the quality of the pavement condition data is inadequate, the consequent decision making will be compromised. The synthesis compiled information from various sources, including information from an extensive literature review, an electronic survey of state and provincial practices and data collection contractors, and follow-up communications with a select number of state agencies. The survey was conducted electronically using interactive web-based commercial software. Fifty-five agency responses covering 45 states and 10 Canadian provinces were received.

Center for Smart Infrastructure and Sensing Technology

The Center for Smart Infrastructure Sensing and Technology (CSIST) will focus on the application of pavement mechanics, applied sensing technologies, and transportation-related geotechnical engineering.

New Projects

Transportation Fellowship

This is a U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) research grant. The long-term objective of the grant is to prepare the Eisenhower recipient for a career in transportation. The FHWA is interested in the effects of wide-base tires, which are seeing increased usage in the United States. The intent of this study is to process and analyze data collected from instrumented pavement sections that were loaded by a truck equipped with both dual and wide-base tires in hot weather conditions. The data were collected from the SPS-8 pavement test sections at the Ohio Test Road. The analysis of data from these experiments may reveal the relative strains induced by each tire type and design. This work is meant to complement ongoing work on a three-dimensional (3D) finite element method (FEM) tire model at the University of Florida, a 3D FEM pavement modeling at the University of Illinois and the Vehicle-Pavement Interaction work as part of the Asphalt Research Consortium at the University of Nevada – Reno, and the Transportation Pooled Fund solicitation #1175, "The Impact of Wide-Base Tires on Pavement Damage: A National Study."

Integrated Infrastructure Asset Monitoring, Assessment and Management; MAUTC Collaborative Research Project

The goal of this project is to demonstrate the use of cost-effective sensing and monitoring systems to acquire performance data from both bridges and pavements for use in infrastructure assessment and asset management. Specific objectives of the project include: 1) Deployments of cost-effective sensing and monitoring systems for a pavement section and a bridge close to Charlottesville, VA; 2) Development of methods to use acquired bridge and pavement responses to obtain performance and traffic data; and 3) Development of an architecture to integrate the performance and traffic data into network-level infrastructure assessment and management. Upon the successful completion of the project the cost-benefit analysis for a potential statewide deployment will be assessed.

The objective of this project is to develop a prototype pavement monitoring system and an architecture to integrate monitored data for both pavement and bridge into an infrastructure management system.

Mechanical and Structural Nanoscale Modeling

This study targets the Mechanical and Structural Nanoscale Modeling, one of four projects related to nanoscale research as listed in a Broad Agency Announcement (BAA). The significant innovative ideas include: 1) Use of the Reaction Force Field theory (ReaxFF) and its most recent update to bridge Quantum Mechanics (QM) and Molecular Dynamics (MD); 2) Use of multi-scale Computerized Tomography (CT) technology to characterize the material structure from nanometer to millimeter; 3) Use of an ion beam to cut specimens for nanoscale samples and other nanodevices such as a nano-indenter to characterize the mechanical properties of materials at nanoscale and microscale so that modeling, simulation, validation and verification can be integrated; 4) Exploration of chemo-mechanics and mechanical-electromagnetic couplings and association of the continuum scale coupling with QM interpretation; 5) Use of a digital specimen and digital test technique to bridge mesoscale simulations with nanoscale simulations and microscale microstructure and nanoscale structure; 6) Characterization and modeling of interfaces; 7) Innovative use of the micro-continuum

concept to address the significant heterogeneity; and 8) Demonstration of an integrated development by resolving real problems of concern.

Digital Mix Design for Performance Optimization of Asphalt Concrete

The proposed research will make use of advanced x-ray CT to nondestructively characterize the 3D representation of aggregate particles (digital particles); high performance computing to select an optimum gradation through packing a set of digital particles based on maximizing the number of particle contacts and loading transfer uniformity; and the digital specimen and digital test techniques developed through a project supported by the National Science Foundation (NSF) to evaluate asphalt concrete resistance against permanent deformation, fatigue cracking, thermal cracking, and moisture damage. The proposed research will achieve a better understanding of the fundamental mechanics that govern mixture performance and especially balanced capability against rutting, fatigue cracking, thermal cracking and moisture damage. It will enable the integration of mix design into pavement structure design through consistent digital specimen and digital test techniques that incorporate mix design information into pavement analysis.

Ongoing Projects

Asphalt Research Consortium

This project will investigate the molecular mechanics simulations of asphalt-aggregate interfaces. The overall objectives of this subtask, for which Virginia Tech is responsible, are to develop stress-strain or stress-strain rate relationships for aggregate-binder interfaces using MD simulation and to quantify the imperfectness of the aggregate-binder interfaces using an Atomic Force Microscope (AFM). To minimize uncertainty, quartz will be selected as the mineral aggregate for the MD simulations as a start because its molecular structure and parameters are well established. The Atomistic FEM to increase computational efficiency, currently being developed under an NSF grant, will also be used if successfully developed within the timeframe of this sub-subtask.

Modeling, Simulation, Visualization and Damage Characterization for Penetration into Concrete Targets

This research is sponsored by the Army Research Office (ARO). The motivation for the proposed modeling and simulation of penetration into concrete targets comes from the understanding of the deviations of model predictions from experimental discoveries summarized by Heuze (1990): 1) Cracks and joints that are ubiquitous or damage characterization should be incorporated in the modeling and simulation; 2) Shear strength sensitive to the mean stress or yielding strength should be I1 (mean stress)-dependent; 3) Post-fracture properties of the broken material are also essential or the interaction among the fragments should be considered; and 4) The internal friction angle of the target is more important than its cohesive strength in controlling penetration. Based on these understandings, the overall objectives of the proposed research are to develop a rational constitutive model to incorporate distributed damage effects, enhance the model implementation by combining the FEM and the discrete element method (DEM) so that post-fracture behavior can be simulated, and develop methods to back-calculate model constants from comparing test results with simulation results.

A new damage mechanics model was developed to incorporate the initial and evolved damage effects on concrete behavior and the pressure and rate sensitivity of its strength. In the numerical implementation, the three-constituent structure of cement concrete (the void, aggregate, and mortar structure) is obtained using XCT and is

directly incorporated in the simulation using the combined FEM and DEM to enhance the accuracy to predict fracture and fragmentation. The slide-speed dependent internal friction among fragments and between fragment and projectile is implemented in the DEM simulation. The initial and evolved damage parameters for the constitutive model, such as the damage tensor and the mean solid path, are quantified using a stereology method and virtual sectioning through digital representation of the 3D concrete structure. An inverse technique was developed to back-calculate some model parameters that are difficult to quantify by comparing the model simulation with experimental observation of the deceleration and fragmentation process using high-speed imaging.

A major research focus has been on the numerical implementation of the damage mechanics model and the DEM simulations. The innovative features of this research that differ from others include: 1) Associating the DEM simulation that uses more fundamental microscopic material properties with the continuum type (damage mechanics) models. In this way, the microscopic material parameters can be associated with the material properties in the continuum type of models; 2) Combined modeling, simulations, and experimental observations of the same tests using high-speed imaging. This provides immediate validation or verification of the modeling techniques proposed or developed; and 3) Incorporation of the microstructure of concrete obtained through XCT imaging into modeling and simulation. The damage mechanics model captures the essential dynamic behavior during penetration, which is the softening behavior after the peak strength and the rate-dependency of the strength prior to peak strength.

Applications to LADAR in Aggregate Characteristics

This National Cooperative Highway Research Program (NCHRP) project is designed to develop and evaluate a 3D aggregate characterization system and analysis method using laser detection and ranging (LADAR) for aggregate characterizations, which are important components in asphalt concrete, cement concrete, granular base, and treated base.

Compared to XCT, the LADAR method costs less and can be more conveniently portable for field testing. This approach is expected to overcome some of the limitations of current two-dimensional and semi-3D methods (i.e., the 2.5-dimensional). The objective of the project is to develop and evaluate a LADAR system capable of precise and accurate measurement of the aggregate characteristics of shape, volume, angularity, surface texture, specific surface area, and volumetric gradation.

The anticipated results include a prototype of a portable LADAR system that allows for 3D characterization of aggregates, a draft American Association of State Highway and Transportation Officials (AASHTO) method about how to use the system and software to perform 3D aggregate characterizations, a list of requirements for the system that allows others to build similar systems, and a database documenting all of the relevant results that other researchers may share. Therefore, the anticipated results can be directly adopted for applications and can be useful in future research.

Completed Projects

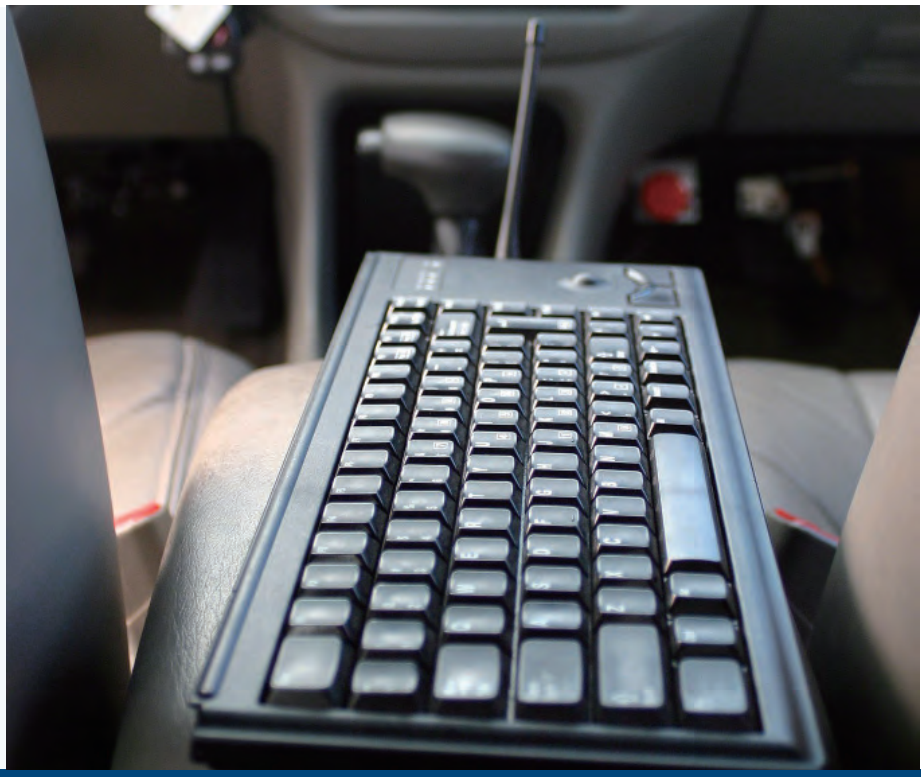
Methods for Assessing the Polishing Characteristics of Aggregates for Use in Pavement Layers

This project dealt with the selection of aggregates for pavement surface layers that play a critical role in providing quality skid resistance through a lengthy service life as the Virginia DOT (VDOT) specifications call for non-polishing aggregates to be used in most surface layers.

The project addressed the problem by developing objective and practical methods to assess the polishing characteristics of aggregates by studying various means and methods to induce wear and assess the impact on aggregates' surface texture. The project provided the VDOT district materials engineers with the tools they need to exercise sound engineering judgment when selecting aggregates to use in pavement surfaces that will save money by increasing the use of local materials.

Center for Technology Development

The Center for Technology Development (CTD) develops, manufactures, implements, and maintains innovative data acquisition, collection, logistics, and analysis systems in support of transportation research.



The Center for Technology Development (CTD) continues to develop innovative solutions in response to the ever changing requirements of VTTI's research centers and sponsors.

The CTD developments include, but are not limited to:

- The technical capability and reliability of VTTI's current Data Acquisition System (DAS), which has been updated to provide for increased data acquisition rates and throughput via updating of communication and processing hardware.
- The implementation, instrumentation and recovery of data from a vehicle- and infrastructure-based DAS, as well as performance of offsite repairs and initial data quality checks.
- Continued development of VTTI's highly integrated DAS, which offers increased research parameters and reduced unit size that will significantly decrease installation times, increase data sampling rates and throughput, provide corrected vehicle dynamics data, and render improved video compression and quality.
- Continued development of machine vision capabilities related to driver, vehicle, and roadway metrics.

Mechanical Systems

The CTD Mechanical Group continuously met the needs of VTTI's research objectives in distinct ways, including the fabrication and installation of various vehicle system build requirements and the development and fabrication of testing equipment and devices. The support, maintenance, and upgrades of all Smart Road facilities and equipment were also handled by the CTD.

Data Acquisition

The CTD Data Acquisition Group developed software and firmware for use in the DAS as regulated by researchers' needs, which was complemented by supplying and implementing data triggers for use in data collection. The CTD personnel also installed the DAS in VTTI-owned, participant and commercial fleet vehicles as well as in highway infrastructure locations such as intersections. The group was responsible for tracking and locating subject vehicles and infrastructure locations and collecting the research data from these locations. This activity was accompanied by performing preliminary quality control in the field to identify and address data acquisition issues as well as repair of the DAS as needed. The CTD tracked, performed causal analysis, and reported data loss for subsequent corrective action.

Advanced Development

In support of transportation research safety, the CTD developed hardware, software, and firmware for VTTI's Next Generation DAS. The system is reduced in size and includes many new and improved parameters to be used in transportation research, including the development of advanced machine vision algorithms to allow remote sensing of driver performance.

The CTD has provided support for the following projects:

- Additional Analysis Using 100-Car Data
- Enhancement of Camera/Video Imaging Systems (E-C/VIS) for Heavy Vehicles
- 511 Virginia - Software Development
- Design of the In-Vehicle Driving Behavior and Crash Risk Study
- Naturalistic Teenage Driving Study
- Assessment of a Drowsy Driver Warning System (ADDWS) for Commercial Vehicle Drivers
- Human Performance Evaluation of Light Vehicle Brake Assist Systems
- Cooperative Intersection Collision Avoidance System to Prevent Violations (CICAS-V)
- Cisco 6
- Driver Distraction in Commercial Vehicle Operations
- Detection-Control System (D-CS) Field Evaluation
- Disability Discomfort Glare Task
- Collision Warning System
- Proprietary MAC Research
- Development of the Luminance Camera System
- Older Driver Data Collection
- Product Development
- Evaluation of Enhanced Brake Lights Using Surrogate Safety Metrics
- Signalized Intersection Red Light Running and Dilemma Zone Study
- Commercial Motor Vehicle Driving Simulator Validation (SimVal) Study, Phase II
- Comparison of Object Detection and Identification with an Advanced Camera/Video Imaging System (A-C/VIS) and a Commercially Available C/VIS on Heavy Trucks
- Pilot Study of Instrumentation to Collect Behavioral Data to Identify On-road Rider Behaviors
- Enhanced Rear Signaling for Heavy Trucks
- Backing Countermeasures Mini Field Operational Test (FOT) – Naturalistic Observational Study
- Hardware in the Loop Evaluation of the Bendix ESP System for Tractor Semi-Trailers

Center for Product Development

The Center for Product Development (CPD) specializes in assessing technologies developed at VTTI for their potential to be commercialized and applied to improve roadway and driving safety.

The CPD staff is experienced in business, marketing, and engineering analyses and has extensive knowledge of issues relating to driving safety, in-vehicle safety devices, driving performance, and driver behavior.

Activities conducted by the Center for Product Development (CPD) include strategic market analysis, concept generation, product requirement specifications, licensing strategy development, and proof of concept demonstration.

New Projects

Railway Cognitive Radio (Rail-CR) to Support Positive Train Control

Robust, reliable, and interoperable wireless communications are the most vital component to the success of Positive Train Control (PTC). The objective of this study is to demonstrate a railway specific cognitive radio system to enhance the existing innovation in communications ongoing in the Federal Rail Administration (FRA) PTC initiative. The proposed application is not readily available in the consumer market, yet it is based on near-ready technologies utilizing an innovative application of Artificial Intelligence to a Software Defined Radio (SDR) platform. The proposed cognitive radio will enhance and leverage the FRA's existing investment in wireless communications for PTC.

Ongoing Projects

Vehicle and Roadside Safety Product Development

The CPD worked in Fiscal Year 2008 to implement feedback received from an early adopters group of likely users of its commercial driver monitoring technologies into its hardware and software product concept. The hardware application included a "black box" data acquisition system (DAS) that could be mounted on commercial trucks to capture a variety of performance measures that could be used to evaluate the safety and operational performance of the individual driver. The software applications included all of the necessary functions to support efficient transfer of data from vehicles to a data storage center, accurate analysis of the collected data, and access to the data for fleet safety managers.

The hardware product was developed and evolved into a comprehensive safety system offering driver monitoring, forward collision warning, and roadway departure functionality. Functional prototypes began in November 2008. The software products also progressed to the point where early user testing of the functionality began in October 2008.

The CPD facilitated the documentation and filing of five Virginia Tech Intellectual Property (VTIP) disclosures that defined the key technologies that made up the hardware and software product concepts described above. The ownership of these disclosures were transferred to the VTIP to support licensing with outside organizations that were interested in applying the product concept toward commercial sales opportunities. An external license was granted for the technologies, and a product launch from that organization was imminent.

Completed Projects

IntelliDrive and ITS Communications Technical Assistance

VTTI continued its ongoing technical assistance contract to the Operations and Security Division (OSD) of the Virginia Department of Transportation (VDOT) Central Office. This project was a task-based scope of work to assist the OSD with technical issues related to the emerging federal initiative of IntelliDrive (SM)[1] and to continue development towards backup communications architectures for VDOT remote devices. Dovetailing from the 2009 project, VTTI researched the feasibility of a satellite modem backup communications system to support the DOT's remote camera/message signs for major evacuation efforts where the cellular infrastructure may have been overrun. VDOT is the lead state agency on a pooled fund study to research the infrastructure aspects of IntelliDrive. Goals for this project included investigating the major roadblocks to infrastructure deployment and developing a deployment plan. VTTI assisted the OSD in developing project ideas for infrastructure-based IntelliDrive projects that support VDOT's mission of improving safety and mobility.

1 IntelliDrive is a service mark of the U.S. Department of Transportation.

Center for Infrastructure-Based Safety Systems

The Center for Infrastructure Based Safety Systems (CIBSS; formerly the Center for Vehicle-Infrastructure Safety) comprises two research groups: the Lighting and Infrastructure Technology (LIT) group and the Cooperative Safety Systems (CSS) group. The LIT group investigates the driver-related effects of advanced roadway lighting, delineation, signage, and vehicle lighting systems, as well as road-user safety during adverse weather conditions. The CSS group focuses on the algorithms, warning methods, and driver behavior associated with cooperative safety systems at traffic signal and stop-controlled intersections.

The Center for Infrastructure Based Safety Systems (CIBSS) specializes in research dealing with safety issues involving vehicle-infrastructure cooperative safety systems, intersection collision avoidance, roadway delineation, and roadway and vehicle lighting.

New Projects

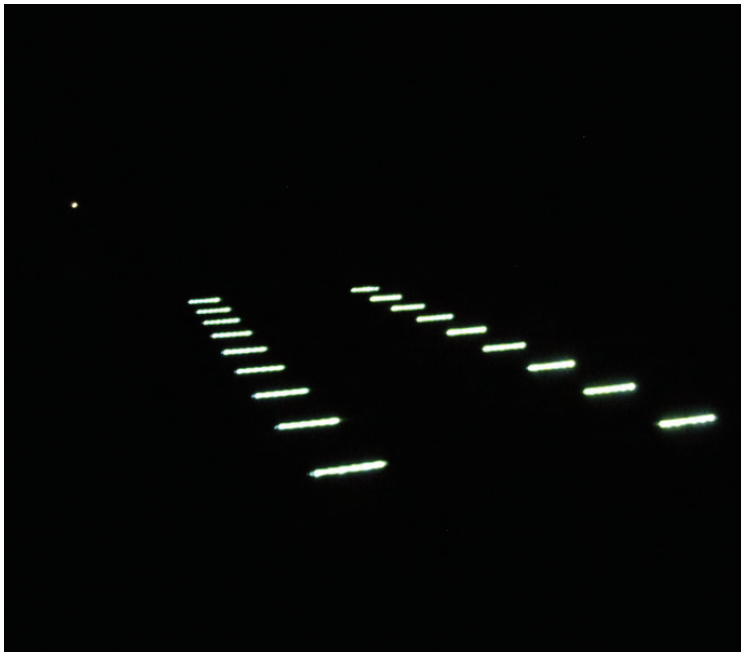
Bright Billboard

The Federal Highway Administration (FHWA) undertook a research study of driver reactions to Commercial Electronic Variable Message Signs (CEVMS) used for off-premise outdoor advertising. The Science Applications International Corporation (SAIC) conducted most of the research activity for this study as part of a Support Services Contract with the FHWA. The study primarily measured the effects of CEVMS and Standard Billboards (SBB) on driver eye glance behavior. However, an important variable that could have an effect on eye glance behavior is the illuminance, luminance and contrast ratio produced by the CEVMS and SBB displays. The SAIC had limited capability and experience in making in situ measurements of these quantities. This subcontract was for the purpose of obtaining technical services in making such display measurements. The purpose of these measurements is to characterize the visual stimulus presented to the driver by CEVMS and SBB displays along the roadway. VTTI has the capability and experience to make these types of measurements.

VTTI has satisfied the statement of work as a subcontractor for this project. The final report is currently undergoing a review process within the SAIC.

Headlamp Sag

This National Cooperative Highway Research Program (NCHRP)-sponsored project investigates the impact of headlamp distribution on visibility through sag vertical curves on roadways. Utilizing the Smart Road and a variety of headlamp configurations, the limits of light above the horizon on headlamps will be investigated in terms of object detection distance through a sag vertical curve. This research also includes a survey of state departments of transportation (DOTs) and a review of the American Association of State Highway and Transportation Officials (AASHTO) Green Guide. The final outcome will be an analysis of the environmental impact and costs associated with changing the sag vertical curve design criteria.



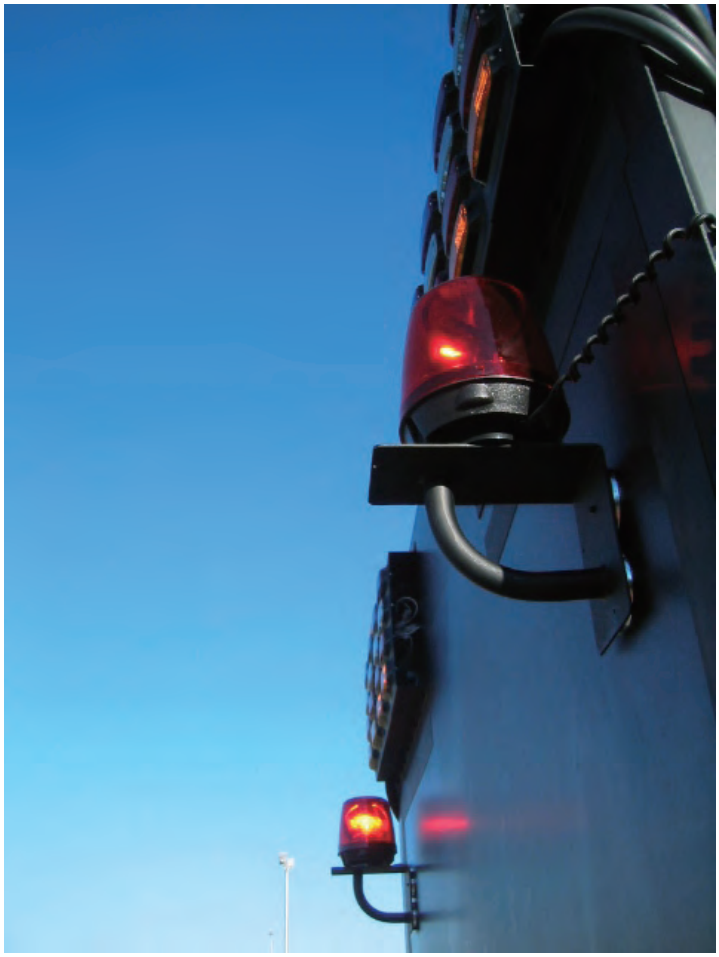
Ongoing Projects

Visibility Model

An analysis of a driver's nighttime visual environment requires consideration of multiple interrelated variables, including human factors and roadway features and lighting. A driver's field of view contains features such as the roadway; the hood of the vehicle; the instrument panel; off-roadway facilities and roadway fixtures such as signs, traffic signals, and pavement markings; and the activities of other road users. From this environment, a driver must continuously draw information about the presence of potential hazards in the roadway, navigate using the roadway signage and delineation, and maintain control of the vehicle. Drivers must attend to and select which objects present important information and determine which are superfluous. Reviewing and identifying, where possible, what attracts a driver's gaze towards an object while driving at night can provide insights into visual behavior at night.

The research project has progressed through a number of tasks that included completing a literature review that incorporated a number of elements such as previous models, eye tracking behavior, and photometric components. The key elements were broken down into specific aspects of the overall topics. These elements were then used in the creation of the experimental and analysis methodology for the project.

An experimental design was constructed to collect data both in a controlled environment on the Smart Road and also on a public roadway drive. A total of 24 Smart Road participants and 8 public road participants took part in the research. The data types included the suite of variables collected on the VTTI data acquisition system (DAS; e.g., distance, global positioning system [GPS], speed, etc.), data from the VTTI-developed luminance camera (e.g., luminance levels), and the eye movement information from the eye tracking unit (e.g., number of glances, fixation duration, etc). When data collection was complete the data were reduced and cleaned.



Data from the eye tracker and the luminance camera were also processed during the data reduction effort. Using a VTTI-specific approach developed in MATLAB, the frame number from the luminance camera was matched to the corresponding frame number from the eye tracker. Sections of time before and after a specific target were also examined to identify eye gaze information and to have the ability to match corresponding luminance data.

As part of the overall project and collaboration effort, VTTI aided with the development and review of the experimental tasks being partially duplicated at the Texas Transportation Institute (TTI) facilities. For example, both VTTI and TTI participated in a luminance camera calibration review at the National Institute of Standards and Technology (NIST). A calibrated light source and a photometer were employed in order to determine the spectral sensitivity of the luminance camera system. Image data were recorded at the NIST.

Data from both facilities will be combined and analyzed in an effort to produce a preliminary visibility model for nighttime driving. The research will assess and provide a new foundation for the development of a predictive model that incorporates the dynamic relationship of driver performance with the safety of the total roadway environment. Once this relationship is defined, safety modification factors can then be developed that relate the quality of the design to driver safety.

Wet Visibility III

Wet Visibility III, sponsored by the Virginia Transportation Research Council (VTRC), is a continuation of the Wet Visibility projects conducted several years ago. The project consists of the measurement of the visibility performance of several different pavement marking technologies in wet conditions. Using the rain making

capabilities of the Smart Road, participants were asked to detect the end of a pavement marking. This detection distance will then be correlated with retroreflectivity measurements made in standardized conditions. These retroreflectivity measurements will be performed according to American Society of Testing Materials (ASTM) methods as well as a new proposed wet retroreflectivity system. The final result of the project is to establish a wet retroreflectivity specification for pavement marking performance based on visibility requirements.

Wet Visibility IV

Wet Visibility IV, sponsored by the VTRC, is another project in the family of the Wet Visibility projects. This project is the evaluation of the durability of six wet night visible pavement marking technologies. These materials have been installed along Route 460 in Blacksburg, Virginia. The retroreflectivity of the pavement markings will be monitored until March 2011, and the marking durability will be evaluated. The visibility performance of the markings will be evaluated in natural rain conditions. Twenty-four participants from the public were asked to determine the end of the pavement marking, the number of skips visible, and to rate the markings. The final results of the project will be the pavement marking technology durability assessment.

Completed Projects

Cooperative Intersection Collision Avoidance System to prevent Violations (CICAS-V)

The CICAS-V project, the largest VTTI award to date at a total of more than $8 million, was a two-year effort to design, develop, and test a CICAS-V in cooperation with the U.S. DOT and five vehicle original equipment manufacturers (OEMs) represented by the Crash Avoidance Metrics Partnership (CAMP). Intersection crashes account for 1.72 million crashes per year in the United States. In 2004, stop-sign and traffic signal violations accounted for approximately 302,000 crashes resulting in 163,000 functional life-years lost and $7.9 billion in economic loss. The objective of the CICAS-V project was to design, develop, and test a prototype system to prevent crashes by predicting stop-sign and signal-controlled intersection violations and warning the violating driver. The intersection portion of the system consisted of a signal controller capable of exporting signal phase and timing information, a local GPS, and roadside equipment that includes computing, memory, and a dedicated short range communication (DSRC) radio.

The vehicle portion of the system included onboard equipment for computing and a 5.9 GHz DSRC radio connected to the vehicle controller area network (CAN), positioning, and the driver-vehicle interface. The intersection sent the signal phase and timing, positioning corrections, and a small map (< 1 kB) to the vehicle. The vehicle received this information and, based on speed and distance to the stop loca-

tion, predicted whether or not the driver would violate. If a violation was predicted, the driver was warned via a visual/auditory/haptic brake pulse driver-vehicle interface. Tests of the system included both on-road and test-track evaluations. System performance was excellent and recommendations were made for continuing with a large field operational test (FOT). The system can be installed at any intersection with sufficient positioning coverage and in any vehicle with an electronic stability system. This system constituted the first FOT-ready vehicle infrastructure integration (VII) safety application.

Disability Discomfort Glare Task

This project focused on an investigation of the state of the art in the evaluation and control of discomfort and disability glare. The project required representation of the FHWA at international meetings and national standards-writing organizations. The project resulted in the development of a white paper and the publication of a technical document.

New Car Assessment Program (NCAP) Non-Destructive Vehicle Testing

This research effort was a follow-on to the rollover New Car Assessment Program (NCAP) Alternate Test Site Development project. It was conducted to support the National Highway Traffic Safety Administration (NHTSA) dynamic rollover testing and data gathering needs. The overall objective was to develop information that could be used in determining the rollover resistance of new vehicles so that those vehicles can be rated in such a way that consumers can consider this information when making a new vehicle purchase.

White Light

White Light, sponsored by the Philips Lighting Company, consisted of the evaluation of the performance of broad spectral band light sources (white light) versus more traditional high pressure sodium (amber) sources. The light sources considered were a new source called CosmoWhite and a new light-emitting diode (LED)-based luminaire. The participant detected a wide variety of objects in the roadway, including colored targets and pedestrians. Foveal (in-the-roadway) targets and peripheral (approaching-the-roadway) targets were used to establish if any benefit provided by a white light source was consistent across the entire visual field. The final goal of the project was to establish a performance scaling factor with the various light sources.

Aloha Nights

Aloha Nights, sponsored by Magnaray International, was designed to evaluate the performance of a white light fluorescent roadway lighting system installed at the Marine Corp Base, Hawaii. It was expected that the white light would appeal to the mesopically adopted eye more than traditional sources, thus allowing a lower lighting level than the traditional system to be used in roadway lighting design. Utilizing the Roadway

Lighting Mobile Measurement System (RLMMS) developed at VTTI, the lighting characteristics were evaluated in situ. These included illuminance, luminance, color, glare, and driver visibility. Twelve Marines were used to evaluate the visibility of large and small multi-colored targets located along the side of the road. The participants were asked to drive a closed road on the Marine base and report when they detected the targets. The detection distance was used as the metric of interest. The final deliverable from the project was an evaluation of the fluorescent system compared with a standard high pressure sodium system.

Southern Lights

Southern Lights, sponsored by San Diego Power and Light, consisted of the comparison of seven light sources proposed for use in San Diego. The city of San Diego installed four luminaires of each of seven lighting technologies. For the test night, the city closed the roadway, and participants were used to evaluate the performance with the VTTI-developed RLMMS. Twenty-seven people from the public were used in groups of three to evaluate the visibility of small objects along the side of the test road. The visibility of pedestrians was also measured to evaluate the performance of the various systems in intersections. The detection distance was measured and compared between all of the systems. The results indicated that lower lighting levels used with white-light LED systems have equivalent performance to more traditional systems.

Object Contrast

This project was designed to use the Smart Road lighting system to analyze the impact of broad spectrum light sources on the detection distance through the impact of color contrast. This project is paired with the National Surface Transportation Safety Center for Excellence (NSTSCE) Object Color project.

Silicon Nights

Silicon Nights was sponsored by the City of San Jose. The project goal was to identify and test advanced street lighting options that provide adequate visibility, safety, and energy savings options. Six different advanced street lighting options were tested by surveying public opinion and visual performance testing using the VTTI-developed RLMMS. Seventy-two participants during two separate nights participated in the performance portion of the test, which asked participants to identify small targets on the side of the closed roadway. Similar to previous tests, detection distance was collected and compared between lighting technologies. The detection distance was measured and compared among all of the systems. Results from the research suggested that San Jose citizens could benefit from broad spectrum lighting sources for comparable or better visibility and color rendering. Also, reduced energy consumption would benefit the *Green Vision* for San Jose.

Transportation Policy Group

The Transportation Policy Group (TPG) identifies and promotes research and outreach for local, regional, statewide, national, and international transportation policy initiatives.

The Transportation Policy Group (TPG) is the policy research group at VTTI. The TPG research projects have focused on community transportation initiatives, contract management, public outreach, transportation finance, intermodalism (passenger and freight), and strategic institutional issues in transportation policy. The TPG is also engaged in a variety of policy outreach efforts. In order to meet diverse research needs, the TPG collaborates with other research groups within VTTI and the larger Virginia Tech community.

Completed Projects

The Impact of Privacy on Emerging Technology on Transportation Safety Applications

With funding from the Virginia Transportation Research Council (VTRC) and NSTSCE, the TPG examined the technology of transportation safety and various types of emerging technology and transportation applications. Privacy concerns have been raised about most technology that collects and processes personal information. This study examined the nature of the information usage, ways personal data are processed, possible misuse of personal data, and ways to mitigate concerns for privacy. The team included two subcontractors well versed in the legislative and legal implications. The project was helped by the addition of the Intelligent Transportation Society of America as a team member.

VDOT and Virginia Department of Conservation and Recreation Bicycle Database Project

The TPG partnered with the Center for Geospatial Information Technology (CGIT) on a project designed to develop a data archive of planned bikeway and pedestrian path data. Historically, the Virginia Department of Transportation (VDOT) has received existing and planned bikeway and pedestrian path data from various stakeholders submitted in a variety of formats (e.g., text descriptions, analog maps, digital files, etc.). The VDOT Transportation and Mobility Planning Division and the Virginia Department of Conservation and Recreation Planning expressed a need to consolidate, standardize, spatially enable (digitize), and integrate data associated with these documents into a statewide, seamless digital file compatible with a geographic information system (GIS). The TPG was awarded a subcontract that was used to fund the work of one doctoral graduate student for two years on a 10-hour per week assistantship. The graduate student was responsible for working with the CGIT to gather various documents and to consolidate the data into a standardized file format.

Virginia Tech Transportation Institute

Tom Dingus, Director

Cynthia (Cindy) Wilkinson
Operations Director
112262

- Kathy Oliver, Human Resource Analyst, 008803
- Sharon Box, Communications Mgr., 007549
- Jessamine Kane, Web/Graphic Designer, 008807
- Mindy Buchanan-King, Tech Communicator, 008225
  Vikki Fitchett, Tech Communicator, 008366
  Stephanie Overton, Tech Communicator,009152
- Leonore Nadler, Smart Road Project Manager, 112491
- Lauren Butterfield, Dispatch Supervisor, 007834
- Ann Madigan, Facilities Manager, 007720,
- VACANT, Front Office Receptionist, 024323

P14 Appointment: Ray Pethtel,
(through -06-16-10)

Sherri L. Cook
Financial Director
112237

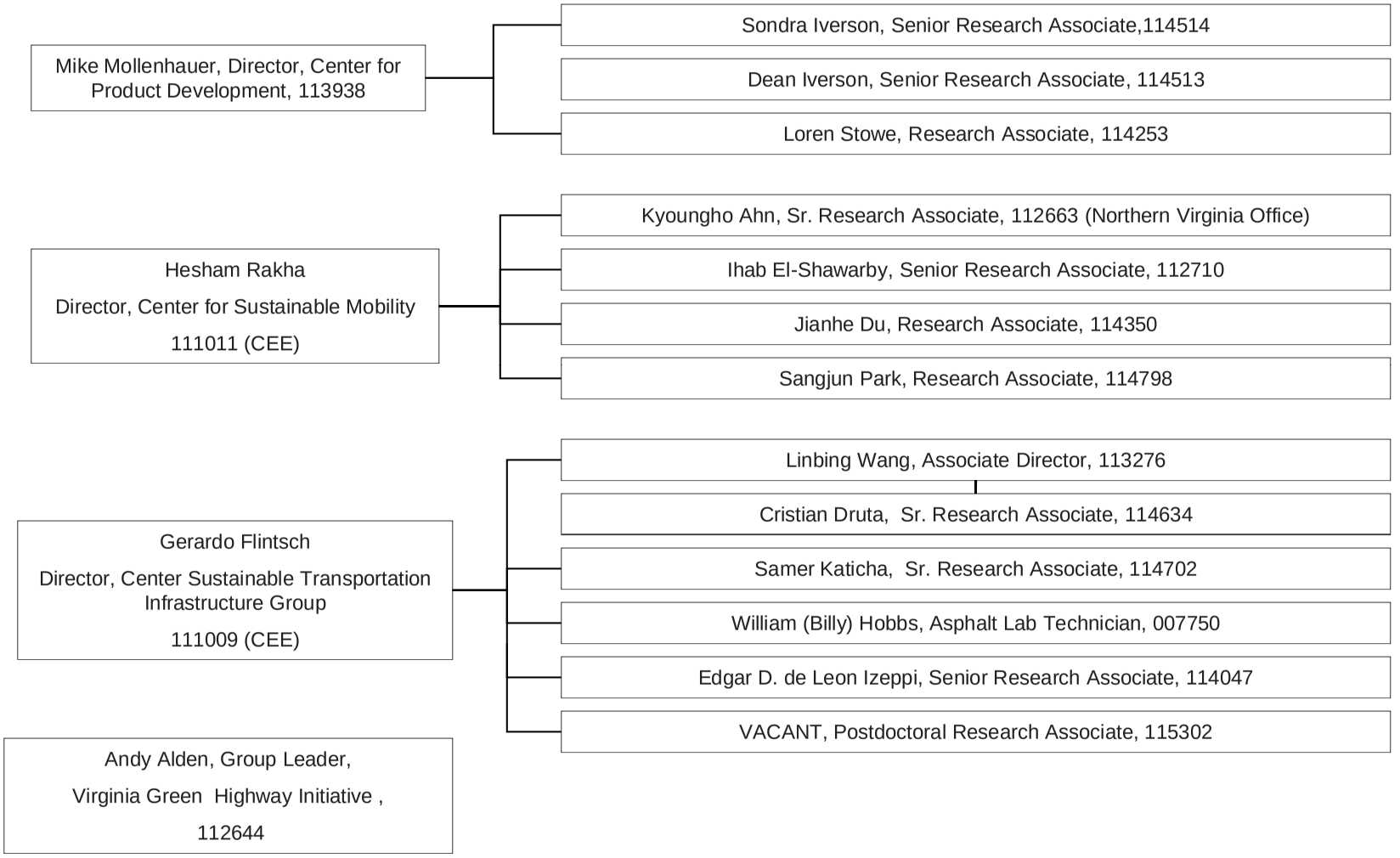
- P14 APPOINTMENT: Mary Wells,
  (through 03-09-11)
- Lisa Jansen, Sr. Budget and Contracts Manager, 008750
  Karen Guynn, Sr. Budget and Contracts Manager, 008516
- Teresa (Terri) Wright, Fiscal Team Manager, 004571
  - Regina Viers, Sr., Fiscal Tech, 008179
    Deborah Boles, Sr., Fiscal Tech, 008786
  - Devon Moeller, Fiscal Tech, 008994
    Diane Turner, Fiscal Tech, 009033
    Gail Radford, Fiscal Tech, 009068

Clark Gaylord
Chief Information Officer
114463

- Doug McGraw, Sr. Database Administrator, 114575
- Brian Daily , Database Administrator, OG1601
- Sally Waldon, Sr. Database Administrator, 009156
- Richard Zimmerman, Research Application Programmer, 008909
- Jeff Baxter, Systems Engineering Spec. 007998
- Tracy McElroy, Sr. IT Project Analyst, 007440
- Chadrick Graham, Sr. Systems Administrator, 008167
- Robert Schnitz, IT Specialist II, Systems Administrator, 007978
- Phil Lambert, IT Specialist II, Support Specialist Lead, 009154
- Steven Gregory, IT Specialist II, Systems Administrator, 009037
- P14 Appointment: Ying Liu
  (through 03-25-11)

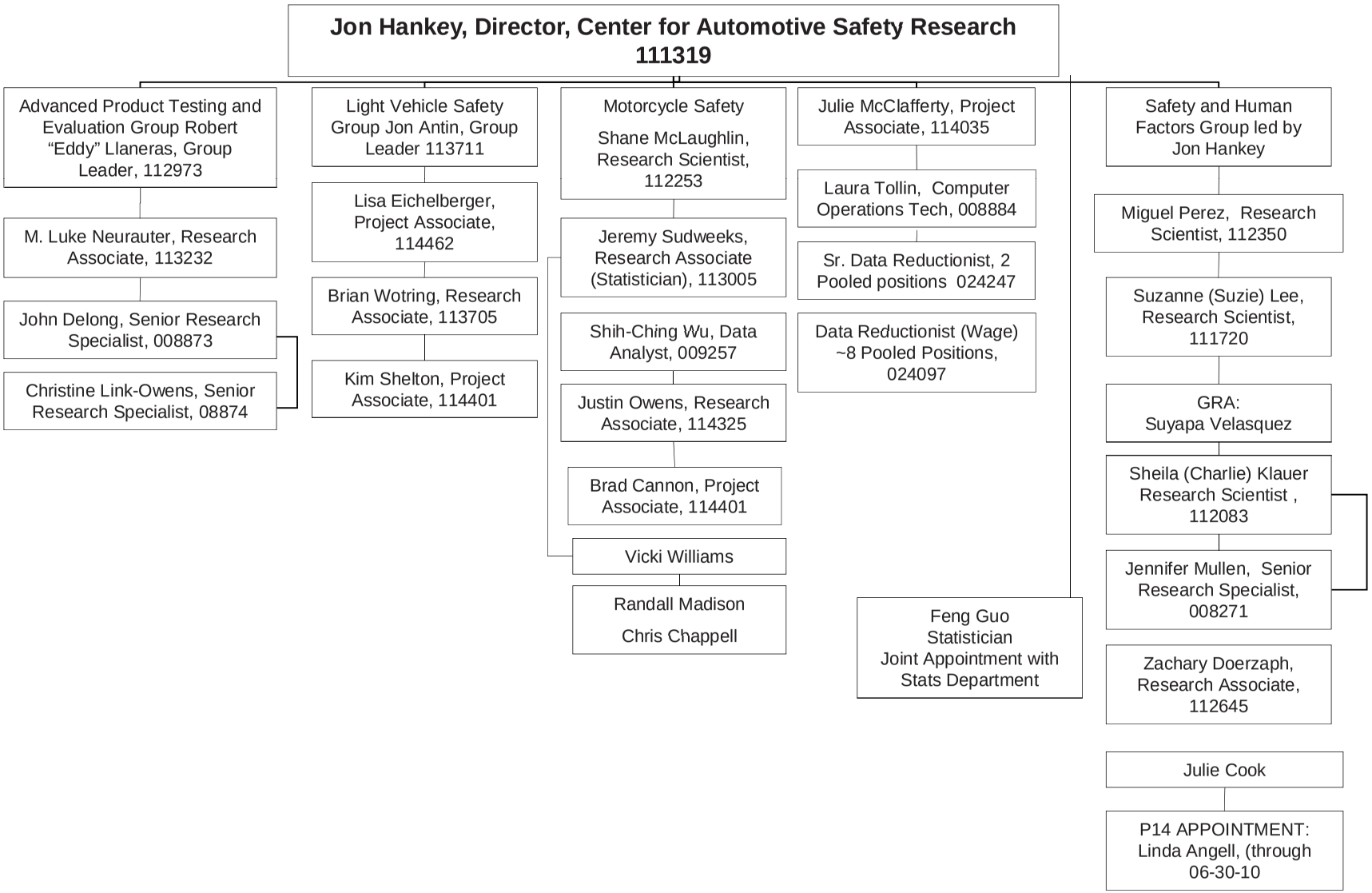
Virginia Tech Transportation Institute

Tom Dingus, Director



Virginia Tech Transportation Institute

Tom Dingus, Director



Virginia Tech Transportation Institute Tom Dingus, Director

Andy Petersen, Director, Center for Technology Development, 111540

Development

- Andy Petersen Technology Development. Group Leader, 111540
- Brian Leeson, Applications Developer, 111534
- Craig Bucher, Software Developer, 112291
- Steve Bears, VHDL Engineer, 114484
- Vasily Kaliniouk, Software Developer, 114744
- Scott Stone, Project Manager, 111299

Data Acquisition

- Carl Cospel Elect. & Systems Integ. Group Leader, 113733
- Fang Huang, Res. Applications Programmer, 113513
- Jean Paul Talledo Vilela, Software Programmer, 113729
- Frank Talbot, Electronic Hardware Developer, 114698
- Julie Jermeland, Research Engineer, 112243
- Wayne Swanson Instrumentation Eng. ,008322
- Mike Ellery, Instrumentation Engineer, 114991
- Stacy Payne, Instrumentation Engineer, 007632
- Scott Aust, Electronics Tech. Supervisor, 008844
- Reginald Bryson, Electronics Tech Supervisor, 008011
- David Mellichamp, Electronics Tech. Supervisor 006836
- Jeff Taylor, Electronics Tech I 008947

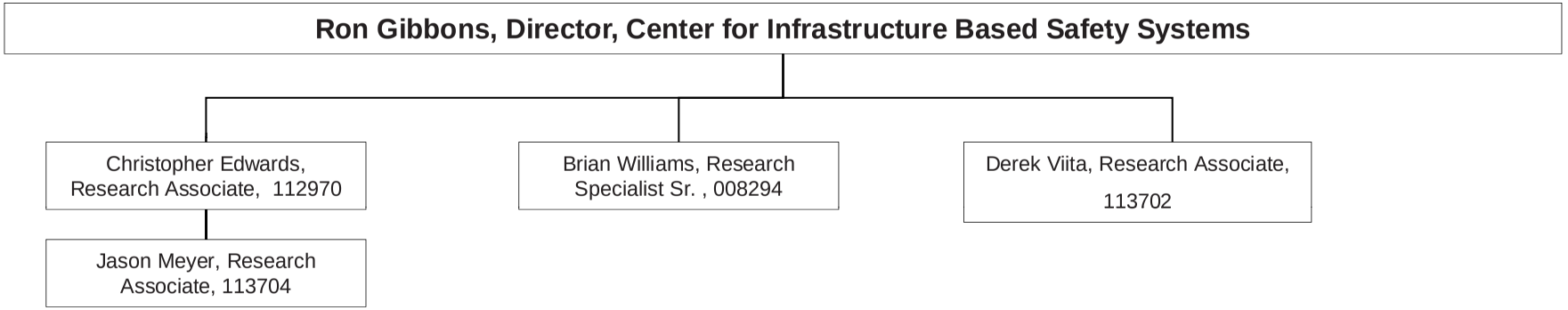
Mechanical Systems

- (Jared) Bryson, SR Mechanical Systems Group Leader , 111648
- Matthew Perez, Mechanical Operations Technician, 007937
- Kenneth Smith, All Weather Testing Technician, 007655
- D. Travis Graham, All Weather Testing Technician, 007841
- Matthew Moeller, Technical Operations Assistant, 007940

Tammy Russell, Project Associate, 114613

Virginia Tech Transportation Institute

Tom Dingus, Director



Virginia Tech Transportation Institute

Tom Dingus, Director

Rich Hanowski, Director, Center for Truck and Bus Safety, 111245

- Behavioral Analysis & Applications Group- Jeff Hickman , 114226
  - Kelly Stanley, Project Associate, 114415
  - Rebecca Olson, Research Associate, 114377
  - Matthew Camden, Research Associate, 114690
  - Erin Mabry, Research Associate, 114919
  - Vacant, Research Specialist Sr. NEW, TBD
- Safety and Human Factors Engineering Group- Myra Blanco, Research Scientist and Group Leader, 112025
  - Adela (Alejandra) Medina-Flintsch, Sr. Research Associate, 111895
  - Gregory Fitch, Research Associate, 113701
  - Joseph Bocanegra, Project Associate-Statistician, 114299
  - VACANT, Project Associate-Statistician, 115325
  - Justin Morgan, Research Associate, 113412
  - Scott Tidwell, Electronics Technician II, 008650
- Advanced Systems & Applications –Darrell Bowman, Group Leader, 113714
  - William Schaudt, Research Associate, 112842
  - Stephanie Baker, Research Associate, 112026
  - Tammy Trimble, Project Associate, 114612
  - Andrew Marinik, Project Associate , 114681

Personnel

New Faculty at the Institute

Name	Department	Research Area
Jessica Mabry	VTTI	Research Associate
Sangjun Park	VTTI	Research Associate
Yang Lu	VTTI	Project Associate

New Staff at the Institute

Name		
Gail Radford	VTTI	Fiscal Technician
Lauren Butterfield	VTTI	Dispatch Supervisor
Shih-Ching Wu	VTTI	Data Analyst

Faculty who Have Left the Institute

Name	Department
Chris Gili	VTTI
Phillip Madison	VTTI
Vicki Lewis	VTTI
Ashwin Amanna	VTTI

Staff who Have Left the Institute

Name	Department
Jodi Bowman	VTTI
Shelby McDonald	VTTI
Mary Reed	VTTI
Jeanne Rice	VTTI
Sarah Jordan	VTTI
David Ramsey	VTTI

Faculty Affiliations of Current Institute Members

Name	Department	College
Hesham Rakha	Civil and Environmental Engineering	Engineering
Gerardo Flintsch	Civil and Environmental Engineering	Engineering
Tom Dingus	Civil and Environmental Engineering	Engineering
Ray Pethtel	University Transportation Fellow/Associate Director, CTR	Architecture and Urban Studies
Stefan Duma	Mechanical Engineering	Engineering
Feng Guo	Department of Statistics	Statistics
Abbas, Montasir	Civil and Environmental Engineering	Engineering
Hardy, Warren	Mechanical Engineering	Engineering
Wang, Linbing	Civil and Environmental Engineering	Engineering
Clay Gabler	Biomedical Engineering	Engineering

Number of Current Minority and Female Participants in the Institute

	Minority	Female
Faculty	3	17
Staff	2	18
Students	14	32
This area reflects current employees		

Personnel

Number of FTE Staff and Administrative Positions at the Institute: Classified Staff

Position	Name	FTE	Funding Source
Classified Staff			
Administrative Staff			
Fiscal Technician	Devon Moeller	1.00	Overhead
Sr. Fiscal Technician	Regina Viers	1.00	Overhead
Sr. Fiscal Technician	Deborah Boles	1.00	Overhead
Fiscal Technician	Gail Radford	1.00	Overhead
Fiscal Technician	Diane Turner	1.00	Overhead
Fiscal Technician Sr.	Teresa Wright	1.00	Overhead
Sr. Budget and Contracts Coordinator	Lisa Jansen	1.00	Overhead
Sr. Budget and Contracts Coordinator	Karen Guynn	1.00	Overhead
Computer Systems Engineer	Robert Schnitz	1.00	Overhead
Computer Operations Technical Consultant	Chadrick Graham	1.00	Overhead
Systems Administrator	Steven Gregory	1.00	Overhead
Computer Systems Engineer	Tracy McElroy	1.00	Overhead
Web/Graphic Designer	Jessamine Kane	1.00	Overhead
Facilities Manager	Ann Madigan	1.00	Overhead
Technical Communicator	Mindy Buchanan-King	1.00	Overhead
Technical Communicator	Vikki Fitchett	1.00	Contracts, OH
Technical Communicator	Stephanie Overton	1.00	Contracts, OH
Communications Manager	Sharon Box	1.00	Contracts, OH
Human Resources Analyst	Kathy Oliver	1.00	Contracts, OH
Systems Engineering Spec.	Jeff Baxter	1.00	Overhead
Research Application Programmer	Richard Zimmermann	1.00	Overhead
Sr. Database Administrator	Sally Waldon	1.00	Overhead
Support Specialist Lead	Phil Lambert	1.00	Overhead
Center for Automotive Safety Research			
Lab and Research Support Senior	Christina Link-Owens	1.00	Contracts
Lab and Research Support Senior	John DeLong	1.00	Contracts
Computer Operation Technician	Laura Tollin	1.00	Contracts
Data Anaylst	Shin-Ching Wu	1.00	Contracts
Research Specialist Senior	Jennifer Mullen	1.00	Contracts
Center for Technology Development			
Electronics Technician Supervisor	Stacy Payne	1.00	Contracts, OH
Instrumentation Engineer	Wayne Swanson	1.00	Contracts, OH
All Weather Testing Technician	Kenneth Smith	1.00	Contracts, OH
All Weather Testing Technician	D. Travis Graham	1.00	Contracts, OH
Technial Operations Assistant	Matthew Moeller	1.00	Contracts, OH
Mechanical Operations Technician	Matthew Perez	1.00	Contracts, OH
Electronics Technician Supervisor	David Mellichamp	1.00	Contracts, OH
Electronics Technician Supervisor	Reginald Bryson	1.00	Contracts, OH
Electronics Technician	Scott Aust	1.00	Contracts, OH
Electronics Technician I	Jeff Taylor	1.00	Contracts, OH
Smart Road Staff			
Daytime Dispatcher Supervisor	Lauren Butterfield	1.00	Contracts

Center for Sustainable Transportation Infrastructure			
Asphalt Lab Technician	Williams Hobbs	1.00	Contracts
Center for Truck and Bus Safety			
Electronics Technician II	Scott Tidwell	1.00	Contracts
Center for Infrastructure Based Safety Systems			
Research Specialist	Brian Williams	1.00	Contracts
Total Classified Staff:	***42***	42.00	

Research Staff

Position	Name	FTE	Funding Source
Research Staff			
Administrative			
Operations Director	Cindy Wilkinson	1.00	Contracts
Finance Director	Sherri Cook	1.00	Contracts
Director	Thomas Dingus	0.53	Contracts
Chief Information Officer	Clark Gaylord	1.00	Contracts
Sr. Database Administrator	Douglas McGraw	1.00	Contracts
Database Administrator	Brian Daily	1.00	Contracts
Virginia Green Highway Initiative	Andrew Alden	1.00	Contracts
Center for Truck and Bus Safety--Safety and Human Factors			
Sr. Research Associate	Richard Hanowski	1.00	Contracts
Research Scientist	Myra Blanco	1.00	Contracts
Research Scientist	VACANT	1.00	Contracts
Sr. Research Associate	Darrell Bowman	1.00	Contracts
Research Associate	Gregory Fitch	1.00	Contracts
Reseach Associate	William Schaudt	1.00	Contracts
Project Associate	Joseph Bocanegra	1.00	Contracts
Research Associate	Jeff Hickman	1.00	Contracts
Project Associate	Andrew Marinik	1.00	Contracts
Project Associate	Tammy Trimble	1.00	Contracts
Sr. Research Associate	Kelly Stanley	1.00	Contracts
Research Associate	Justin Morgan	1.00	Contracts
Sr. Research Associate	Alejandra Medina	0.65	Contracts
Research Associate	Matthew Camden	1.00	Contracts
Reseach Specialist	Rebecca Olsen	1.00	Contracts
Research Associate	Jessica Mabry	1.00	Contracts
Center for Sustainable Mobility			
Senior Research Associate	Kyoungho Ahn	1.00	Contracts
Senior Research Associate	Ihab El-Shawarby	1.00	Contracts
Professor	Hesham Rakha	0.50	Contracts
Research Associate	Sangjun Park	1.00	Contracts
Research Associate	Jianhe Du	1.00	Contracts
Smart Road			
Research Associate	Leonore Nadler	1.00	Contracts

Personnel

Center for Automotive Safety Research			
Research Scientist	Jon Hankey	1.00	Contracts
Research Scientist	Robert Llaneras	1.00	Contracts
Research Associate	Michael Neurauter	1.00	Contracts
Research Scientist	Miguel Perez	1.00	Contracts
Research Scientist	Jon Antin	1.00	Contracts
Project Associate	Julie McClafferty	1.00	Contracts
Research Associate	Jeremy Sudweeks	1.00	Contracts
Reseach Scientist	Sheila Klauer	1.00	Contracts
Research Associate	Zachary Doerzaph	1.00	Contracts
Research Associate	Brian Wotring	1.00	Contracts
Research Associate	Justin Owens	1.00	Contracts
Research Scientist	Suzie Lee	1.00	Contracts
Senior Research Associate	Shane McLaughlin	1.00	Contracts
Project Associate	Kim Shelton	1.00	Contracts
Project Associate	Brad Cannon	1.00	Contracts
Project Associate	Lisa Eichelberger	1.00	Contracts
Center for Technology Development			
Research Associate	Michael J. Bryson	1.00	Contracts
Research Associate	Craig Bucher	1.00	Contracts
Research Associate	Julie Jermeland	1.00	Contracts
Research Associate	Brian Leeson	1.00	Contracts
Project Manager	Scott Stone	1.00	Contracts
Senior Research Associate	Andrew Petersen	1.00	Contracts
Reseach Associate	Carl Cospel	1.00	Contracts
Research Associate	Fang Huang	1.00	Contracts
Research Associate	Jean Paul Talledo Vilela	1.00	Contracts
Software Developer	Vasily Kaliniouk	1.00	Contracts
VHDL Engineer	Steve Bears	1.00	Contracts
Instrumentation Engineer	Michael Ellery	1.00	Contracts
Instrumentation Engineer	Ryan Talbot	1.00	Contracts
Project Associate	Tammy Russell	1.00	Contracts
Center for Sustainable Transportation Infrastructure			
Professor	Gerardo Flintsch	0.20	Contracts
Director	Linbing Wang	1.00	Contracts
Sr. Research Associate	Cristian Druta	1.00	Contracts
Sr. Research Associate	Edgar Leon Izeppi	1.00	Contracts
Sr. Research Associate	Samer Katicha	1.00	Contracts
Postdoctoral Research Associate	Yang Lu	1.00	Contracts
Center for Product Development			
Research Scientist	Michael Mollenhauer	0.80	Contracts
Sr. Research Associate	Dean Iverson	0.90	Contracts
Sr. Research Associate	Sondra Iverson	0.90	Contracts
Research Associate	Loren Stowe	1.00	Contracts

Center for Infrastructure Based Safety Systems			
Research Scientist	Ron Gibbons	1.00	Contracts
Research Associate	Christopher Edwards	1.00	Contracts
Research Associate	Jason Meyer	1.00	Contracts
Research Associate	Derek Viita	1.00	Contracts
		70.48	
Total Research Staff:	***70.48***		
Total FTE Staff:	***112.48***		

Number of Part-Time Professional Faculty at the Institute

Position	Name	FTE	Funding Source
Project Manager	Stephanie Baker	0.50	Contracts
Research Associate	Ying Liu	0.50	Contracts
Proposal Manager	Mary Wells	0.80	Overhead
University Transportation Fellow	Ray Pethtel	0.22	Contracts
Research Associate	David Dietter	0.50	Contracts
Research Scientist	Linda Angell	0.50	Contracts
Total Professional Part-time Faculty:	***6***		

Number of Part-Time Wage Staff at the Institute

Name	Position	FTE	Funding Source
Putman, Jared Robert	Data Reductionist	0.75	Contracts
Stulce, Kelly Elizabeth	Data Reductionist	0.75	Contracts
Berkley-Coats, Melinda Alene	Front Desk Receptionist	0.75	Contracts
Cook, Julie	Human Factors Engineer	0.75	Contracts
Hulse, Melissa Colson	Human Factors Engineer	0.75	Contracts
Williams, Vicki Higginbotham	Human Factors Engineer	0.75	Contracts
Bell, Kevin Charles	IT Help Desk Technician	0.75	Contracts
Haynes, Edward Calhoun	IT Help Desk Technician	0.75	Contracts
Thistle, Karen J	IT Help Desk Technician	0.75	Contracts
Kulick, Julie A	Research Assistant	0.75	Contracts
Howard, Edwin Henry	Research Specialist	0.75	Contracts
Nobles, Jade Sue	Research Specialist	0.75	Contracts
Amos, Kimberly Michelle	Smart Road Dispatcher	0.75	Contracts
Connolly, Timothy Joseph	Smart Road Dispatcher	0.75	Contracts
Croy, Nathan Andrew	Smart Road Dispatcher	0.75	Contracts
Gilliam, Timothy Michael	Smart Road Dispatcher	0.75	Contracts
Landry, Elizabeth Ellyson	Smart Road Dispatcher	0.75	Contracts
Long, Andrew Morgan	Smart Road Dispatcher	0.75	Contracts
Minisi, John Anthony	Smart Road Dispatcher	0.75	Contracts
Pappas, Angelea Bowden	Smart Road Dispatcher	0.75	Contracts
Sachs, Mary K	Smart Road Dispatcher	0.75	Contracts
Stumpf, Brandon Joseph	Smart Road Dispatcher	0.75	Contracts
Dellapenta, Anna Rae	Smart Road Dispatcher	0.75	Contracts
Liles, Jerry Michael	Smart Road Dispatcher	0.75	Contracts
McManus, Ian Alastair	Smart Road Dispatcher	0.75	Contracts
Wedan, Dylan Robert	Smart Road Dispatcher	0.75	Contracts
Baynes, Peter Allen	Sr. Data Reductionist	0.75	Contracts
Lewis, Tyler W	Sr. Data Reductionist	0.75	Contracts
Robbs, Timothy Joshua	Sr. Data Reductionist	0.75	Contracts
Ruggiero, Paul G	Technical Editor	0.75	Contracts
Total Professional Part-time Staff:	***30***		

Personnel

Students Active at the Institute

Name	VTTI Support	Department	College	Degree Sought/Awarded in FY09
Aich, Sudipto	100	Industrial and Systems Engineering	Engineering	M.S. Sought
Amer, Ahmed Mohamed Mostafa	100	Civil Engineering	Engineering	B.S. Candidate
Amos, Kimberly Michelle	100	Industrial and Systems Engineering	Engineering	M.S. Candidate
Ashar, Dhawal Bipin	100	Civil Engineering	Engineering	Unknown
Awwad, Yousef Ahmad	100	Engineering Science and Mechanics	Engineering	B.S. Sought
Beeman, Stephanie Marie	100	Biomedical Engineering	Engineering	Ph.D. Sought
Bhagavathula, Rajaram	100	Industrial and Systems Engineering	Engineering	M.S. Awarded
Campbell, John Murray	100	Business Information Technology	Business	B.S. Candidate
Castor, Michael Stephen	100	Finance	Business	B.S. Candidate
Chen, Hao	100	Civil Engineering	Engineering	Ph.D. Sought
Cox, Erin Ruth	100	Wildlife Science	Natural Resources	Unknown
Dehghani Sanij, Mohammad Saied	100	Civil Engineering	Engineering	Ph.D. Sought
Donoughe, Kelly	100	Civil Engineering	Engineering	M.S. Sought
Dwivedi, Pooja B	100	Civil Engineering	Engineering	M.S. Sought
El-Metwally, Maha Salah	100	Civil Engineering	Engineering	Unknown
Field, Ryan Bayne	100	Mechanical Engineering	Engineering	B.S. Sought
Flickinger, Joshua Andrew	100	Biological Systems Engineering	Agriculture and Life Sciences	Unknown
Gendron, Brooke Evans	100	English	Liberal Arts and Human Sciences	B.S. Candidate
Golman, Adam Joseph	100	Engineering Science and Mechanics	Engineering	B.S. Sought
Hampton, Carolyn Elizabeth	100	Biomedical Engineering	Engineering	Ph.D. Sought
Harris, Christopher Robert	100	Building Construction	Architecture and Urban Studies	B.S. Candidate
Hart, Adam Michael	100	Biology	Science	M.S. Sought
Jackson, Meredith	100	Civil Engineering	Engineering	M.S. Sought
Johnson, Nicholas S	100	Mechanical Engineering	Engineering	Unknown
Kehoe, Nick Paul	100	Civil Engineering	Engineering	M.S. Sought
Kern, Mitchell Jacob	100	Wildlife Science	Natural Resources	B.S. Sought
Kingma, Adrienne Nichole	100	Apparel, Housing, Resource Mgmt.	Liberal Arts and Human Sciences	B.S. Pending
Laumer, Paul Jackson	100	English	Liberal Arts and Human Sciences	Pre-law Sought
Li, Huan	100	Civil Engineering	Engineering	M.S. Sought
Liles, Jerry Michael	100	English	Liberal Arts and Human Sciences	M.S. Sought
Lung, Philip Chu	100	Fisheries Science	Natural Resources	B.S. Pending

Name	VTTI Support	Department	College	Degree Sought/Awarded in FY09
Madison, Christopher Randall	100	Aerospace Engineering	Engineering	B.S. Candidate
Markwith, Scott Gordon	100	Fisheries Science	Natural Resources	Unknown
McGowan, Kelly Ann	100	Biology	Science	Unknown
McManus, Ian Alastair	100	Management	Business	B.S. Candidate
Mladenovic, Milos	100	Civil Engineering	Engineering	M.S. Science
Murphy, Patrick Wayne	100	Communications	Liberal Arts and Human Sciences	B.S. Candidate
Najafi, Shahriar	100	Civil Engineering	Engineering	M.S. Pending
Oliver, Eva Marie	100	Hospitality and Tourism Management	Business	B.S. Sought
Pierce, Jacob Eugene	100	Sociology	Liberal Arts and Human Sciences	B.S. Pending
Price, Matthew James	100	Electrical Engineering	Engineering	M.S. Sought
Putman, Jared Robert	100	English	Liberal Arts and Human Sciences	B.S. Sought
Rowson, Steven	100	Biomedical Engineering	Engineering	Ph.D. Sought
Saleh, Mohamed Ibrahim	100	Computer Engineering	Bradely Department, Engineering	Ph.D.
Santago, Anthony Charles	100	Biomedical Engineering	Engineering	M.S. Sought
Shetty, Sameer Shashikant	100	Civil Engineering	Engineering	M.S. Sought
Sun, Wenjuan	100	Civil Engineering	Engineering	Ph.D. Sought
Tang, Lijie	100	Civil Engineering	Engineering	Ph.D. Sought
Tanner, Stephen Lee	100	General Engineering	Engineering	B.S. Sought
Tawfik Aly Ahmed Abdel Gal, Aly Moh	100	Civil Engineering	Engineering	Ph.D. Sought
Terry, Travis Neal	100	Industrial and Systems Engineering	Engineering	M.S. Sought
Turner, David Anthony	100	Biology	Science	M.S. Sought
Valeri, Stephen Michael	100	Civil Engineering	Engineering	B.S. Sought
Verhoeven, Jack George	100	Civil Engineering	Engineering	Unknown
Wang, Dong	100	Civil Engineering	Engineering	Ph.D. Sought
Wedan, Dylan Robert	100	EDCI	Liberal Arts and Human Sciences	MAED Sought
Wharton, Amy Elizabeth	100	Psychology	Science	B.S. Sought
Wilson, Zachary Adam	100	Engineering Science and Mechanics	Engineering	B.S. Sought
Xiao, Pei	100	Statistics	Science	M.S. Sought
Xue, Wenjing	100	Civil Engineering	Engineering	B.S. Sought
Yeatts, Allyson Glynn	100	Psychology	Science	M.S. Sought
Yin, Weihao	100	Civil Engineering	Engineering	M.S. Sought
Zhou, Yu	100	Forest Products	Natural Resources	B.S. Candidate
Zohdy, Ismail H	100	Civil Engineering	Engineering	M.S. Sought

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Ahn, K. and Rakha H. (2009). "A field evaluation case study of the environmental and energy impacts of traffic calming," Transportation Research Part D: Transport and Environment, Vol. 14(6), pp. 411-424.

Amer A., Rakha H., and El-Shawarby I. (2010). "A Behavioral Modeling Framework of Driver Behavior at the Onset of a Yellow Indication at Signalized Intersections," Accepted for presentation at the 89th Annual Meeting, Jan. 10-14, Washington D.C. (Paper 10-3794).

Amer A, Rakha H., and El-Shawarby I. (2010). "A Behavioral Modeling Framework of Driver Behavior at the Onset of Yellow at Signalized Intersections," Proceedings of the Transportation Research Board 89th Annual Meeting, Washington D.C., CD-ROM [Paper 10-3794].

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Beeman, S, Kemper, A, Madigan, M, Duma, S (2010). "Effects of Muscle Activation on Occupant Kinematics in Frontal Impacts," Ohio State Symposium.

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Candia-Gallegos, M., Flintsch, G.W. (2009). "Asphalt Pavement Quality Measurement, Management, and Acceptance" (Medición, Manejo y Aceptación de la Calidad del Pavimento Asfáltico: Nuevos Conceptos y Desafíos), XV Ibero-Latin-American Asphalt Congress (XV CILA), Nov. 22-27, 2009, Lisboa, Portugal.

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Daniello, A., Swanseen, K., Mehta, Y., and Gabler, H.C. (Accepted). "Rating Roads for Motorcyclist Safety: Development of a Motorcycle Road Assessment Program," Transportation Research Record: Journal of the Transportation Research Board, Transportation Research Board of the National Academies.

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presentation), 89th Annual Meeting of the Transportation Research Board, Jan. 10-14, 2010.

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Hampton, C.E. and Gabler, H.C. (2009). "NASS/CDS Delta-V Estimates: The Influence of Enhancements to the WinSmash Crash Reconstruction Code," Annals of Advances in Automotive Medicine, v.53, pp. 91-102.

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Publications

10-2487, to be published in the Journal of the Transportation Research Board.

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Kusano, K.D. and Gabler, H.C. (Accepted). "Potential Occupant Injury Reduction in Pre-Crash System Equipped Vehicles in the Striking Vehicle of Rear-end Crashes," Annals of Advances in Automotive Medicine.

de León, E.D., Flintsch, G.W., Saleh, M.I., and McGhee, K.K. (2009). "Stereo Vision Application for Macrotexture Measurement," Sixth International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (MAIREPAV6), July 8-10, 2009, Torino, Italy.

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Morgan, J.F., Trimble, T.E., Bowman, D.S., Baker, S., Pickett, R., Murray, D., & Bergoffen, G. (In Press). Synthesis of literature and operating safety practices related to cell phone/personal data assistant use in commercial truck and bus operations (Tech. Rep.). Washington, DC: Federal Motor Carrier Safety Administration.

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Park S., Rakha H., and Guo F. (In press). "Multistate Travel Time Reliability Model: Model Calibration Issues," Transportation Research Record: Journal of the Transportation Research Board.

Park S., Rakha H., and Guo F. (2010). "Multistate Travel Time Reliability Model: Model Calibration Issues," Accepted for presentation at the 89th Annual Meeting, Jan. 10-14, Washington D.C. (Paper 10-1289).

Rakha H., El-Shawarby I., and Arafeh M. (In press). "Trip Travel-Time Reliability: Issues and Proposed Solutions," Journal of Intelligent Transportation Systems.

Rakha H., Fitch G., Arafeh M., Blanco M., and Hanowski R. (In press). "Safety Benefit Evaluation of a Heavy Vehicle Forward Collision Warning System," Transportation Research Record: Journal of the Transportation Research Board.

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Rakha H. and Gao Y. (2010). "Calibration of Steady-state Car-following Models using Macroscopic Loop Detector Data," Accepted for presentation at the 89th Annual Meeting, Jan. 10-14, Washington D.C. (Paper 10-0211).

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Schaudt, W. A., Bowman, D., Marinik, A., Hanowski, R. J., and Simmons, J. (2010). Development of hazardous materials (HM) shipper prioritization application. Paper No. 10-0409. TRB 89th Annual Meeting, Compendium of Papers (DVD). Washington, DC: Transportation Research Board.

Schaudt, W.A., Bowman, D., Bocanegra, J., Baker, S., and Hanowski, R.J. (May 2010). Enhanced rear signaling (ERS) for heavy trucks: Phase III – development of field operational test; Task 4 report: Real-world data collection. Contract No. DTMC75-07-D-00006, Task Order 2. Prepared for the Federal Motor Carrier Safety Administration.

Schaudt, W.A., Bowman, D., Bocanegra, J., Baker, S., Marinik, A., Wierwille, W.W., and Hanowski, R.J. (November 2009). Enhanced rear signaling (ERS) for heavy trucks: Phase III – development of field operational test; Task 3b report: analysis of countermeasures. Contract No. DTMC75-07-D-00006, Task Order 2. Prepared for the Federal Motor Carrier Safety Administration.

Simons-Morton, B. G., Ouimet, M. C., Wang, J., Klauer, S. G., Lee, S.E., and Dingus, T. A. (2009). Hard braking events among novice teenage drivers by passenger characteristics. Proc. Fifth International Driving Symposium on Human Factors in Driving Assessment, Training and Vehicle Design, Big Sky, Montana. The University of Iowa, Iowa City, Iowa, pp. 236-242.

Stitzel, J, Danelson, K, Gayzik, F, Yu, M, Martin, S, Duma, S (2009). "Bilateral Carotid Artery Injury Response in Side Impact Using a Vessel Model Integrated with a Human Body Model," Annals of Advances in Automotive Medicine, 53:271-278, 2009.

Tawfik A., Rakha H., and Miller S. (2010). "An Experimental Exploration of Route Choice: Identifying Drivers Choices and Choice Patterns, and Capturing Network Evolution," IEEE Intelligent Vehicles Symposium, June 2010.

Thor, C.P. and Gabler, H.C. (Accepted). "Assessing the Residual Teen Crash Risk Factors after Graduated Drivers License Implementation," Annals of Advances in Automotive Medicine.

Trimble, T., Medina, A.F., Schaudt, W.A., Bowman, D., and Hanowski, R.J. (October 2009). Enhanced rear signaling (ERS) for heavy trucks: Phase III – development of field operational test; Task 3a report: Phase 1 GES database analysis update. Contract No. DTMC75-07-D-00006, Task Order 2. Prepared for the Federal Motor Carrier Safety Administration.

Van Ee, C.A., Thibault, K.L., Hardy, W.N., Raymond, D.E., Plunkett, J. (2009). Evaluation and Refinement of the CRABI-6 Anthropomorphic Test Device Injury Criteria for Skull Fracture, IMECE2009-12973.

Wang, H., Flintsch, G.W. (2010). "Comparative Study of Road Profilers' Accuracy and Precision," Journal of Testing and Evaluation, American Institute of Physics, Vol. 38(2).

Weaver, J.L., Gao, W., Chin, S., Iverson, D. (2009). Pro JavaFX™ Platform: Script, Desktop and Mobile RIA with Java™ Technology. Apress: New York, New York.

Wiegand, Douglas M., Hanowski, Richard J. and McDonald, Shelby E. (2009). "Commercial Drivers' Health: A Naturalistic Study of Body Mass Index, Fatigue, and Involvement in Safety-Critical Events," Traffic Injury Prevention, 10:6, 573 – 579.

Wierwille, W.W., Schaudt, W.A., Blanco, M., Alden, A., and Hanowski, R.J. (In press). Enhanced camera/video imaging systems (E-C/VISs) for heavy vehicles: Final report. Contract No. DTNH22-05-D-01019, Task Order 6. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration (Submitted September, 2008).

Wierwille, W. W., Llaneras, R.E., and Neurauter, M.L. (2009). Evaluation of Enhanced Brake Lights Using Surrogate Safety Metrics: Task 1 Report: Further Characterization and Development of Rear Brake Light Signals (No. DOT HS 811 127). Washington, D.C.: National Highway Traffic Safety Administration.

Publications

Yu, M, Stitzel, J, Duma, S, Manoogian, S (2009). "Finite Element Modeling of Human Placental Tissue," Annals of Advances in Automotive Medicine, 53:257-270, 2009.

Zohdy I., Sadek S., Rakha H. (In press). "Empirical Analysis of Wait Time and Rain Intensity Effects on Driver Left-Turn Gap Acceptance Behavior," Transportation Research Record: Journal of the Transportation Research Board.

Zohdy I., Sadek S., Rakha H. (2010). "Empirical Analysis of Wait Time and Rain Intensity Effects on Driver Left-Turn Gap Acceptance Behavior," Accepted for presentation at the 89th Annual Meeting, Jan. 10-14, Washington D.C. (Paper 10-0206).

Works Published Since 2009 Annual Report or Published in New Format

Ahn K. and Rakha H. (2009). "Energy and Environmental Assessment of High-Speed Roundabouts," Transportation Research Record: Journal of the Transportation Research Board, n 2123, pp. 54-65.

Antin, J. F., Stanley, L. M., Cicora, K. F. (2009). Conventional Versus Moving-Map Navigation Methods: Efficiency and Safety Evaluation. Transportation Research Record, No. 2138, 34-41.

Blanco, M. Hickman, J.S., Hanowski, R.J., & Morgan, J.F. (2010). The commercial driver. In D. Fisher, J. Lee, J. Caird, and M. Rizzo (Eds.), Handbook of Driving Simulation for Engineering, Medicine and Psychology. Boca Raton, FL: CRC Press.

Bowman, D., Schaudt, W. A., Wierwille, W.W., Hanowski, R. J., and Flanigan, C. (October 2009). Enhanced rear signaling for heavy trucks [Abstract]. Proceedings of the Society of Automotive Engineers Commercial Vehicle Engineering Conference. (CD-ROM).

Daniello, A., Gabler, H.C., and Mehta, Y. (2009). "The Effectiveness of Motorcycle Training and Licensing," Transportation Research Record: Journal of the Transportation Research Board, No. 2140, Transportation Research Board of the National Academies, pp. 206–213, Washington, DC.

Fitch, G.M., Blanco, M., Morgan, J.F., Wierwille, W.W., & Hanowski, R.J. (2010). Human performance evaluation of light vehicle brake assist systems (Paper No. 10-0470). In: Proceedings of the 89th Annual Meeting of the Transportation Research Board, Washington, DC.

Fitch, G.M., Blanco, M., Morgan, J.F., Rice, J.C., Wharton, A., Wierwille, W.W., & Hanowski, R.J. (2010). Human performance evaluation of light vehicle brake assist systems (Report No. DOT HS 811 251). Washington, DC: National Highway Traffic Safety Administration.

Hanowski, R.J., Hickman, J.S., Blanco, M., and Fitch, G. (2010). Long-haul truck driving and traffic safety: Studying drowsiness and truck driving safety using a naturalistic driving method. In Verster, J.C. (Ed.) Sleep, Sleepiness and Traffic Safety. Hauppauge, NY: Nova Science Publishers.

Hickman, J.S., & Hanowski, R.J. (2009). Evaluating the Safety Benefits of a Low Cost Driving Behavior Management System in Commercial Vehicle Operations: Final Report. Contract No. DTMC75-07-D-00006, Task Order #1. Federal Motor Carrier Safety Administration: Washington, D.C.

Katz B., Coffey P., and Rakha H. (2009). "Analysis of Enforcement Techniques for DWI Checkpoints and Their Impact on Traffic Operations," Transportation Research Record: Journal of the Transportation Research Board.

Olson, R.L., Hanowski, R.J., Hickman, J.S., & Bocanegra, J. (September 2009). Driver distraction in commercial vehicle operations, final report. Report No. FMCSA-RRR-09-042. Washington, DC: Federal Motor Carrier Safety Administration. http://www.fmcsa.dot.gov/facts-research/research-technology/report/FMCSA-RRR-09-042.pdf.

Park S. and Rakha H. (2009). "Environmental Impacts of High-Emitting Vehicles," Transportation Research Record: Journal of the Transportation Research Board, n 2123, pp. 97-108.

Rakha H. and Wang W. (2009). "Procedure for Calibrating Gipps Car-Following Model," Transportation Research Record: Journal of the Transportation Research Board, n 2124, pp. 113-124.

Rakha H., Pasumarthy P., and Adjerid S. (2009). "A Simplified Behavioral Vehicle Longitudinal Motion Model," Transportation Letters: The International Journal of Transportation Research, Vol. 1(2), pp. 95-110.

Schaudt, W.A., Bowman, D., Marinik, A., Baker, S., Trimble, T., and Hanowski, R.J. (In press). Development of hazardous materials (HM) shipper prioritization program: final report. Contract No. TMC75-07-H-00008, Task Order 1. Washington, DC: Federal Motor Carrier Safety Administration.

Sung K. and Rakha H. (2009). "A Genetic Algorithm for Trip Distribution and Traffic Assignment from Traffic Counts in Stochastic User Equilibrium," International Journal of Management Science, Vol. 15(1), pp. 51-69.

Wu N. and Rakha H. (2009). "Derivation of Van Aerde Traffic Stream Model from Tandem-Queueing Theory," Transportation Research Record: Journal of the Transportation Research Board, n 2124, pp. 18-27.

Yao J., Rakha H., Teng H., Kwigizile V., and Kaseko M. (2009). "Estimating Highway Capacity Considering Two-Regime Models," Journal of Transportation Engineering, v 135, n 9, pp. 670-676.

Presentations and Honors

Myra Blanco

- Naturalistic Data Collection, Reduction, and Analysis Workshop. PROLOGUE Work Package 3 Meeting (June, 2010). Tel Aviv, Israel.

Tom Dingus

- Invited to testify before the U.S. Congressional Subcommittee on Commerce, Trade and Consumer Protection regarding, "Driven to Distraction: Wireless Devices and Vehicle Safety," November 4, 2009.
- Invited to testify before the U.S. Congressional Subcommittee Highways and Transit regarding, "Addressing the Problem of Distracted Driving," 2009.
- Invited Panelist at U.S. Transportation Secretary Ray LaHood's Distracted Driving Summit Leaders to Explore Solutions to Distracted Driving, Washington, DC, September 30 – October 1, 2009, National Webcast.
- Women's Health, scheduled for release March 2010.
- Is Your Cell Phone Putting Your Health at Risk, Oprah Winfrey Show, January 18, 2010.
- Driving and Texting: Not Worth the Risk, Cosmopolitan, November 2009.
- Teen Driving Safety Programs; Challenges Faced by Federal Agencies in Trying to Improve Teen Driver Safety, Government Accountability Office, Washington, DC, October 28, 2009.
- Administration takes aim at distracted driving, Associated Press, October 6, 2009; ran in more than 2,000 national and international media outlets.
- Stop sign ahead for texting while driving? Atlanta Journal Constitution, October 5, 2009.
- Cops, lawmakers send message: Dnt txt & drive; Movement to ban text messaging while behind the wheel gathers steam, MSNBC, September 3, 2009.
- Texting & Driving Don't Mix, National Safety Council Defensive Driving Video, September 2009.
- The Dangers of Texting While Driving, Time Magazine, August 24, 2009.
- Methods used in cell-phone/driving studies spur debate, ComputerWorld, July 29, 2009.
- Texting & Driving Don't Mix, CNN, July 28 and 29, 2009.
- In Study, Texting Lifts Crash Risk by Large Margin, front page of the New York Times, July 28, 2009; ran in more than 3,100 media outlets nationally and internationally and had 6 additional articles related to this lead story, also in the New York Times.

Zachary Doerzaph

- Doerzaph, Z. R., Bhagavathula, R., & Guo, F. (2010). Identification of factors related to violation propensity using large naturalistic intersection approach-level database. Paper presented at the 89th Transportation Research Board Annual Meeting.
- Doerzaph, Z. R., & Neale, V. L. (2010). Data Acquisition Method for Developing Crash Avoidance Algorithms through Innovative Roadside Data Collections. Paper presented at the 89th Transportation Research Board Annual Meeting.
- Doerzaph, Z. R., Neale, V. L., & Kiefer, R. J. (2010). Cooperative Intersection Collision Avoidance for Violations (CICAS-V) Threat Assessment Algorithm Development and Evaluation Method. Paper presented at the 89th Transportation Research Board Annual Meeting.

Stefan Duma

- Hosted a two-day military injury biomechanics symposium in Washington, DC, during August 2009 with 125 attendees from the Department of Defense and Department of Transportation.
- Associate Editor, Annals of Biomedical Engineering
- Reviewer, Journal of Biomechanics
- Reviewer, Journal of Biomedical Engineering
- Reviewer, Medicine and Science in Sports and Exercise
- Reviewer, Society of Automotive Engineers
- Reviewer, International Journal of Human Factors Modeling and Simulation

Greg Fitch

- Invited member to the Association for the Advancement of Automotive Medicine (2010).
- Society of Automotive Engineers Commercial Vehicle Exhibition & Congress Presentation Award (2009).
- Fitch, G. M., Blanco, M., Morgan, J. F., & Wharton, A. E. (In press). Driver Braking Performance to Surprise and Expected Events. Paper presented at the Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, California.
- Montague, E., Mcguire, K., Fiore, S., Holden, R., Fitch, G. M., & Lee, J. (In press). Trust in Sociotechnical Systems. Paper presented at the Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, California.

Presentations and Honors

- Fitch, G. M., Blanco, M., Hanowski, R. J., Rau, P., & Flanigan, C. (In press). Field Demonstration of a Camera/Video Imaging System for Heavy Vehicles – Driver Lane Change Performance Preliminary Results. Paper No. 2010-01-2020. Paper presented at the Society of Automotive Engineers Commercial Vehicle Engineering Congress and Exhibition, Chicago, IL.
- Fitch, G. M., Blanco, M., Camden, M., & Hanowski, R. J. (In press). Field Demonstration of Heavy Vehicle Camera/Video Imaging Systems: Preliminary Results. Paper presented at the 2nd International Symposium on Naturalistic Driving Research, Blacksburg, Virginia.
- Fitch, G.M., (2010). Field Testing Indirect Visibility Systems. Poster presented at the 2010 Virginia Trucking Association Safety Management Conference, Hilton Garden Inn, Blacksburg, VA.
- Fitch, G. M., Blanco, M., Morgan, J. F., Wierwille, W. W., & Hanowski, R. J. (2010). Human Performance Evaluation of Light Vehicle Brake Assist Systems. Paper presented at the Transportation Research Board (TRB) 89th Annual Meeting, Washington, D.C.
- Fitch, G. M., Hankey, J. M., & Kleiner, B. M. (June 22-26, 2009). Driver Comprehension of Integrated Collision Avoidance System Alerts Presented through a Haptic Driver Seat. Paper presented at the 5th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design Big Sky Resort, Big Sky, Montana, USA.

Gerardo Flintsch

- Flintsch, G.W., "Sustainable Pavement Systems" (Sistemas de Pavimentos Sostenibles), invited workshop presentation, XV Ibero-Latin-American Asphalt Congress (XV CILA), Nov 22-27, 2009, Lisbon, Portugal.
- Flintsch, G.W., "Impact of the Adoption of Mechanistic-Empirical Design methods on Pavement Management" (Impacto de la Adopción de Métodos de Diseño Empírico-Mecanísticos en la Gestión de Pavimentos)," keynote presentation, 7th Uruguayan Road Congress, Oct 7-9, 2009, Montevideo, Uruguay.
- Flintsch, G.W., Ferne, B., and Diefenderfer, B., "R06-F: Development of Continuous Deflection Sensors," SHRP 2 Workshop on the Integration and Implementation of SHRP 2 Pavement Related Research, Nov 17-18, 2009, Washington, DC.
- Flintsch, G.W., Ferne, B., Diefenderfer, B., and Clark, T., "Use of Continuous Deflection Measurement for Network-Level Pavement Structural Assessment," Developing a Research Agenda for Transportation Infrastructure Preservation and Renewal Conference, Nov 12-13, 2009, Washington, DC.

- Flintsch, G.W., and McGhee, K.K., "Quality Management Practices for Pavement Condition Data Collection," scheduled for presentation at the 8th National Conference on Transportation Asset Management - Putting the Asset Management Pieces Together, Oct 19–21, 2009, Portland, OR.
- Flintsch, G.W., "Impact of the Adoption of Mechanistic-Empirical Design methods on Pavement Management" (Impacto de la Adopción de Métodos de Diseño Empírico-Mecanísticos en la Gestión de Pavimentos)," 7th Uruguayan Road Congress, Oct 7-9, 2009, Montevideo, Uruguay.
- Flintsch, G.W., Ferne, B., and Diefenderfer, B., "SHRP 2 R06(F) - Development of Continuous Deflection Device Project Update," TRB AFD80 Annual Committee Meeting, January 2010, Washington, DC.
- Chair, Pavement Evaluation 2010 Conference, Oct. 25-27, 2010, Roanoke, VA.
- Tutorials International Chair, 8th International Conference on Managing Pavement Assets, Nov 15-19, 2011, Santiago, Chile.
- Chair, International Workshop on Sustainable Pavements, in Airlie, VA, January 6-9, 2010, in cooperation with the University of Nottingham.
- Chair, First World Bank – Virginia Tech Knowledge Exchange Workshop on Infrastructure Asset Management.

H. Clay Gabler

- Invited Presentation, "Rollover Risk in Road Departure Crashes," TRB Summer Meeting, AFB20 Roadside Safety Design Committee, Napa, CA (May 2009).
- Invited Presentation, SAE Expert Panel on Event Data Recorders, SAE World Congress (April 2010).
- Best Paper, Roadside Safety, TRB 89th Annual Meeting, AFB20 Roadside Safety Design Committee (2010).

Ron Gibbons

- Alternative Lighting Systems in Roadway, Commision Internationale D'Eclairage Symposium, March 2010, Vienna, Austria.
- Lighting on the Minneapolis I-35 West Bridge, Commision Internationale D'Eclairage Symposium, March 2010, Vienna, Austria.
- Impact of Glare on Driver Performance, Illuminating Engineering Society of North America (IES), Annual Conference, Seattle, November 2009.
- Alternative Light Sources in Roadway Lighting, IES Washington, DC, Section, January 2010.

Presentations and Honors

- Alternative Light Sources in Roadway Lighting, IES Grand Rapids Section, January 2010.
- Alternative Light Sources in Roadway Lighting, IES Maritime Regional Conference, Badek, Nova Scotia, June 2010.
- Committee Chair, IES Roadway Sign Lighting Committee
- Committee Chair, IES Research Committee

Jon Hankey

- Invited to speak at The Eye and the Auto International Conference, September 16-18, 2009, Detroit, Michigan.

Rich Hanowski

- 2009-2010 Governor's Awards Program Nominee (Virginia)
- 2008 SAE Arch T. Colwell Merit Award for outstanding paper (received in 2010)

Warren N. Hardy

- Brain Injury in the Laboratory. Presented May 18, 2010, at The Ohio State University's 6th Annual Injury Biomechanics Symposium, Columbus, OH. Invited speaker.
- Named Associate Professor, Childress Institute for Pediatric Trauma; Wake Forest University School of Medicine, 2009.
- Named Scientific Program Committee Vice-Chair for the Association for the Advancement of Automotive Medicine (AAAM).
- Appointed Director of the Center for Injury Biomechanics (CIB) on the VT campus.
- Named Associate Editor for the SAE Passenger Car Engineering - Mechanical Systems Journal.
- Received a 2010 VT SBES Distinguished Leader in Research award (internal).
- Organizer for the Biomechanics sessions (three) for the SAE World Congress, 2010.
- Organizer for the Abdominal Injury Biomechanics session for the 6th World Congress of Biomechanics, 2010.
- Session chair for the 53rd Conference of the AAAM – Occupant Crash Protection.
- Session chair for one and co-chair for another of the Biomechanics sessions at the SAE World Congress, 2010.

Jeff Hickman

- Hickman, J.S. (2010). Use of an onboard safety monitoring device to reduce commercial motor vehicle drivers' safety-related events. Poster presented at the annual Transportation Research Board conference in Washington, D.C.
- Hanowski, R.J., Olson, R.L., Hickman, J.S., & Bocanegra, J. (2009). Driver distraction in commercial vehicle operations. Paper presented at the First International Conference on Driver Distraction and Inattention in Gothenburg, Sweden, September 28-29, 2009.
- Hickman, J.S., Olson, R., & Hanowski, R.J. (2009). Using Odds Ratios to Determine Estimated Relative Risk of Driving While Distracted. Paper presented at the annual Joint Statistical Meeting in Washington, D.C.
- Hickman, J.S. (2010). Driver distraction in commercial vehicle operations: A naturalistic approach. Paper presented at the annual American Gas Association's annual conference in New Orleans, LA.
- Hickman, J.S. (2010). Driver distraction in commercial vehicle operations: A naturalistic approach. Paper presented at the annual Pike Energy Solutions Customer Safety Summit conference in Washington, D.C.
- Hickman, J.S. (2010). Driver distraction in commercial vehicle operations: A naturalistic approach. Paper presented at the annual Maersk President's Safety Council conference in Charlotte, NC.
- Hickman, J.S. (2009). Distraction in commercial vehicle operations: A naturalistic approach. Paper presented at the annual Network of Employers for Traffic Safety conference in Charlottesville, VA.
- Hickman, J.S. (2009). Distraction in commercial vehicle operations. Paper presented at the annual Marcello and Kivisto, LLC Trucking Safety and Litigation conference in Carlisle, PA.
- Appointed to the Transportation Research Board's Committee on Truck and Bus Safety (ANB70).

Jason Meyer

- Illuminating Engineering Society Annual Conference, November 15-17, 2009, Seattle, WA, "Luminance Metrics for Roadway Lighting," Ron Gibbons, Jason Meyer, Chris Edwards; Virginia Tech Transportation Institute.

David Mellichamp

- Featured staff employee, Virginia Tech Human Resources, 2010.

Presentations and Honors

Justin Morgan

- Whitmire, J.D. II, Morgan, J.F. Oron-Gilad, T., & Hancock, P.A. The effect of in-vehicle warning systems on speed compliance in work zones. Paper presented at the European Conference on Human Centered Design for Intelligent Transport Systems (HUMANIST), April 29-30, 2010. Berlin, Germany.

Hesham Rakha

- Rakha H. (2010). "Energy and Emission Modeling for Intersection Control," Presented in the Emerging Issues in Traffic Signal Systems: Air Quality and Traffic Signal Systems in an IntelliDrive World, TRB Traffic Signal Systems Committee Workshop, 89th Annual Meeting, Jan. 10-14, Washington D.C.
- Rakha, H. A., Fitch, G. M., Arafeh, M., Blanco, M., & Hanowski, R. J. (2010). Safety Benefit Evaluation of a Heavy Vehicle Forward Collision Warning System. Paper presented at the Transportation Research Board 89th Annual Meeting, Washington, D.C.
- Guest speaker at the Transportation seminar at the University of California, Irvine. Sponsored by the University of California, Irvine. Attendance 50 students and faculty.
- Conference Co-Chair: 13th International IEEE Conference on Intelligent Transportation Systems, Madeira Island, Portugal, 19 – 22 September 2010.
- Technical Advisory Committee: 3rd International Conference, Transport Science and Technology Congress (TRANSTEC 2010), New Delhi, 4th – 7th April 2010.
- Associate Editor, IEEE Transactions on ITS.
- Member, Transportation Research Board Committee on Traffic Flow Theory.
- Member, Transportation Research Board Sub-Committee on Traffic Modeling.
- Member, Transportation Research Board Committee on Air Quality.
- Member, ITS America Benefits, Evaluation and Cost Committee.

Andy Schaudt

- Schaudt, W. A., Bowman, D.S., Bocanegra, J., Hanowski, R. J. and Flanigan, C. (2010, March). Enhanced Rear Signaling (ERS) For Heavy Trucks: Mitigating Rear-end Crashes Using Visual Warning Signals. Abstract presented at the Washington Academy of Sciences: Capital Science 2010. Arlington, VA.
- Schaudt, W.A. (2010, January). Enhanced Rear Signaling (ERS) on Heavy Trucks. Transportation Research Board (TRB) 90th Annual Meeting: ANB70 Truck and Bus Safety Committee Meeting. Washington, DC.

- Presiding Officer for the Transportation Research Board (TRB) Annual Meeting Truck and Bus Safety Poster Session, Washington DC, 2010.
- Reappointed the Secretary of the Transportation Research Board (TRB) Truck and Bus Safety Committee for a three-year term.
- Society of Automotive Engineers Technical Papers Reviewer for the Commercial Vehicle Engineering Congress in 2009.
- Accepted to the Professional MBA program at Virginia Tech (began class work in May of 2010).
- Notified in 2010 that a paper authored in 2008 was awarded the 2008 SAE Arch T. Colwell Merit Award.
- First Aid certification awarded July 13, 2009 (expires July 13, 2012).
- Cardiopulmonary Resuscitation (CPR) and Automated External Defibrillator (AED) certification awarded July 13, 2009 (expires July 13, 2011).

Tammy Trimble

- Member, New River Valley Transportation Technical Advisory Committee.

Linbing Wang

- L. Wang, C. Druta, Y. Zhou, C. Harris. "Three-Dimensional Aggregate Evaluation Using Laser and X-Ray Scanning." GeoX 2010: 3rd International Workshop on X-Ray CT for Geomaterials, Feb 2—Mar 3, 2010, New Orleans, LA, USA.