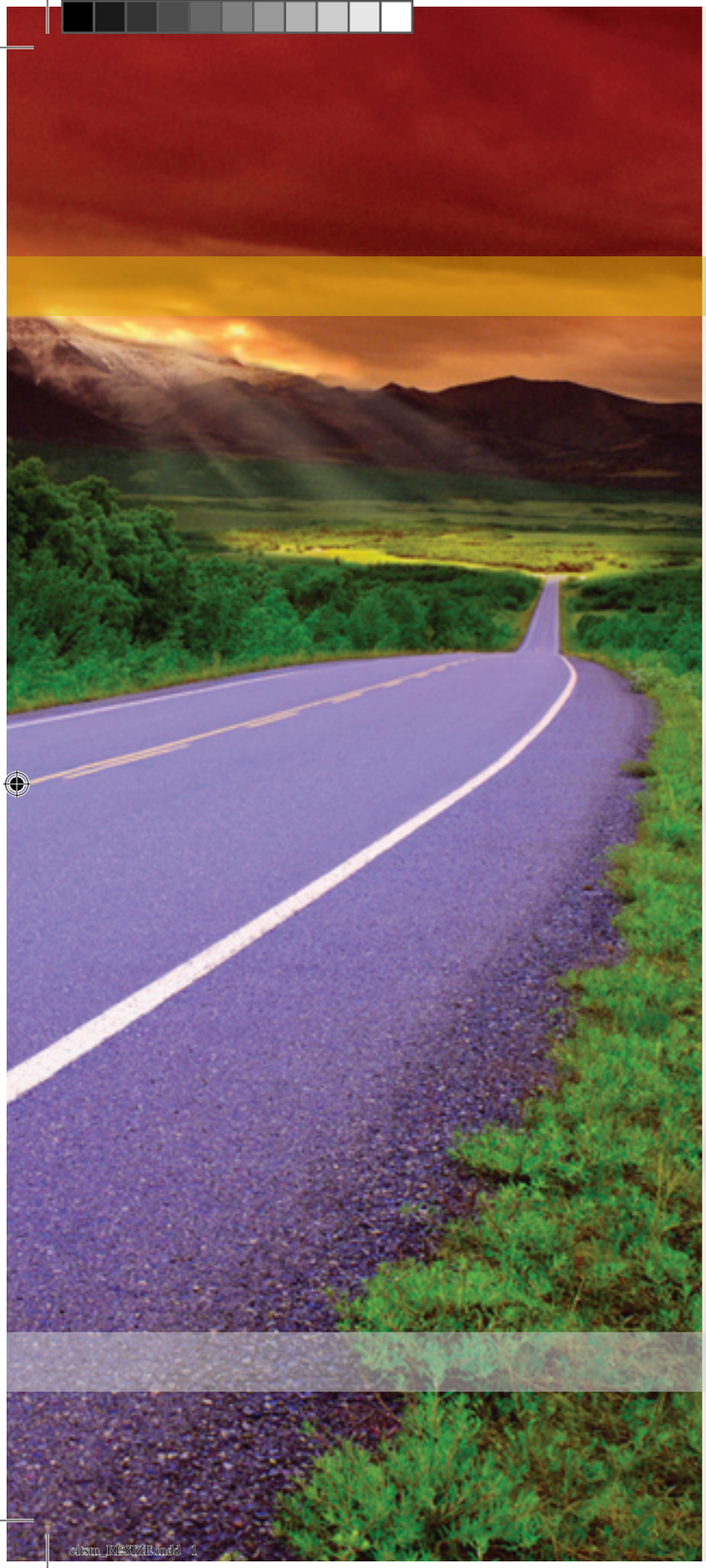
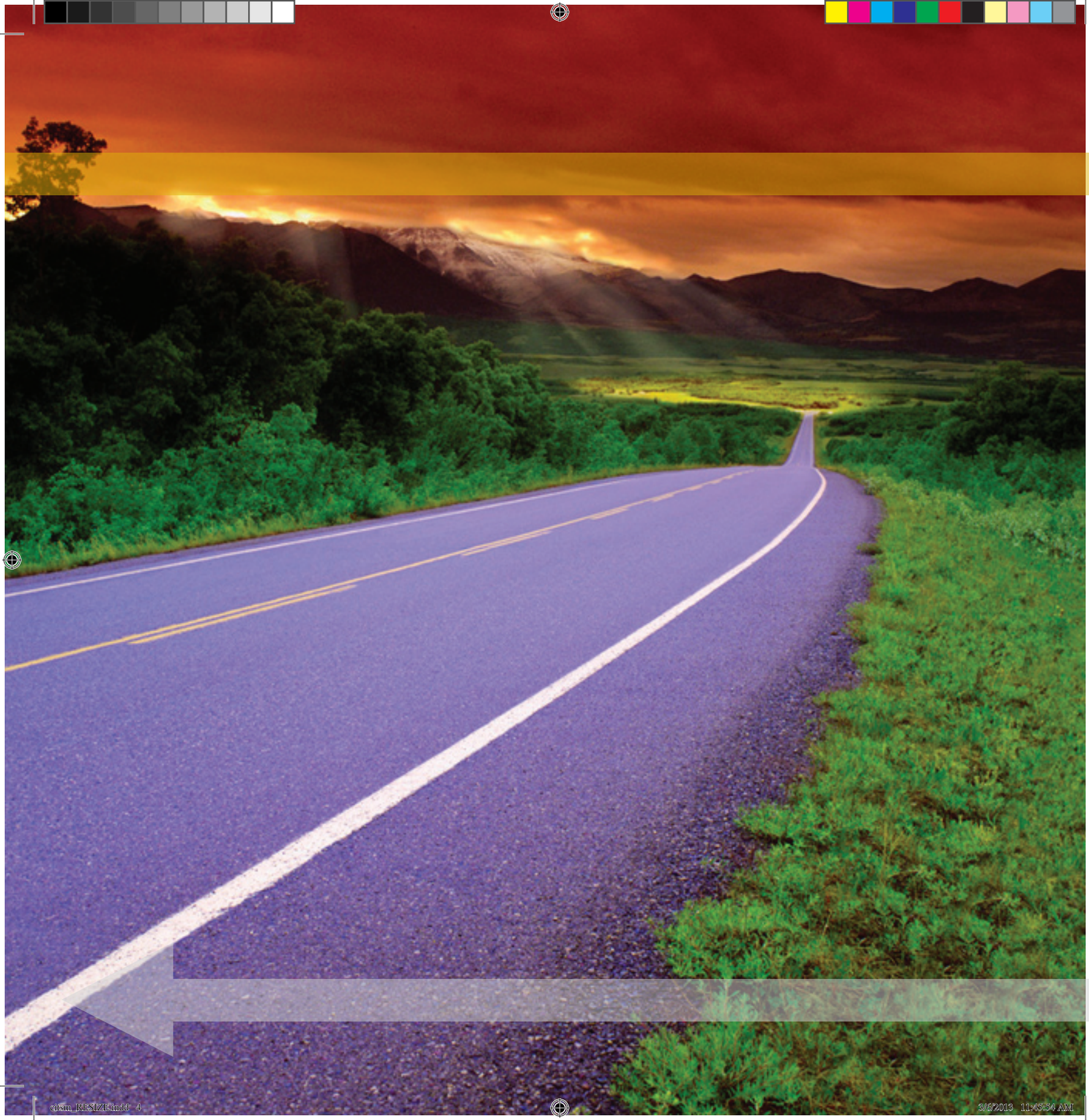


CENTER FOR INTEGRATED TRANSPORTATION SYSTEMS MANAGEMENT

annual report: **2011**



CHAPTER 1: **LETTER FROM THE CITSM DIRECTOR**

The Center for Integrated Transportation Systems Management (CITSM) has completed its third year of operation. In the past three years, the CITSM faculty and researchers have made significant contributions to the state of the art and practice in surface transportation. The research conducted in the center addresses many of the Nation's critical challenges in transportation.

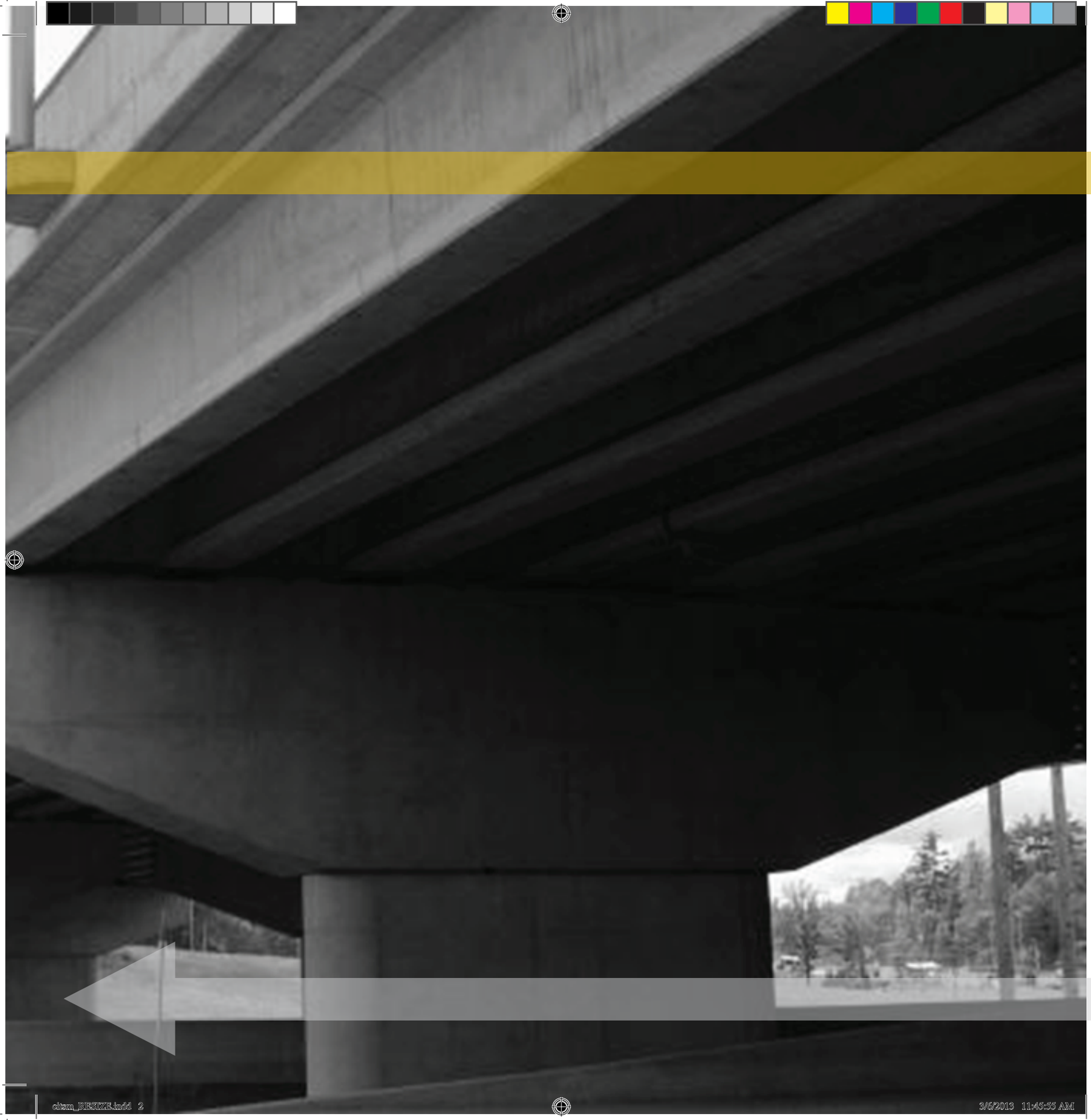
The CITSM research activities in the past three years has been focused on developing new technologies for traffic detection and surveillance, developing new models for improving the efficiency of the transportation systems, developing and using new technologies for real-time travel time prediction, and developing a statewide multi-faceted modeling system intended to support the high level development of transportation policy among others. During this period, the CITSM has funded 48 projects and has supported a cadre of faculty from several departments in the Clark School of Engineering, the School of Architecture, Planning and Preservation, the College of Computer, Mathematical and Natural Sciences, and the Center for Smart Growth. CITSM strives to maintain an interdisciplinary research program that best addresses the national transportation research needs within its theme.

On educational front, the CITSM continued to support the Consortium for ITS Training and Education (CITE), a unique organization of universities and industry associations focused on providing comprehensive training and education related to Intelligent Transportation System technology that is delivered in a manner that is flexible and convenient for its students, and the Operations Academy a nationally recognized activity developed and run by members of the CITSM staff to provide senior management training to personnel within State Departments of Transportation. The CITSM also funded the development and delivery of two new academic courses in intelligent transportation systems, and highway safety. The highway safety Course is to be offered in Fall 2011 and the intelligent transportation systems course will follow in the 2012-2013 academic year.

In April 2011 the University Research Technology Transfer Day hosted by the Research and Innovative Technology Administration was held at the West Atrium Building. This event was organized by the CITSM and showcased the excellent theoretical and applied research work conducted at many University Transportation Centers around the nation. Researchers from 24 different universities, Federal Highway Administration and Federal Aviation Administration showcased some of the outstanding and high impact research that is sponsored by the US Department of Transportation. CITSM faculty and staff worked tirelessly to make this event a very successful one and we are proud to have played a small part in putting together such an outstanding event.

It has been a very productive year for the CITSM. I invite you to browse through this report and learn about exciting projects that are ongoing at the CITSM. I hope you enjoy reading about the details of our accomplishments in the pages that follow. Thank you for your interest and support of CITSM.

Ali Haghani




Q. CUI


G.L. CHANG


C. CIRILLO


C. DAVIS


A. HAGHANI


G.-J. KNAPP

NEW FACULTY

QINGBIN CUI
Assistant Professor,
Civil & Environmental Engineering
INTERESTS
- Infrastructure Finance & Sustainability
- Project Delivery
- Contract Engineering
- Project Complexity
- Global Project Administration

CINZIA CIRILLO
Assistant Professor,
Civil & Environmental Engineering
INTERESTS
- Discrete Choice Analysis
- Advanced Demand Modeling
- Activity-based Models
- Revealed & Stated Preference Surveys
- Large Scale Model Systems
- Value of Time Studies

ALI HAGHANI
Professor & Chair,
Civil & Environmental Engineering
INTERESTS
- Transportation network modeling
- Freight transportation & logistics
- Emergency response
- Dynamic fleet management
- Container transportation
- Mass transit operations

CONTINUING FACULTY

GANG-LEN CHANG
Professor,
Civil & Environmental Engineering
INTERESTS
- Network Traffic Control
- Freeway Traffic Management and Operations
- Real-time Traffic Simulation
- Dynamic Urban Systems

CHRISTOPHER DAVIS
Professor,
Electrical and Computer Engineering
INTERESTS
- Directional Wireless Communication Systems
- Communication networks
- Sensor networks
- Fiber sensors
- Biosensors
- Characterization of Antennas in the Near Field

GERRIT-JAN KNAPP
Professor & Director,
National Center for Smart Growth
INTERESTS
- Smart Growth and Urban Growth Management
- Land Economics and Public Finance
- Environmental Policy

M. K. KHANDANI

E. MILLER-HOOKS

S. MILLER

C. PLAISANT

P. SCHONFELD

L. ZHANG

K. CLIFTON

P. TARNOFF

MEHDI KALANTARI KHANDANI
Assistant Research Scientist,
Electrical and Computer Engineering
INTERESTS

- Communication theory
- Internet security and, in particular, Distributed Denial of Service (DDoS) Defense
- Modeling and Analysis of Wireless Networks
- Vehicular Networking Technologies

ELISE MILLER-HOOKS
Associate Professor,
Civil & Environmental Engineering
INTERESTS

- Stochastic and Dynamic Network Algorithms
- Optimization and Mathematical Modeling with Applications in Transportation
- Regional and Building Evacuation
- Emergency Preparedness, Response and Recovery
- Transportation Infrastructure Vulnerability and Protection
- Routing and Scheduling
- Hazardous Materials Routing
- Inter-modal Goods Transport
- Collaborative and Multiobjective Decision-making

STUART MILNER
Research Professor & Director,
Center for Networking of Infrastructure Sensors
INTERESTS

- Scalability of Dynamic Wireless Net works and Topology Control in Hybrid Free Space Optical/RF Directional
- Wireless Networks
- Optical Wireless Sensor Networks for Critical Infrastructure Surveillance
- Broadband optical/RF Wireless Networks

CATHERINE PLAISANT
Research Scientist & Associate Director of Research,
Human Computer Interaction Lab
INTERESTS

- Information Visualization
- Digital Libraries
- Universal Access
- Image Browsing, Help
- Digital Humanities
- Technology for families
- Valuation methodologies

PAUL SCHONFELD
Professor,
Civil & Environmental Engineering
INTERESTS

- Transportation Engineering

LEI ZHANG
Assistant Professor,
Civil & Environmental Engineering
INTERESTS

- Transportation and Urban Systems Analysis
- Land Use and Transportation Planning
- Transportation Economics and Policy
- Innovative Pricing and Financing
- Infrastructure Project & Policy Evaluation
- Traveler Information Systems
- Mathematical and Agent-based Simulation Models with Applications in ITS
- Demand Forecasting
- Network Dynamics

FORMER FACULTY

KELLY CLIFTON
Assistant Professor
INTERESTS

- Interactions between Land Use, Transportation and Human Behavior

PHIL TARNOFF
Former Director
INTERESTS

- Development of Advanced Technology
- Improved Processes
- Enhanced Organizational Structures for the Integrated Management and Operation of Transportation Facilities and Corridors

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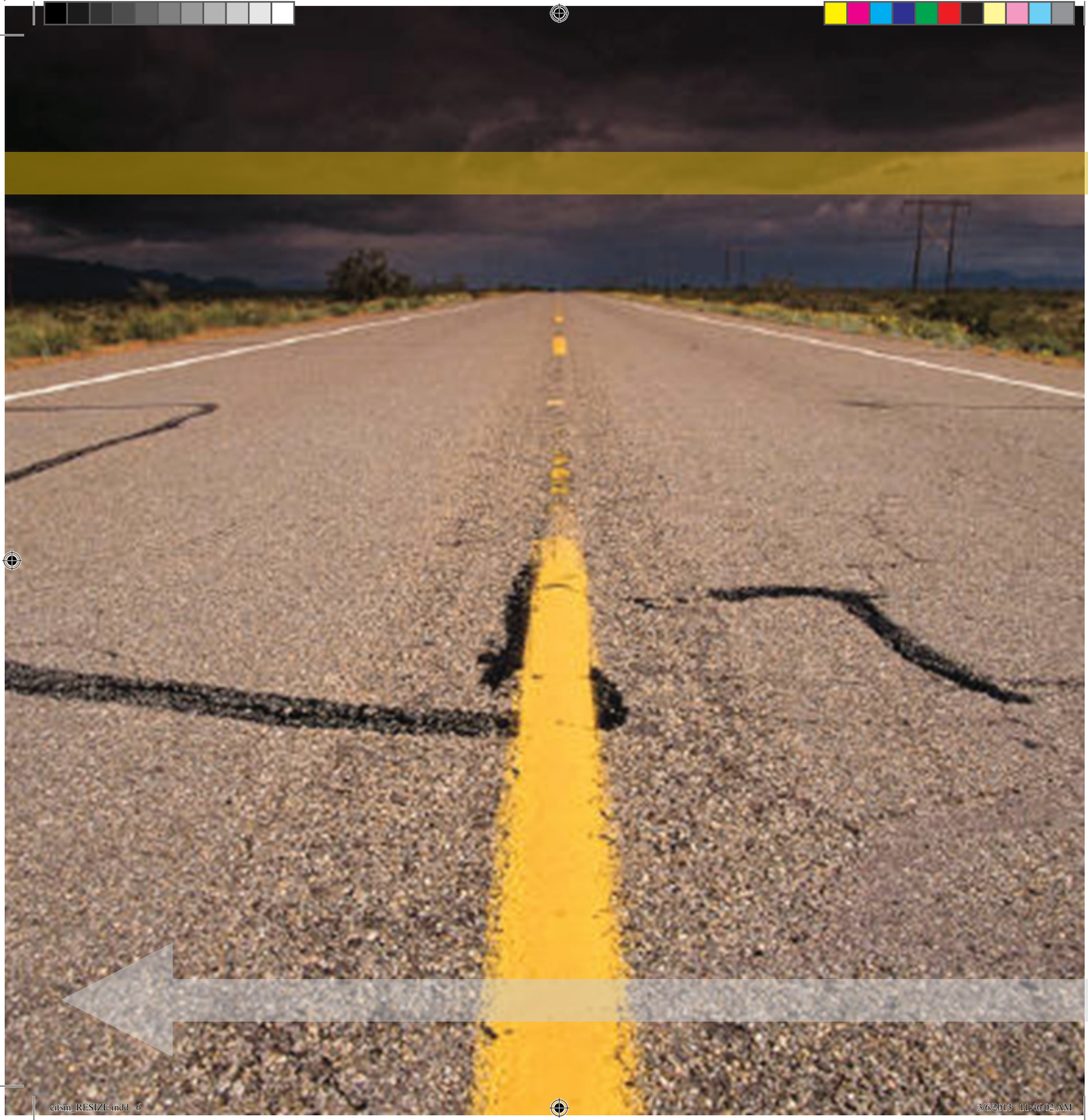
Director

MASOUD HAMEDI
Assistant Director

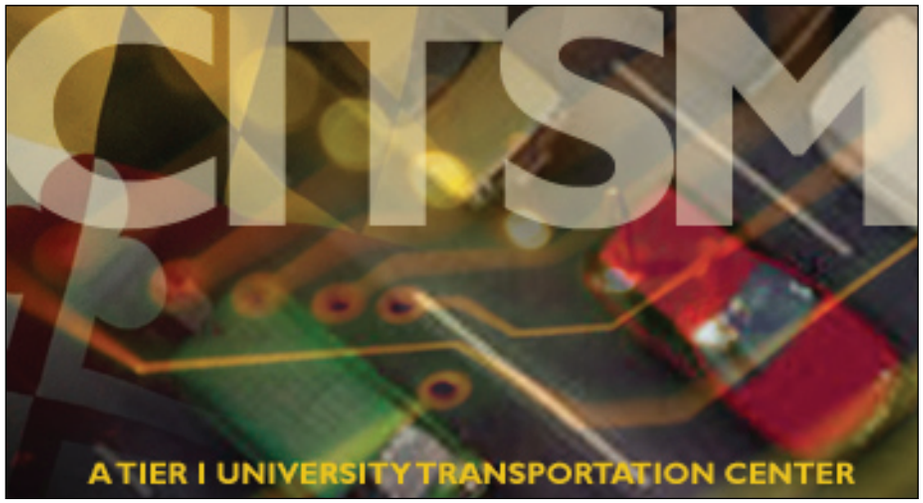
N'KOLA (NIKKI) MORRIS
Accounting Associate

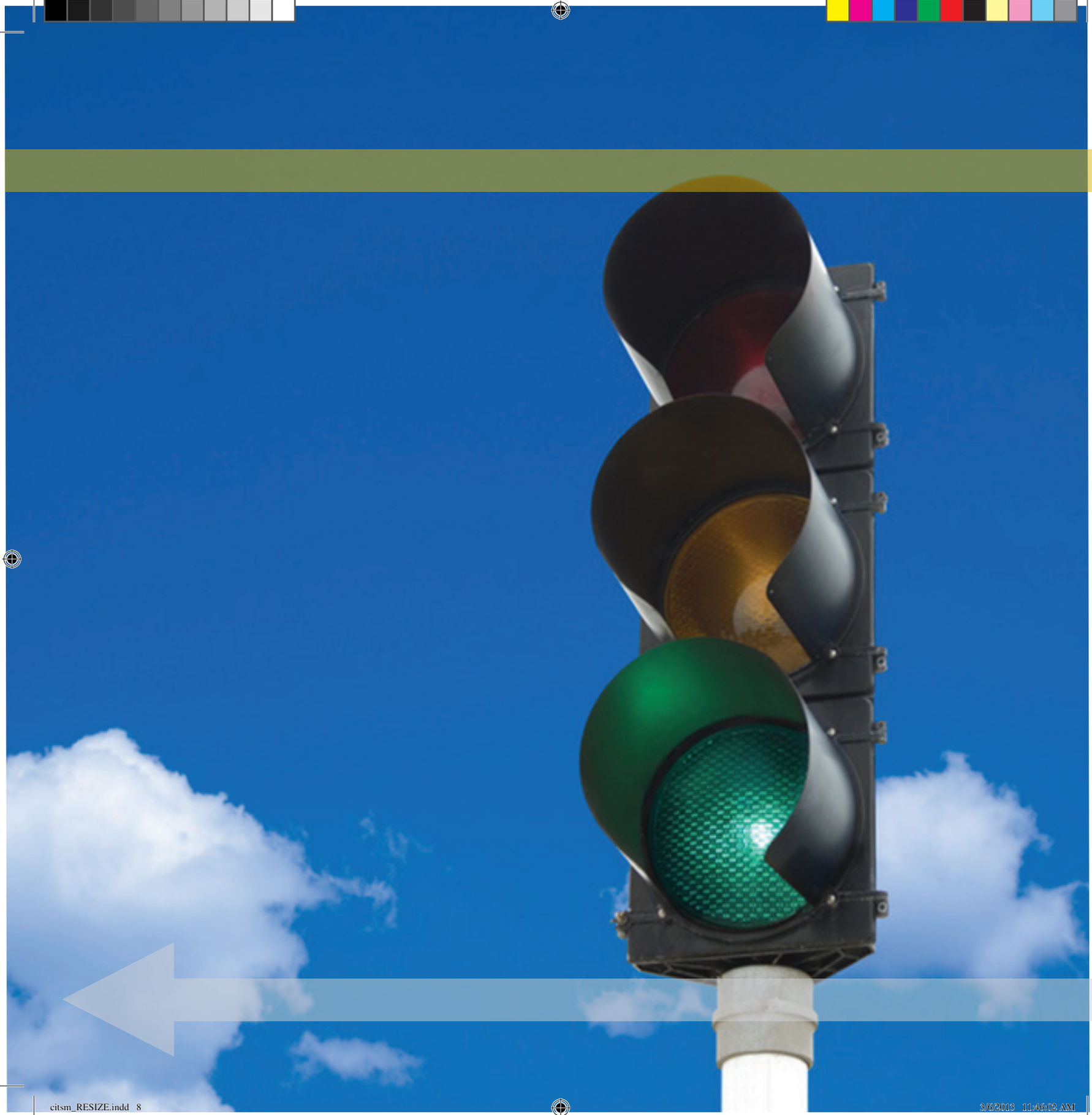


CHAPTER 3: **CITSM THEME**

The theme of the CITSM is "Integrated Transportation Systems Management". The Center conducts research and provides education and technology transfer related to this theme. The goal of the Center is to provide improved mobility and reduced congestion for travelers and shippers using the nation's transportation system. The objectives of the Center include the development of advanced technology, improved processes and enhanced organizational structures for the integrated management and operation of existing transportation infrastructure and facilities. Because of the significance of the problems addressed by this theme, parallel research activities are underway within other Universities and their transportation centers. The CITSM activities are coordinated with these other programs such as the work related to mobility in the northeast corridor being conducted by the Institute for Public Administration at the University of Delaware.

Our theme recognizes the likelihood that additions to the capacity of transportation facilities will fail to keep pace with demand, and that the public will increasingly require that existing and planned facilities be managed and operated as efficiently as possible. Current management and operations (M&O) inadequacies reflect inadequate emphasis on this aspect of the transportation system, as well as a shortage of appropriately trained personnel, technological deficiencies, and incompatibilities with existing administrative and political structures. These problems are further compounded by the stove-piping of management functions such that there is little interaction between planners, engineers and operators, and still less interaction between the organizations responsible for the M&O of various transportation modes. These issues are directly addressed by the CITSM theme, which emphasizes a balanced approach to integrated M&O that focuses on education, technology and organizational needs. The Center's activities are further enhanced through the creation of a strong outreach program to ensure that its research successes are implemented by transportation practitioners.





CHAPTER 4: **CITSM SCOPE**

The CITSM is concerned with the integrated operation of all modes serving the nation's transportation system, including the institutional issues associated with their management and operation. A balanced multi-modal approach will be used that considers freight and passenger mobility, as well as system operation during periods of both recurring and nonrecurring congestion, including response to major emergencies. The modes included in this theme include highway, transit, rail, and inter-modal interfaces including ports, terminals and airports. The scope of the center is best described in terms of eight overarching topic areas presented below that address both technical and institutional issues. The activities associated with each of the topic areas include research, education and outreach.

Transportation System Data Acquisition and Monitoring. Integration of currently independent information sources, including electronic forms of system monitoring, monitoring of video images, and manual data inputs, is required for the creation of a fully integrated system in which automated vision processing and data fusion techniques can be applied to acquire a comprehensive picture of existing conditions within the transportation system. Knowledge of such conditions can greatly aid in congestion management, emergency response, private or public sector fleet management and other operations within the transportation system.

Real-time System Management and Operations. Existing management and operations focus on the independent needs of incident and emergency management, traffic signal operations, tolling and other demand management strategies, transit operations, and terminal (port and airport) operations. Rarely are these independent activities combined and coordinated in a manner that takes advantage of available capacity and the unique ability of these activities to influence demand. The potential of coordinated operation has been demonstrated by a number of research activities, such as a study performed at the University of Maryland under the Vehicle Infrastructure Integration (VII) project funded by the RITA's ITS Joint Programs Office. This study demonstrated that coordinated operation of facilities offers the potential for reducing vehicle delays by more than 50% in the presence of major incidents. CITSM researchers will focus on the development of processes and decision support tools that will facilitate coordinated system management and operations.

Transportation System Safety. In 2005, there were more than 43,000 transportation system-related fatalities in the US and nearly 1.2 million fatalities worldwide. By most definitions this would be considered a pandemic, with transportation-related accidents ranked as the third leading cause of death, ahead of more highly publicized death causes such as wars (ranked number 8) and HIV (ranked number 10). Victoria, Australia proved that the problem can be effectively addressed, decreasing the fatality rate by 60% in fifteen years, to a rate that is approximately ½ that of the United States. The Victoria success relied on a combination of technology, enforcement and political will. The CITSM research, education and outreach activities are well suited to address this problem by focusing on the political processes that must be energized in order to replicate the Victoria experience. In addition to the obvious benefits of reducing the human cost associated with crashes, improved safety will improve the travel reliability of the system.

Transportation Systems Planning. Consideration of the transportation system as subsystems of networked infrastructure and of the interactions between these subsystems can greatly affect performance. The Center faculty and staff will

develop techniques for planning and operating both single-mode systems (such as transit, rail, highway, air) and multi-mode and inter-modal systems (such as inter-modal freight transport systems involving rail, waterways, roadways, ports and terminals) with special attention to potential efficiencies that can be gained through integration and resulting seamless operation. Research projects undertaken within the CITSM will also focus on the development of modeling and other analysis techniques that will permit the extension of system planning to emphasize not only construction of new facilities and expansion of existing facilities, but also changes to operations and interactions between supply and demand that can lead to more efficient use of existing facilities.

Management and Operations in Extreme Events. Human populations are faced with numerous hazards, both natural (e.g. hurricanes, earthquakes, tornados, tsunamis, volcanic eruptions, flooding, mudslides, wildfires) and human-caused, whether accidental (e.g. a hazardous materials release or a nuclear power plant malfunction) or purposeful (e.g. terrorist attack), that have the potential to cause significant devastation. The Center faculty and staff offer a unique range of hands-on knowledge of the issues and procedures associated with emergency preparedness and response. Integrated, coordinated operations are essential in the preparation for such an event and in the decision-making and emergency response that immediately follow.

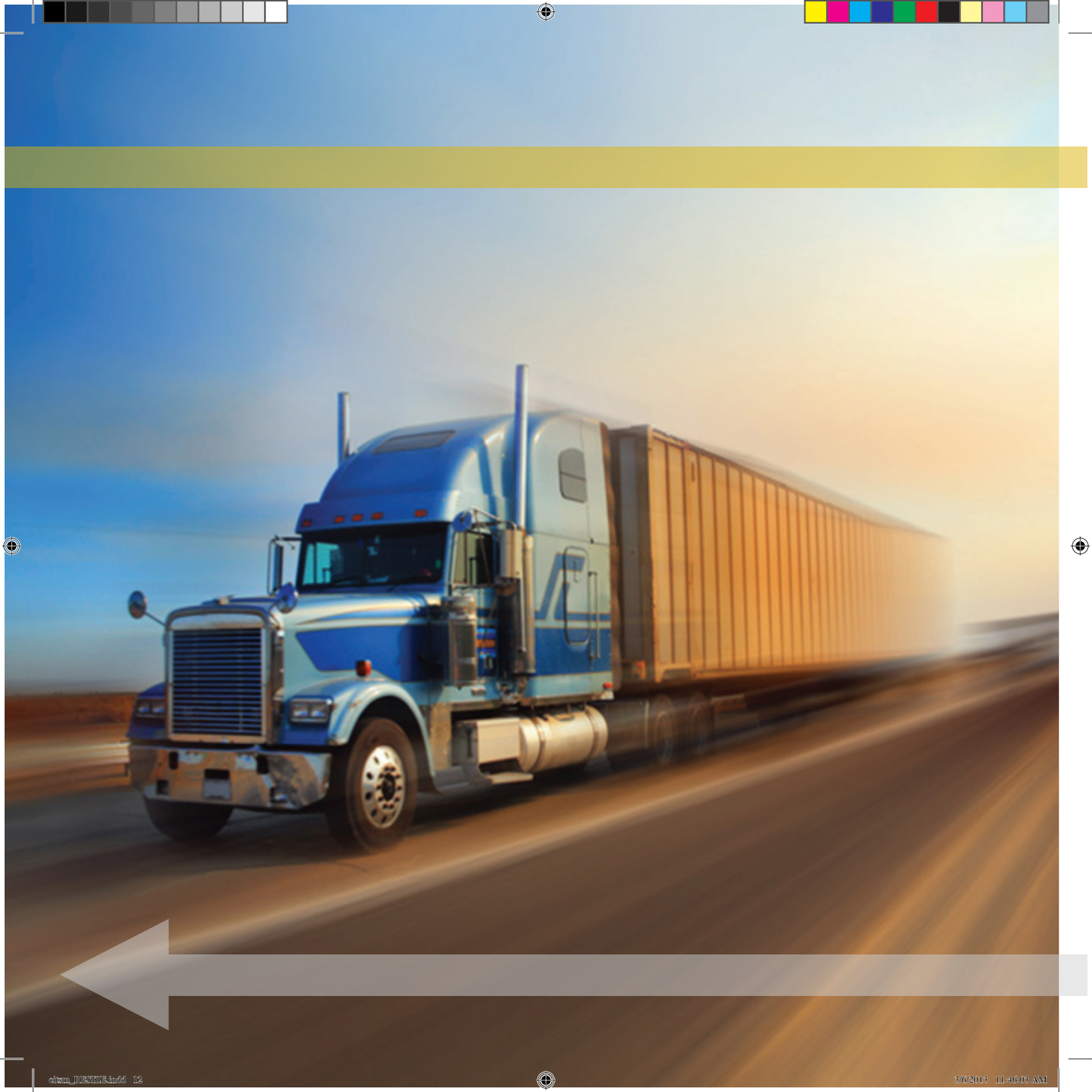
Information Dissemination to System Users and Operators (including traveler information). One of the most significant shortcomings of today's transportation systems is the absence of integrated information regarding system status. This shortcoming reduces the ability of public agencies to manage the system and prevents travelers, carriers, shippers, and others from making informed decisions regarding the best route, departure time, and mode to use for their intended trip. Existing efforts (e.g. the 511 phone number) are only a first step in providing such information, because their geographic scope is limited and the data are rarely integrated in ways that support informed decision-making. In research conducted within CITSM, integration of data sources and presentation of information in ways that facilitate travel decisions will be emphasized.

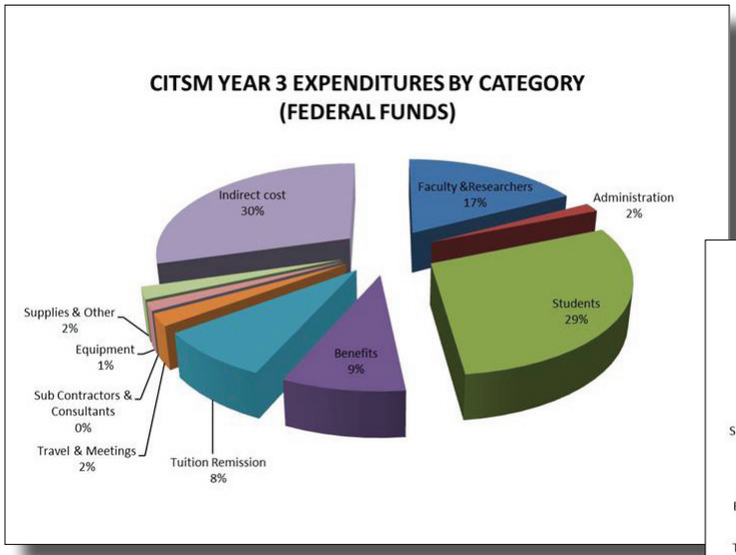
Performance Measurement. The Center's activities will focus on development of performance measures to facilitate integration of transportation management and operations. Center faculty and staff have played a lead role in the develop-

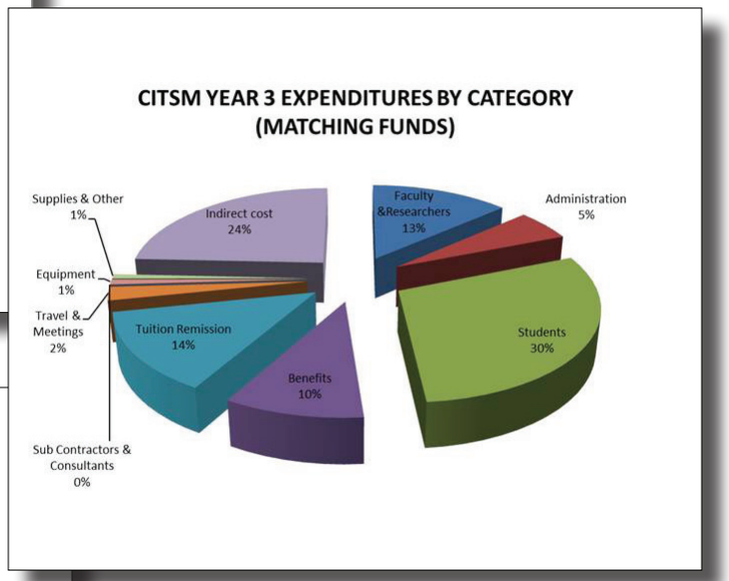
ment of mobility performance measures locally, regionally and nationally. Their work addresses the entire spectrum of performance measurement, from the regular assessment of performance of the State of Maryland's traffic management activities to the development of national standards for measuring mobility. Their activities include the development of measures to support planning, engineering, operations and staff management. Such measures are intended for use in communicating with the public, state legislature and regional Metropolitan Planning Organizations (MPOs) in both the Baltimore and Washington, D.C. regions. The focus of research under the CITSM will be on the development of outcome-oriented and system-wide performance measures as opposed to functions related to performance of facilities that fall within the purview of a particular agency.

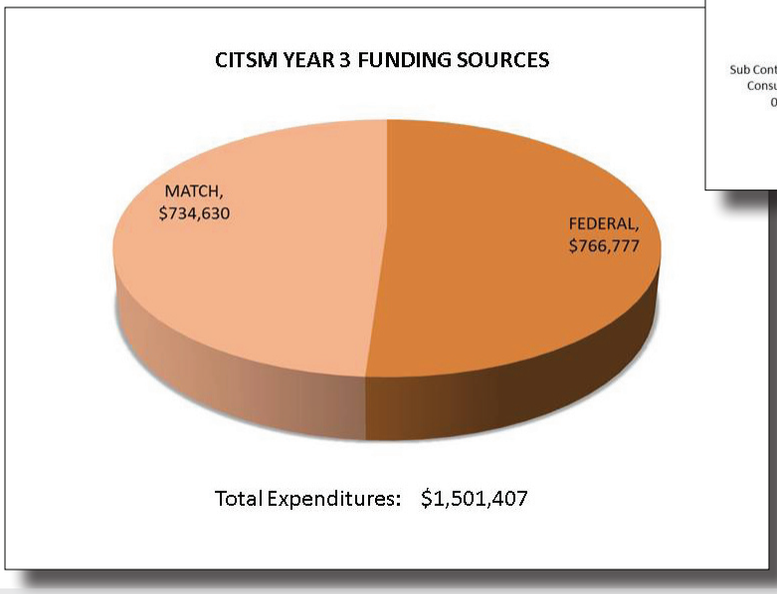
Policy and Institutional Issues. The challenges that the Center's faculty and staff have faced in their ongoing involvement with regional transportation system management and operations (e.g. CapWIN and RITIS) have highlighted the significance of policy and institutional considerations when attempting to establish an integrated transportation system. Existing institutions are intended to serve the local jurisdictions in which they reside. Little credit is given to politicians who think regionally rather than locally. Parochialism is further promoted by required planning (and funding) processes in which projects are initiated by local jurisdictions. This is often done in a manner that discourages region-wide and system-wide support. Activities undertaken within the Center will study deficiencies that exist in the structure of, and coordination between, the various local, regional and federal transportation agencies and the resulting impact of these deficiencies on system performance. The absence of an integrated strategy has led to, for example, significant insufficiencies in intermodal transport as a result of the current structure of modal-based agencies.

These topics, while varied in nature, are united by the common theme of developing a fully integrated approach to managing and operating available transportation resources. As appropriate, research projects will focus on the development of near-term mitigation strategies for traffic congestion and more basic, exploratory findings whose effects may be experienced further in the future.









Prototyping A Low Cost and Scalable Wireless Sensor Network for Traffic Measurement

Dr. Mehdi Kalantari Khandani,
Electrical and Computer Engineering (CITSM)

In this project, we develop low cost, low profile, and energy self-sufficient sensor modules for different applications of intelligent transportation systems. The proposed sensors harvest the mechanical vibration in street pavement and convert it to electrical energy for operation of sensors. As an important application of this architecture, prototyping and field evaluation will be done for a variation of the proposed sensors that measure quantities such as traffic volume, speed, density, and distribution of vehicle lengths. Compared to the existing solutions, the proposed architecture is economical, easy to install, easy to maintain, and energy self-sufficient.

We expect the following outcome for this project: (i) Architectural design, development, and implementation of wireless sensors that harvest their energy from vibration in the road pavements; (ii) Signal processing techniques and algorithms to convert raw data of sensors into quantities such as space mean speed, vehicle length, etc. and, (iii) reports on road evaluation of the developed sensor in field experiments and simulations.

Modeling Car Ownership Decisions and Vehicle Availability in the State of MD

Dr. Gerrit-Jan Knaap,
Urban Studies & Planning (CITSM, MDSHA & NCSG)

Under a contract with the Maryland State Highway Administration and in cooperation with Parson's Brinkerhoff, the National Center for Smart Growth is building a sketch-level transportation model. That model, which will include the entire states of Maryland and Delaware, the District of Columbia, and parts of Virginia, West Virginia, and Pennsylvania will be used for a variety of purposes, including but not limited to examining the effects of various transportation investments on traffic flows, examining the effects of transportation investments on land use patterns, and examining alternative future development scenarios. The model is expected to play an important role in transportation decision making for years into the future. Among the many policy decisions that must be made in the near future is how to respond to climate change. A recently issued report from the Maryland Climate Commission recommends that emissions associated with vehicle miles traveled be reduced by 25 to 50 percent of 2006 levels by 2020. Interim reduction goals are 10 percent by 2012 and 15 percent reductions by 2015, respectively. Under this project supported by the Maryland University Transportation Center, researchers at the National Center for Smart Growth will enhance the capacity of the transportation model and exercise the model to explore alternative options for meeting these greenhouse gas reduction goals.

A Proof-of-Concept and Demonstration of a High Definition, Digital Video Surveillance and Wireless Transmission System for Traffic Monitoring and Analysis

Dr. Christopher Davis,
Electrical & Computer Engineering;
Dr. Stuart Milner,
Civil & Environmental Engineering
(CITSM & various industry sources)

In this applied research project, we plan to conduct a proof-of-concept and demonstration of a high definition (HD), digital video surveillance and wireless transmission system for traffic monitoring and analysis, enabled by rapidly deployable, RF directional wireless links. This system will also provide improved capabilities to emergency responders. The demonstration will consist of HD cameras networked through a 4-node directional wireless network on the University of Maryland campus, and will include the development

of real-time "event" detection algorithms specially tailored to our unique combination of HD image capture, wireless transport, and real-time processing. This project will lead to a greater understanding of video technology and image analysis requirements for HD traffic analysis with rapidly deployable advanced wireless systems. It will further allow analysis of gaps between current practice and capability vis-à-vis our HD, high capacity, and deployable wireless image transport system.

Discovering and Communicating Temporal Patterns within Incident Data
Dr. Catherine Plaisant,
Human Computer Interface Lab (CITSM & HCIL)

While the transportation community emphasizes developing standards for archiving and transmitting raw incident data, little effort has been made to design appropriate visual analytics tools to explore the data, extract meaningful knowledge, and represent results. To improve the integrated management of transportation facilities we believe that novel designs are needed for (1) enabling exploratory search of rich incident data, (2) providing user-controlled visualizations of results, and (3) facilitating cause and effect analysis. Traditional safety and incident analysis has mostly focused on incident attributes data (such as the location and time of the incident or type of vehicle involved). In this project we will focus on exploring temporal aspects that are often overlooked e.g. the length of time there has been water on the road, how long it took for responders and equipment to arrive on scene, the length of time that lanes were blocked or closed, etc.)

By bridging the worlds of databases, user interface design and information visualization, we believe that we can create the next generation of potent visual analytic tools for temporal data exploration of incident data. After 30 years in which SQL was the dominant query framework, we offer a fresh visual approach that promises to impact theory and practice for temporal data exploration, which can in turn help identify both effective countermeasures and improve the integrated management of transportation systems

Intermodal Transfer Coordination in Logistic Networks
Dr. Paul Schonfeld,
Civil & Environmental Engineering (CITSM)

A model will be developed for integrating and optimizing logistic networks relying on intermodal transfers. It will combine (1) a pre-planning component for optimizing system characteristics such as terminal and vehicle characteristics, routes and schedules, and (2) real-time control algorithms for dealing with service disruptions.

Traffic Data Collection and Anonymous Vehicle Detection Using Wireless Sensor Networks
Dr. Ali Haghani,
Civil & Environmental Engineering (MDSHA)

In this project, we develop low cost, low profile, and energy self-sufficient sensor modules for different applications of intelligent transportation systems. The proposed sensors harvest the mechanical vibration in street pavement and convert it to electrical energy for operation of sensors. As an important application of this architecture, prototyping and field evaluation will be done for a variation of the proposed sensors that measure quantities such as traffic volume, speed, density, and distribution of vehicle lengths. Compared to the existing solutions, the proposed architecture is economical, easy to install, easy to maintain, and energy self-sufficient. We expect the following outcome for this project: (i) Architectural design, development, and implementation of wireless sensors that harvest their energy from vibration in the road pavements; (ii) Signal processing techniques and algorithms to convert raw data of sensors into quantities such

as space mean speed, vehicle length, etc. and, (iii) reports on road evaluation of the developed sensor in field experiments and simulations.

Development of Advanced Applications Using Bluetooth-Generated Traffic Flow DATA

Dr. Ali Haghani,
Civil & Environmental Engineering (CITSM)

Because of the quality and large sample size of the Bluetooth data sets, this project is focused on research related to the use of this data for advanced analysis of the traffic conditions that existed at the time that the data was collected. This research is intended to address both near-term analytical challenges and long-term applications.

In the first year, research personnel of the CATT successfully developed and demonstrated a new technology for the collection of travel times and space mean speeds of traffic based on the reception of signals emitted by Bluetooth equipped electronics (PDAs, cell phones, car radios, laptop computers, etc.) located in passing vehicles. Bluetooth is a standards-based, pervasive wireless networking protocol whose use is rapidly expanding throughout the computer electronics industry.

In the second year, focused on the following topics: Real-time short term freeway travel time prediction under an innovative automatic vehicle identification setting and the of Bluetooth data to evaluate the impact of variable message sign (VMS) (also known as dynamic message sign (DMS) messages on traffic diversions;

This year (year three), the team has been focusing on the following:

- Continued use of Bluetooth data to evaluate the impact of variable message sign (VMS) (also known as dynamic message sign (DMS) messages on traffic diversions;
- Developing procedures for distinguishing between motor vehicles and pedestrians in urbanized areas;
- Automatic identification of the existence of freeway incidents;
- Predicting the impacts of incidents on travel time

On the Maryland side of the Beltway discussions about HOT lanes as a possible strategy to reduce congestion and collect revenues for other major infrastructure investments is at a much earlier stage. Therefore, with this project we propose to investigate the acceptability of HOT lanes and the willingness to pay for their use from the traveler perspective. In particular, we aim at formulating a model system that simulates individual behavior in response to HOT lanes on

I-495 in Maryland. The project will utilize state-of-art and advanced discrete choice models to calculate the number of riders that will be willing to pay to use HOT lanes, the distribution of the willingness to pay and the main factors affecting their choices. Furthermore, our objective is to capture the ability of travelers to change their behavior in response to congestion pricing and their flexibility to accept more sustainable way to access work, shopping and leisure places. Finally the project team intends to establish a continuous dialog with local State agencies in order to adapt our modeling tool to their needs in terms of policy analysis.

A Cognitive Systems Approach to Managing the Movement of Large Crowds

Dr. Elise Miller-Hooks,
Civil & Environmental Engineering (CITSM)

This project will develop techniques to support design and assembly of a cognitive and adaptive system for the management of crowds during a large-scale public event or emergency evacuation. In a cognitive systems approach, system design is based on supporting goals at both system and individual levels. Such an approach is well-suited to the management of pedestrian movement in complex situations with high levels of uncertainty. In these situations, the goals of the pedestrians, security personnel and other system users or operators change during the course of the event in response to environmental factors that are affected by both evolving conditions associated with the physical surroundings and crowd movement and growth. Assistance provided by such a system can aid in alleviating over-crowding, improving flow rates, and regaining individual control of personal movement, thus, gaining greater efficiency from the existing physical capacity. Instructions that are provided are suited to individual priorities and goals, improving adherence to given directives. This research effort will culminate in (1) designed strategies for instructing system operators and users so as to improve event efficiency, safety and security while exploiting knowledge of individual and crowd behavior and rules and (2) a working system prototype of a cognitive and adaptive control framework that enables (a) changing goals of the crowd manager, security personnel and system users; (b) changing instructions that reflect knowledge of changing goals, evolving conditions associated with the physical environment, and the evolution of crowd movement and growth; and (c) response by system users to instructions that are updated as a consequence of improved situational awareness and changing environmental conditions.

Departure Time Choice Model in the Presence of Time-of-Day Toll Pricing

Dr. Cinzia Cirillo,
Civil & Environmental Engineering (CITSM)

Express Toll Lanes (ETL) initiative is Maryland's statewide initiative aimed to provide cost-effective way for congestion management including toll pricing and

managed lanes. As a consequence, this initiative is expected to implement toll pricing on major Maryland's corridor including the Intercounty Connector (ICC), the capital beltway (I-495), and the I-95. One of the pricing schemes considered by the initiative is the time-of-day toll pricing scheme where toll price is adjusted in correspondence to the time of day or on the basis of the traffic conditions.

This pricing scheme is gaining attention as a travel demand management strategy by providing incentive to travelers with more flexible departure time to travel during off peak period, thereby shifting peak travel demand. Meanwhile, travel demand model that forecasts the time when trips are taken need to be developed. Modeling departure time is essential for policy makers evaluating travel demand management alternatives, such as time-of-day toll pricing. Different toll prices by time of day induce traveler to perceive departure time choice similar to the mode choice selection. This modeling framework is challenging for analysts. First, the choice of departure time has to be identified or approximated either by simulation or by means of stated preference survey. Next, the interdependency of departure time choice and mode choice has to be carefully examined. The traditional approaches dealing with time of day estimate time of day factors (TODF) from observed data and assume that the same behavior will pertain in the future; this technique is used to estimate traffic volume by time period using the TODF. The newer methodologies such as "Peak Spreading" improve the limitation of TODF approach by accounting for the excess demand in certain corridors during the peak period and allow for more realistic assessment of travel condition in the future. However, peak spreading approach has relatively weak behavioral foundation and cannot fully address travel response to system changes; for instance, it cannot be used to fully analyze policy changes or the effects of travel demand management actions. The departure time choice, on the other hand enable analyst to assess the extent to which travelers respond to congestion at disaggregate level.

Despite the widespread interest in the concept of departure time choice, there is very little empirical study on the impact of departure time choice in the presence of time-of-day toll pricing (especially in Maryland). This project proposes an empirical study that integrates the joint effects of departure time and mode choice. We will consider variables affecting departure time such as travel time, travel cost, travel time reliability and activity duration. The presence of time-of-day toll pricing will be taken into account in the model estimation process to develop a model that represents behavioral responses to pricing. Possible response of traveler to pricing in term of mode shift and departure time shift will be carefully examined. The extent to which the model could aid local agencies to achieve several objectives including toll revenue, system performance, and environmental impact will be examined.

A Comprehensive Approach for Evaluating Value Pricing and Innovative Financing Policies

Dr. Lei Zhang,
Civil & Environmental Engineering (CITSM)

This project will develop a comprehensive quantitative approach for evaluating the impact of value pricing and innovative financing policies on transportation system performance, considering both the revenue generation and reinvestment stages (hence the word "comprehensive" in the project title). System performance measures include efficiency (e.g. delay, travel time), equity (e.g. distributional effects on various income groups), and sustainability (e.g. fuel consumption, emissions).

This research will achieve the research objectives by answering the following specific questions:

- How is transportation revenue (fuel

tax revenue, toll revenue etc.) currently invested by various authorities?

- What are the impacts of value pricing and innovative financing policies on transportation system performance and various user groups in the long run, under the existing investment process? How about under alternative investment processes (e.g. revenue dedicated to highway capacity expansion, or more revenue invested on transit, or direct compensation to certain user groups)?
- How will the consideration of user benefits from revenue reinvestment influence the evaluation results?
- How can findings from this research be incorporated into policy debates on congestion pricing, transportation revenue generation, and transportation investment?

Developing a Data and Modeling Framework for Integrated Transportation Operations and Planning

Dr. Lei Zhang,
Civil & Environmental Engineering (MDSHA)

This research project has three main objectives:

1. Develop a route choice/traffic diversion model based on existing travel behavior data for the ICC (Inter-County Connector) study area.
2. Develop a peak spreading model to capture departure time choice decisions based on existing travel behavior data for the ICC study area.
3. Integrate the traffic diversion and peak spreading models with a microscopic traffic simulation model for the ICC study area.

Development of An Integrated Multi-modal Simulation System for the I-270 Commuting Corridor

Dr. Gang-Len Chang,
Civil & Environmental Engineering (CITSM)

The primary objective of this study is to develop an integrated multimodal simulation system for the I-270 corridor, which includes the I-270 freeway and its parallel routes, the subway and rail lines from the city, Germantown, all way to the I-495 Capital Beltway. The proposed system shall serve as an effective tool for responsible transportation agencies to address the following vital issues:

- The impact of HOT and other control strategies on the distribution of traffic patterns along the I-270 freeway and among all available commuting transportation modes;
- The cost-benefit of any proposed new supply-side congestion mitigation plan, such as additional travel lanes, light rail line, BRT, and their impacts on the distribution of daily travel demand among all transportation models;
- The impact of any major land-use development on the spatial and temporal distribution of traffic congestion patterns; and
- The optimal distribution of commuting trips between all available modes during major incidents where one or more modes suffer a substantial capacity reduction.

Cost-benefit Analysis of the Use of Carbon Credits in Transportation System Development and Management

Dr. Qingbin Cui,
Civil & Environmental Engineering (CITSM)

The overall goal of the proposed research is to evaluate the benefit and cost of participating in the carbon market for transportation agencies, including Metropolitan Planning Organizations, State Highway Agencies, airports, transit authorities, and so on.

The research will also define the elements of a carbon credit program, and identify opportunities, challenges, administrative efforts and costs to develop such carbon credit program. It is expected that the successful completion of this research project would provide transportation

agencies with a decision model and procedure for developing agency's carbon credit program.

In particular, this research will:

- Document U.S. and international carbon markets and regulatory regimes
- Identify the trading mechanism, including instruments, entry requirement, market liquidity and volatility, compliance requirement, verification and credit pricing method, etc.
- Evaluate the feasibility of transportation agencies participation
- Determine the risks, institutional challenges, and regulatory issues
- Develop a market entry decisio model
- Develop guidance for developing agency's carbon credit program

Understanding the Potential Impact of Various DMS Messages on Traffic Flow

Dr. Ali Haghani & Michael Pack, Civil & Environmental Engineering (MDSHA)

Knowledge of rapidly changing traffic conditions gives road users the option to modify their behavior in order to avoid delays and dangerous situations. Many states, as part of an Advanced Traveler Information System (ATIS), have installed Dynamic Message Signs (DMS) in order to help provide this information.

While most agree that DMS are a valuable tool in reaching motorists and conveying important information, there has long been speculation that DMS messages could possibly adversely affect traffic conditions, too. Recent publicity surrounding the new travel time messages on DMS have rekindled this debate. The question remains: can a message posted onto a DMS adversely affect traffic? If so, do all "classes" of messages have this potential or do only certain types and/or lengths of messages pose a threat? Another important measure of the value of a DMS message is its credibility. It is vitally important that travelers believe that a message displayed on a DMS is based on fact and accurately describes present roadway conditions. Without consistently valid information, road users will begin to ignore DMS messages altogether.

This research project will strive to understand the potential impact of the DMS messages on traffic flow and evaluate the quality of the messages posted on the signs in term of accuracy, timeliness, relevance and usefulness. Additionally the anonymous vehicle tracking feature of the Bluetooth sensors will be used for analyzing the diversion of traffic to the alternative routes suggested by the messages as a proxy for drivers' response to the DMS.

Sustainability Impact of Multimodal Corridor Improvements in Urbanized Area

Dr. Lei Zhang,
Civil & Environmental Engineering (MDSHA)

This research project will support the existing SHA Sustainability Initiative and CHC Program with the following objectives:

1. Develop methods to analyze the planning-level sustainability impact (i.e. mobility, safety, energy and environment, natural resources, socio-economic, and cost) of multimodal improvements on highway corridors, including:
   - Road diet (i.e. lane removal)
   - High occupancy vehicle (HOV) lane
   - High occupancy toll (HOT) lane
   - Bus rapid transit/bus-only lane
   - Light rail transit
   - Truck-only lane
   - Express toll lane
   - Park-and-ride facility

2. Refine and improve the existing MOSAIC modules by both developing improved impact evaluation methods (e.g. regarding pollution emissions, GHG emissions, and other environmental impacts) and replacing model parameters based on national-level analysis with Maryland-specific parameters (e.g. emission rates, vehicle fleet composition, construction and maintenance cost).

With these enhancements, MOSAIC will be capable of analyzing the long-term sustainability impact of both highway and multimodal corridor improvements in urban and rural areas in Maryland.

Bridge Health Monitoring System Based on Flexible, Wireless, and Batteryless Patch Sensors

Dr. Mehdi Kalantari Khandani, Electrical and Computer Engineering (MDSHA)

According to the National Bridge inventory Database of the Federal Highway Administration in year 2008, the U.S. transportation infrastructure has 601,027 bridges from which 71,429 are rated as structurally deficient. State of Maryland is not an exception of this issue. According to the above database, the State has a total of 5,168 bridges from which 396 are rated as structurally deficient. Structural health monitoring is required to anticipate the impending failure of bridges – as well as other critical infrastructure such as pipelines, railways, and drilling platforms. Yet, existing instrumentation techniques for structural health monitoring of bridges suffer from non-scalability due to high cost of instrumentation devices, large installation costs (e.g., due to wiring needs), or high maintenance costs. Currently, the only practice for monitoring the health of bridges is a mandated bi-annual manual inspection; however, manual inspection has proved extremely insufficient to ensure safety of bridges, as such inspections do not provide enough information to prevent catastrophic failures.

To protect the infrastructure systems against aging, structural malfunction, and collapse, this project will offer a cost effective and scalable solution for the real time monitoring of important structural state quantities such as stress, strain, fatigue cracks, vibration, etc. The solution is based on patent pending Active RF Test (ART) technology, which incorporates novel sensing, energy harvesting, and wireless communication technologies into a flexible, wireless, and batteryless sensor.

The proposed approach is capable of accurately identifying structural distress such as overstrain, crack initiation and growth, and deformation. Key advantages of the proposed system include (1) flexibility and compact size of sensors, allowing them to be applied to curved surfaces and complex geometries; (2) wireless operation with a self-contained energy harvesting device as a power supply; and (3) very low cost, enabling a large scale distribution in which data fusion techniques can be utilized for enhanced damage severity evaluation and source location.

Development & Testing of an Intelligent Dilemma Zone

Dr. Gang-Len Chang, Civil & Environmental Engineering (MDSHA)

The entire project was divided into two phases with Phase-I focused on field observations of driver response during a signal yellow phase, and Phase-II devoted to system design and implementation.

After taking more than two years to analyze more than 1200 drivers' reactions to a yellow phase at 8 different intersections, Phase-I concluded that dilemma zone is dynamic in nature, varying with the approaching speed distribution of the driving population. Field observed data in Phase-I was successfully used to calibrate a set of models to estimate the spatial distribution of intersection dilemm

COMPLETED PROJECTS

Modeling and Optimization of Supply Chain Operations during Emergency Response
Abbas Afshar & Dr. Ali Haghani, Civil & Environmental Engineering (CITSM)

Integration of Off-ramp and Arterial Signal Controls to Minimize the Recurrent Congestion on Capital Beltway
Dr. Gang-Len Chang, Civil & Environmental Engineering (CITSM)

Development of a Real-time Traffic Simulator for I-695, Baltimore Beltway, for Traffic Operations and Incident Management
Dr. Gang-Len Chang, Civil & Environmental Engineering (MDSHA)

Development and Operations of a Travel Time Prediction System With Variable Message Signs for the Highway Network between Salisbury and Ocean City
Dr. Gang-Len Chang, Civil & Environmental Engineering (MDSHA)

An Integrated Computer System for Analysis, Selection, and Evaluation of Unconventional Intersections
Dr. Gang-Len Chang, Civil & Environmental Engineering (MDSHA)

Integrating Vehicle Ownership Decisions Into the Maryland Statewide Transportation Model
Dr. Kelly Clifton, Urban Studies & Planning; Dr. Cinzia Cirillo, Civil & Environmental Engineering (CITSM & NCSG)

Estimating Drivers' Willingness to Pay for HOT Lanes on I-495 in Maryland
Dr. Cinzia Cirillo, Civil & Environmental Engineering (CITSM & NCSG)

Modeling Violations in High-Occupancy Toll Lane Studies
Dr. Elise Miller-Hooks, Civil & Environmental Engineering (CITSM)

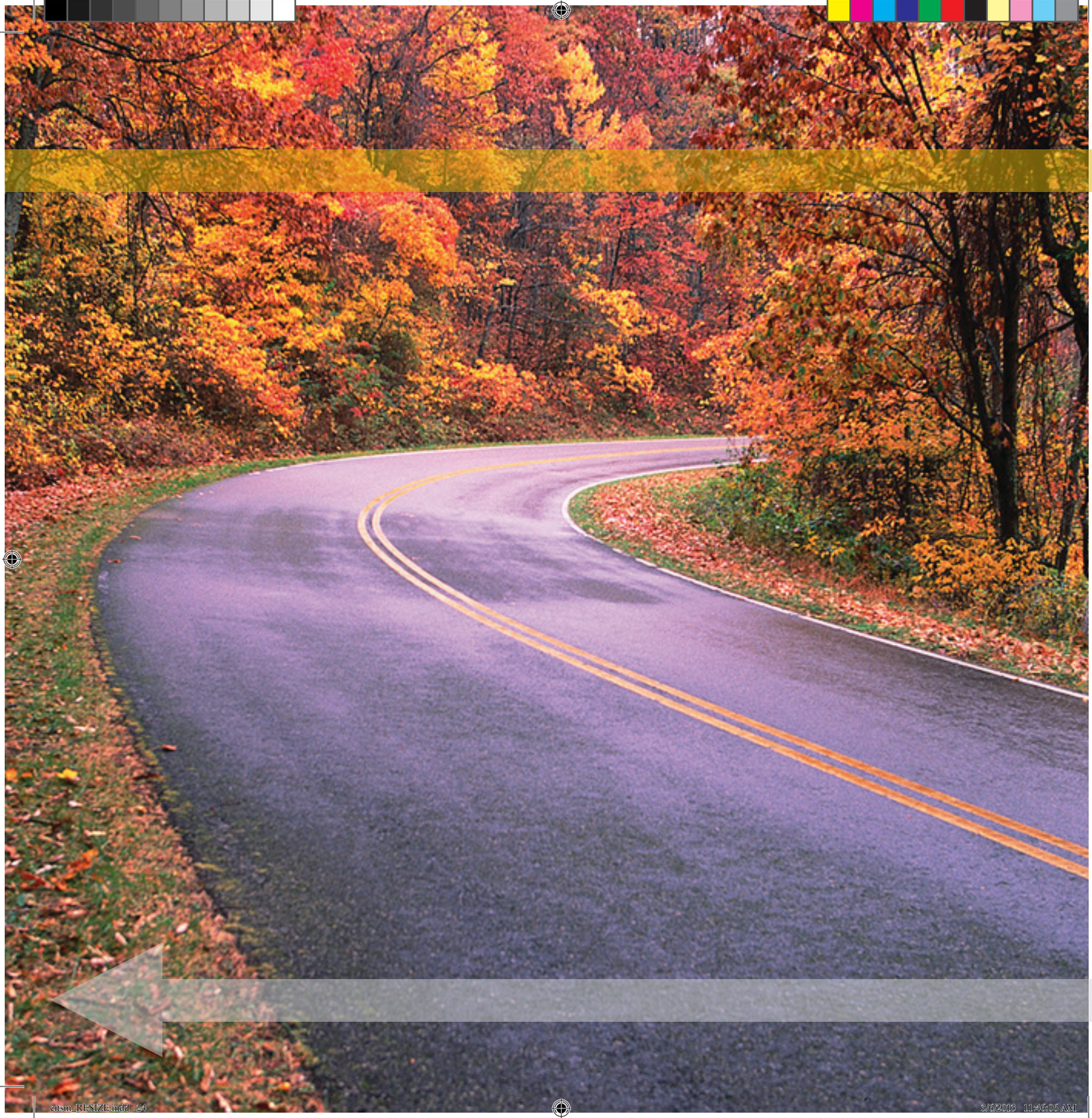
TRAFFAX Traffic Detector Design and Testing
Dr. Ali Haghani, Civil & Environmental Engineering (UMD-MIPS)

Resilience of Freight Transportation Networks
Dr. Elise Miller-Hooks, Civil & Environmental Engineering (CITSM)

Comprehensive Highway Corridor Planning with Sustainability Indicators
Dr. Lei Zhang, Civil & Environmental Engineering (MDSHA)

Feasibility and Benefit of Advanced Four-Step and Activity-Based Travel Demand Models for Maryland
Dr. Lei Zhang, Civil & Environmental Engineering (MDSHA)

Effectiveness and Equity of Future Transportation Financing Options at the Federal and State Levels
Dr. Lei Zhang, Civil & Environmental Engineering (CITSM)



CHAPTER 7: **CITSM PUBLICATIONS & PATENT APPLICATIONS**

PUBLICATIONS/ PATENTS

KALANTARI, ET AL. (2010)
United States Patent Application #20100328105: *Method and Apparatus for Energy Self Sufficient Automobile Detection and Reidentification.* Filed June 24, 2010.

ROBITAILLE, A., METHIPARA, J., AND ZHANG, L..
Effectiveness and Equity of Vehicle Mileage Fee at the Federal and State Levels. Journal of the Transportation Research Board (accepted for publication).

ZHANG, L., AND METHIPARA, J. (2011)
Internalizing Congestion and Environmental Externalities with Green Transportation Financing Policies. Paper presented at the 90th Transportation Research Board Annual Meeting, Washington, D.C. January 23-27.

GUERRA GÓMEZ ET AL (2011)
Analyzing Incident Management Event Sequences with Interactive Visualization. In proceedings of the Transportation Research Board 90th annual meeting, The National Academies, Washington, D.C.

WONGSUPHASAWAT ET AL (2011)
LifeFlow: Visualizing an Overview of Event Sequences. In proceedings of the 2011 Annual Conference on Human Factors in Computing Systems (CHI'11), 1747-1756.

CHEN, C.C. AND SCHONFELD, P.
Modeling and Performance Assessment of Intermodal Transfers at Cargo Terminals. Transp. Res. Record 2162, Oct. 2010, pp. 53-62.

MARKOVIC, N. AND SCHONFELD, P.
Scheduling under Uncertainty for a Single-Hub Intermodal Freight System. Accepted for the Transp. Res. Record, Feb. 2011.

CHEN, C.C. AND SCHONFELD, P.
Real-time Dispatching Control to Alleviate Schedule Disruptions at Intermodal Freight Transfer Terminals. Accepted for the Transp. Res. Record, Feb. 2011.

MARKOVIC, N. AND SCHONFELD, P.
Stochastic Scheduling for a Single-Terminal Transfer System with Poisson Arrivals. Accepted for Strojniski Vestnik (Slovenian J. of Mechanical Eng.), Sep. 2011.

MARKOVIC, N. AND SCHONFELD, P.
Simulation-based Optimization of Recovery for a Multi-terminal Freight Transportation System. Submitted to the Transp. Res. Record, Aug. 2011.

MICHAEL A. POWERS AND CHRISTOPHER C. DAVIS
Spectral LADAR: Toward Active 3D Multispectral Imaging. Proc. SPIE 7684, 768409 (2010); doi:10.1117/12.850599.

JAIME LLORCA, STUART D. MILNER, AND CHRISTOPHER C. DAVIS
Molecular System Dynamics for Self-Organization in Heterogeneous Wireless Networks. EURASIP Journal on Wireless Communications and Networking, Volume 2010, Article ID 548016, 13 pages. (2010).

CHOU, C.-S. E. MILLER-HOOKS AND X. CHEN (2010)
Violations Modeling in Studies of Concurrent-Flow Lanes. Transportation Research Record 2178, 147-155.

CHEN, L. AND E. MILLER-HOOKS
Resilience: An Indicator of Recovery Capability in Intermodal Freight Transport. In press in Transportation Science, available electronically through Articles in Advance, pp. 1-15.

CHOU, C.-S. AND E. MILLER-HOOKS
Exploiting Capacity of Managed Lanes in Diverting Traffic around an Incident. In press in Transportation Research Record.

MILLER-HOOKS, E., X. ZHANG AND R. FATURECHI
Measuring and Maximizing Resilience of Freight Transportation Networks. In second round of reviews for publication in Computers and Operations Research.

CUI, Q. AND HSU, S.C. * (2011)
Project Complexity under Carbon Regulation and Trading. Project Perspectives, 33, 78-83, International Project Management Association.

PRESENTATIONS

KRIST WONGSUPHASAWAT, JOHN ALEXIS GUERRA GÓMEZ, HSUEH-CHIEN CHENG, A. ZACHARY HETTINGER, CATHERINE PLAISANT, BEN SHNEIDERMAN
LifeFlow: Understanding Millions of Event Sequences in a Million Pixels.

JOHN ALEXIS GUERRA GÓMEZ, CATHERINE PLAISANT, BEN SHNEIDERMAN
TreeVersity: Comparing Tree Structures by Topology and Node Attribute Values. HCIL Symposium, May 2011, Slides.

JOHN ALEXIS GUERRA GÓMEZ
Analyzing Incident Management Event Sequences with Interactive Visualization. Fulbright Science and Technology scholarship capstone seminar (poster), June 2011.

JOHN ALEXIS GUERRA GÓMEZ
Visualization Temporal Events in Traffic Incidents. 6th International Symposium on Visualization in Transportation (August 2011) (http://www.cvent.com/events/6th-international-visualization-in-transportation-symposium/event-summary-0b645c0892d74fe8938db875c37e7c52.aspx)

JOHN ALEXIS GUERRA GÓMEZ
TreeVersity: Comparing Tree Structures by Topology and Node's Attributes Differences. IEEE VisWeek 2011 (accepted, to be presented in Oct 2011), Doctoral consortium presentation and poster.

MARKOVIC, N. AND SCHONFELD, P.
Scheduling under Uncertainty for a Single-hub Intermodal Freight System. Annual TRB Meeting, Jan. 2011 (11-2291).

CHEN, C.C. AND SCHONFELD, P.
Real-time Dispatching Control to Alleviate Schedule Disruptions at Intermodal Freight Transfer Terminals. Annual TRB Meeting, Jan. 2011 (11-2268).

MARKOVIC, N. AND SCHONFELD, P.
Simulation-based Optimization of Recovery for a Multi-terminal Freight Transportation System. Submitted for the Annual TRB meeting, Aug. 2011.

M.A. POWERS AND C.C DAVIS
Spectral Ladar: Towards Active 3D Multispectral imaging. In Laser Radar Technology and Applications XV, edited by Monte D. Turner, Gary W. Kamerman, proceedings of SPIE Vol. 7684 (SPIE, Bellingham, WA 2010) 768409.

J. LLORCA, S.D. MILNER, AND C.C. DAVIS
Molecular Iinspired Models for Prediction and Control of Directional FSO/RF Wireless Networks. In Free-Space Laser Communications X, edited by Arun K. Majumdar, Christopher C. Davis, proceedings of SPIE Vol. 7814 (SPIE, Bellingham, WA 2010) 781405.

J. LLORCA, S. D. MILNER, AND C.C. DAVIS
Molecular System Dynamics for Robustness and Survivability in Heterogeneous FSO/RF Wireless Networks. Paper presented at the SPIE Conference on Free-Space Laser Communications, San Diego California, August 2-3, 2010.

HAIJUN ZHANG, JAIME LLORCA, CHRISTOPHER C. DAVIS, AND STUART D. MILNER.
A Novel Flocking Inspired Algorithm for Self-organization and Control in Heterogeneous Wireless Networks. Proceedings of the Sixth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), S. Maru-

sic, M. Palaniswami, J. Gubbi, P. Corke, Eds. Brisbane Australia, 7-10 December 2010.

M.A. POWERS AND C.C. DAVIS *Spectral LADAR for Autonomous Navigation.* Paper presented at the AUVSI—Association for Unmanned Vehicle Systems International Conference, 24-27 August, 2010, Denver, Colorado.

M.A. POWERS AND C.C. DAVIS *Spectral LADAR as a UGV Navigation Sensor.* Paper presented at the SPIE Defense Security & Sensing Conference, April 21-25, 2011, Orlando, Florida.

STUART D. MILNER, CHRISTOPHER C. DAVIS. AND JAIME LLORCA *Control and Prediction in Hierarchical Wireless Networks.* Proceedings of the 3rd IEEE INFOCOM International Workshop on Mobility Management in the Networks of the Future World (MobiWorld 2011), April 10, 2011, Shanghai, China.

JOHN RZASA, STUART D. MILNER, AND CHRISTOPHER C. DAVIS *Design and Implementation of Pan-Tilt FSO Transceiver Gimbals for Real-time Compensation of Platform Disturbances using a Secondary Control Network.* Paper presented at the SPIE Conference on Free-Space and Atmospheric Laser Communications, San Diego California, August 24-25, 2011.

Chou, C.-S.*, E. Miller-Hooks* and X. Chen *Modeling Violations in Studies of Concurrent Flow Lanes.* 89th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2010.

X. ZHANG*, R. FATURECHI* AND E. MILLER-HOOKS Resilience of Freight Transportation Networks. INFORMS, Austin, November 2010.

CHOU, C.-S.* AND E. MILLER-HOOKS* Exploiting Capacity of Managed Lanes in Diverting Traffic around an Incident. 90th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2011.

CHOU, C.-S.* AND E. MILLER-HOOKS* Safety Implications of Violations in Concurrent Flow Lane Operations. 90th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2011.

ZHU, X., WHITTEN, L., AND CUI, Q. (2011) *Green Performance Contracting on Highway Construction Projects.* Second Transportation Construction Management Conference in Orlando, FL, Feb 8-10, 2011.

CUI, Q. AND ZHU, X. (2011) *Green Contracting in Highway Construction: State of Practice.* Transportation Research Board annual meeting, Washington, D.C.

CATT

The Center for Advanced Transportation Technology (CATT) at the University of Maryland, College Park was created in order to respond to the significant changes brought about by increasing use of advanced technologies in the transportation field. A permanent staff of ITS professionals and affiliated faculty of the Department of Civil Engineering supports the CATT. All offer extensive knowledge and experience in the areas of ITS technology, traffic engineering and control, systems analysis, and operations research. CATT provides an organizational umbrella for four major initiatives including CapWIN, CATT Lab, CITE, and MD T^2 Center.

The CATT provides a bridge between the intelligent transportation systems (ITS) community, the information technology community, and other disciplines essential to the successful application of ITS.

CURRENT CATT PROJECTS:

RESEARCH

- *3-D, Real-time Traffic Monitoring (Virtual Helicopter)*
- *3-D Traffic Data Spatial and Temporal Graphing*
- *3-D, Virtual Commute Fly-over*
- *Automated Small Vehicle Transportation*
- *Automated TMC Performance Measurement System*
- *Bluetooth Traffic Monitoring Technology*
- *Evacuation Planning*
- *I-270 Analysis, Modeling, and Simulation (AMS)*
- *Incident Data Extraction Software*
- *Incident Management Software*
- *Md Transportation Operations Summit (MTOS)*
- *Performance Measures for Mobility*
- *Performance Measures for Statewide Congestion*
- *Regional Performance Measures*
- *Temporal Event Pattern Recognition*
- *Timelines for Real-time and Historical Incident Visualization*
- *Visual Analytics for Transportation Datasets*
- *Wide-area, Archived Travel Time & Bottleneck Analysis Tools*

EDUCATION

- *Consortium for ITS Training and Education (CITE)*
- *CITE Blended Learning Courses*
- *Md Transportation Technology Transfer (MD T^2) Ctr*
- *NCHRP 20-77 Transportation Operations Framework*
- *Operations Academy*
- *Road Scholar Program*
- *Virtual Incident Management Training*

DEPLOYMENT ASSISTANCE

- Capital Wireless Information Net (CapWIN)
- CHART Support
- Explore and Visualize Accidents (EVA)
- I-95 Corridor Coalition
- I-95 Corridor Coalition Vehicle Probe Project
- Incident Cluster Explorer
- Maryland Statewide ITS Architecture
- Metropolitan Area Transportation Operations Coordination (MATOC)
- Mobile Traveler Services
- NCHRP 20-7 Guide to Benchmarking Operations Performance
- Regional Integrated Transportation Information System (RITIS)
- State Highway Administration Commercial Vehicle Information System and Network (CVISN) Support
- Traveler Information on the Web

CATT LAB

The CATT Lab is supported by an interdisciplinary staff of graduate and undergraduate student researchers, affiliated faculty of the Department of Civil Engineering, and a permanent team of ITS professionals. The CATT Lab's research and development activities provide a bridge between the intelligent transportation systems (ITS) community, the information technology community, and other disciplines essential to the successful application of ITS. Though a complete list of our research initiatives can be seen in the research section of this website, the CATT Lab specializes in:

- data archiving
- data retrieval tools
- data visualization
- 3D modeling and simulation
- traveler information systems
- video image processing
- software development

The primary resource of the CATT Laboratory is the interdisciplinary group of over 45 undergraduate and graduate researchers and talented staff. CATT Lab staff and students have (or are seeking) degrees in Civil Engineering, Computer Engineering, System Engineering, Electrical Engineering, Computer Science, Aerospace Engi-

neering, Mechanical Engineering, Geography & Geographic Information Systems, and Art.

The lab has access to sophisticated process control & sensing software, mathematical software, modeling and simulation software, Geographic Information Systems (GIS) software, and a collection of video detection and sensing hardware. The lab also has over 50 high-end workstations and laptops plus an impressive array of servers and VMware machines in its networking and data center. The lab has also established a T1 connection with the Maryland State Highway Administration›s (SHA) Coordinated Highway Action Response Team (CHART) system that enables the lab to monitor CHART databases, live video feeds, Dynamic Message Signs, and incidents. The CATT Lab maintains a CHART operator workstation, and archives CHART databases for real-time simulation and modeling, traveler information systems, traffic prediction algorithms, and for future research initiatives. *http://www.cattlab.umd.edu/*

CapWIN

The Capital Wireless Information Net (CapWIN) is a regional coalition of public safety and transportation agencies across Maryland, Virginia, the District of Columbia, and the Federal Government whose mission is to enable and promote interoperable data communications, operational data access, and incident coordination and situational awareness across jurisdictions and disciplines. The CapWIN program is staffed by the University of Maryland Department of Civil and Environmental Engineering's Center for Advanced Transportation Technology. It operates under the guidance of a Board of Directors made up of representatives from local, state, and Federal first responder agencies across Maryland, Virginia and the District of Columbia.

This multi-disciplinary, multi-jurisdictional effort focuses on first responders in the field and the unique requirements of wireless users. Today, CapWIN has over 5000 registered users from more than 80 public safety, transportation, and emergency services agencies drawn from all levels of government–including regional authorities–operating in the three state jurisdictions. *http://www.capwin.org/*

National Center for Smart Growth

The National Center for Smart Growth Research and Education is a non-partisan center for research and leadership training on smart growth and related land use issues in Maryland, in metropolitan regions around the nation, and in Asia and Europe. Located at the University of Maryland in College Park, MD., just eight miles from Washington, D.C., the National Center for Smart Growth was founded in 2000 as a cooperative venture of four University of Maryland schools: Architecture, Planning and Preservation, Public Policy, Agriculture and Natural Resources, and Engineering.

The mission of the Center is to bring the diverse resources of the University of Maryland and a network of national experts to bear on issues related to land use and the environment, transportation and public health, housing and community development, and international urban development. The Center accomplishes this through independent, objective, interdisciplinary research, outreach and education.

In addition to its research efforts, the Center also is partners with Smart Growth America in the Governors' Institute on Community Design, a program designed to assist governors throughout the United States who are interested in issues of land use, development land conservation, community design, or related issues. This project is funded by the National Endowment for the Arts and the U.S. Environmental Protection Agency.

Upon request, the Center also offers smart growth leadership training to federal, state and local government officials as well as to private sector decision-makers. The Center staff and its affiliate faculty offer specialized education and training programs as well as smart growth study tours and workshops. Center staff invites suggestions or ideas for tours, training or workshop programs and is interested in establishing partnership arrangements. *http://www.smartgrowth.umd.edu/*

NEXTOR

NEXTOR is a Government-Academic-Industry alliance dedicated to the advancement of aviation research and technology. NEXTOR is sponsored by the Federal Aviation Administration (FAA) Office of Technology Development and Operations Planning. In collaboration with the FAA and its industry partners, NEXTOR looks to develop an understanding of how the National Airspace System (NAS) service providers and users will respond to alternative system architectures, operational concepts, investment strategies and finance mechanisms. The knowledge and capabilities gained from this government-sponsored Research Program provides critical information to executives and senior government officials on a host of issues ranging from near-term investment choices to long-term strategies. Through its Knowledge Exchange Program, NEXTOR researchers, industry members, and government agents present state-of-the art research to the aviation community. The program offers two to three conferences and seminars per year on such subjects as NAS Infrastructure Management, Performance Metrics and the Economic and Social Value of Air Transportation. In addition, the partnership seeks to increase the breath of aviation operations research knowledge through its Education Program. More than 100 graduate students have participated in NEXTOR's research programs since the organization's birth in 1996. Short courses are taught by faculty members and are open to any FAA, federal government, or industry affiliate employee interested in air transportation systems analysis. *http://www.nextor.org/*

Center for Networking of Infrastructure Sensors (CNIS)

The CNIS is an interdisciplinary research center at the University of Maryland. CNIS is concerned with sensors, communication, and infrastructure security in the military and civilian domains. The University of Maryland, College Park, has developed a remote, real-time surveillance system to demonstrate the ultra-broadband capability of hybrid Free Space Optical (FSO)/RF links. Our system transmits ultra-high bandwidth, high resolution images from surveillance cameras monitoring regions of interest on campus. Hybrid wireless links transfer live, high resolution, video imagery that can be processed in real time to provide important information about targets of interest in the field of view. Targets of interest can be "events" detected by intelligent image analysis software, moving vehicles, or background changes in the field of view. This requires high quality, both in terms of spatial resolution and in the time domain (frame rate), which demands a large bandwidth. An important feature of our system is that it provides transmission of high-resolution imagery, which requires low latency, high data-rate frame transfer end-to-end over the Internet, with wireless communications in the "last mile." Our system, which includes high resolution, zoomable, tracking cameras, with 1.25Gb/s FSO and 100Mbs 24GHz directional RF links, can remotely process incidents over an internet and execute follow up activity such as tracking in real time. The average data transfer rate for this application is approximately 183Mb/s, corresponding to slightly less than 15% of total available bandwidth. *http://www.cnis.umd.edu/index.htm*

Applied Technology and Traffic Analysis Program (ATTAP)

ATTAP is jointly initiated by the Office of Traffic and Safety at the Maryland State Highway Administration and the Traffic Safety and Operations Laboratory at the University of Maryland–College Park. The primary focus of the program is to develop and apply advanced technologies in contending with day-to-day congestion and in improving traffic safety in highway networks. Research projects performed by the program range from basic human behavior study to deployment of real-time control systems for monitoring and guiding emergency evacuations. *http://attap.umd.edu/*

Traffic Monitoring System for the Ocean City Region

This project is to design and implement a real-time network traffic monitoring system in the Eastern shore region that includes a set of algorithms for traffic monitoring, travel time prediction, and emergency evacuation. *http://oceancity.umd.edu/*

Consortium for ITS Training and Education (CITE)

The Consortium for ITS Training and Education (CITE) is a unique organization of universities and industry associations focused on providing comprehensive training and education related to Intelligent Transportation System technology that is delivered in a manner that is flexible and convenient for its students. CITE offers over thirty interactive web-based courses to be used both within college curricula and continuing education.

The purpose of the Consortium for ITS Training and Education (CITE) is to create an integrated advanced transportation training and education program. The program, based on a consortium of universities, is open to anyone pursuing a career in advanced transportation. Instruction offered through CITE may include graduate and undergraduate level courses, as well as skill-based training and technology transfer. Courses are delivered either in the form of web-based learning, or using a hybrid format that integrates web-based instruction with instructor led teleconferences. *http://www.citeconsortium.org/index.html*

MDT²

The Maryland Transportation Technology Transfer Center (MD T² Center) was established in 1984 at the University of Maryland, College Park. LTAP provides an excellent foundation for T² activities in Maryland. Each year, the Center works with the Maryland SHA and the FHWA to develop a work plan that meets the training and technology assistance needs of agencies with transportation responsibilities within the state of Maryland.

Some of the services the Center provides through the LTAP Program include:

- Training Courses and Conferences: The MD T² Center organizes more than seventy-five training courses and conferences per year. LTAP funds provide partial support for more than half of these events. Training Catalog: *http://www.mdt2center.umd.edu/courses/course-catalog.html*
- Media Library: The MD T² Center maintains a library of numerous resources on topics of interest to local agencies in Maryland. Visit us online at *http://www.mdt2center.umd.edu/library/index.html*
- TechNotes: A quarterly newsletter published by the MD T² Center. Download the latest TechNotes or browse through past issues at *http://www.mdt2center.umd.edu/newsletter/index.html.*
- Outreach and Community Service: The MD T² Center participates in transportation-related conferences and meetings throughout the state and region:

- County Engineers Association of Md
- The Maryland Municipal League
- The Maryland Association of Counties
- America Public Works Assn. (DC\MD\VA) Chapter
- Roadway Management Conference
- ITS Maryland

http://www.mdt2center.umd.edu/

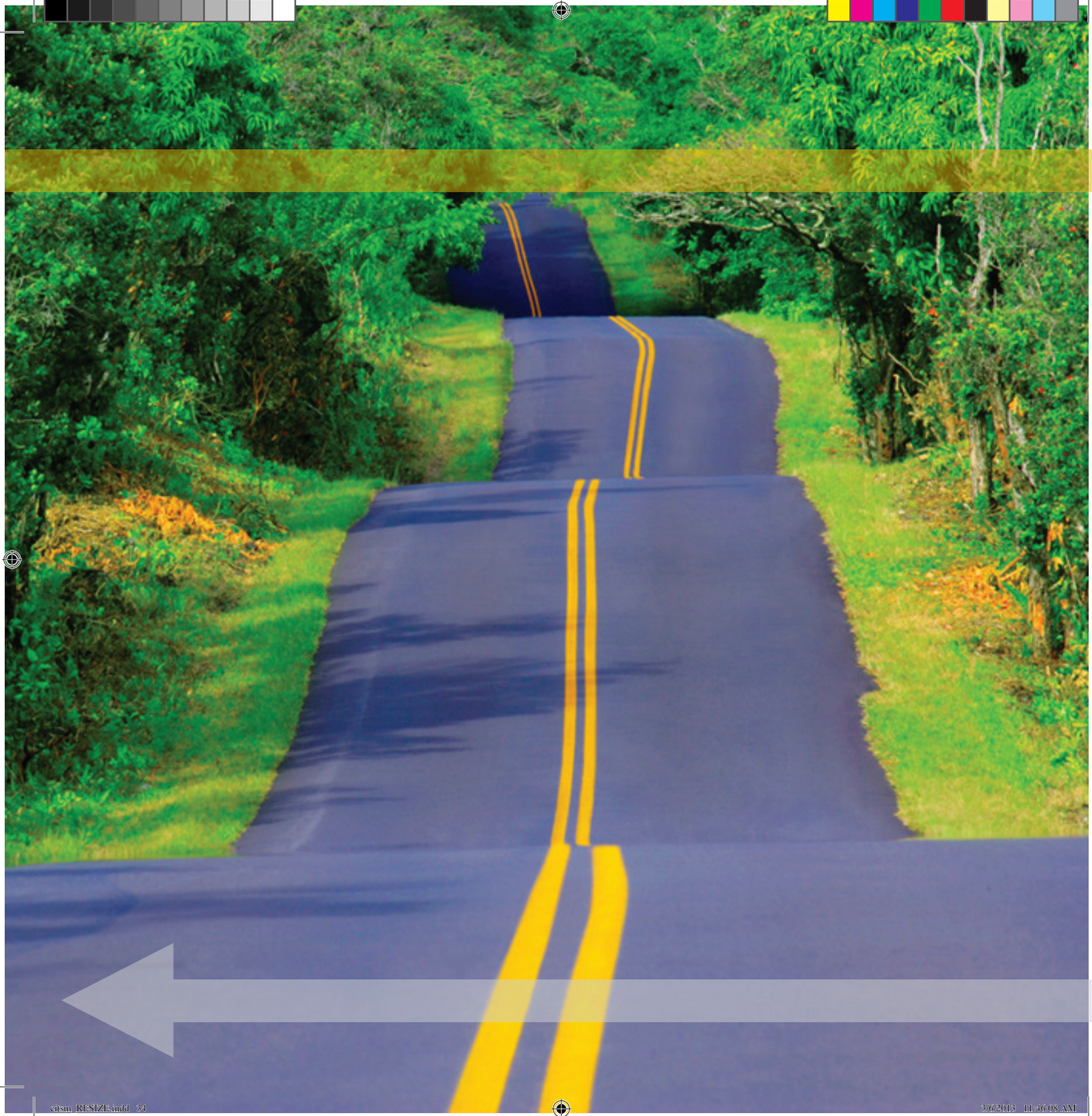
Operations Academy

As the emphasis on transportation management and operations increases, the demand for personnel with skills in these areas is also increasing. Unless sufficient numbers of personnel with adequate training and experience can be identified, it is unlikely that the State and local transportation agencies will be able to increase their focus on the effective use of existing transportation infrastructure.

The Operations Academy is designed to address these needs. It is based on the concept of total immersion in the subject of transportation management and operations, using a mix of classroom instruction, workshops, and analysis of existing systems to ensure the retention of the principles being presented. The academy will provide opportunities to practice and internalize the principles learned which is not possible in traditional classes and short courses.

Acceptance for the program is competitive, and requires the nomination of a local, State or Federal transportation agency. It also requires a commitment on the part of those attending the program to satisfy the self-study requirements, and to spend two uninterrupted weeks participating in the Academy's activities. The rewards for participating in this program include national recognition of graduates, certificates of accomplishment, Continuing Education Units (CEUs), and the involvement of supervisors from the participants' home organization. The academy will provide a significant development opportunity to career professionals in transportation management and operations.

The development of the Operations Academy was initially funded by the I-95 Corridor Coalition. The Academy receives its funding from student tuition fees, some of which are supported by scholarships awarded by the Federal Highway Administration and the I-95 Corridor Coalition. *http://www.operationsacademy.org/index.html*



Modeling Heterogeneous Risk-taking Behavior in Route Choice: A Stochastic Dominance Approach

[Speaker: Yu (Marco) Nie]

Short Biography: Dr. Yu(Marco) Nie is an Assistant Professor of Civil and Environmental Engineering at Northwestern University. He received his B.S. in Structural Engineering from Tsinghua University (Beijing) and his Ph.D. in Transportation Engineering from the University of California, Davis. Dr. Nie's research covers a variety of topics in the areas of transportation systems analysis, traffic simulation and traffic flow theory. He has extensive experience in developing software tools for various transportation applications. Currently, Dr. Nie is a member of the TRB committee on Transportation Network Modeling (ADB30), TRB committee on Traffic Flow Theory and Characteristics (AHB45) and the Editorial Advisory Board of the Journal of Transportation Research Part B. He has also served as an ad-hoc reviewer for a variety of transportation journals, and as review panelists for National Science Foundation. Dr. Nie's research has been supported by National Science Foundation, U.S. Department of Transportation, Federal Highway Administration (FHWA), and Illinois Department of Transportation.

Abstract: Transportation systems are affected by uncertainties of various sorts. As in user experience of transportation services. On one hand, lack of reliability either encourages overly conservative risk-averse behavior or leads to uncomfortable, sometimes disastrous, disruptions to personal and business schedules. On the other hand, users' risk-taking behavior in presence of uncertainties may collectively affect the "equilibrium" of traffic in the system, and hence the design and operational decisions. In this talk, a unified approach is proposed to model heterogonous risk-taking behavior in route choice based on the theory of stochastic dominance (SD), a tool widely used in finance and economics. We show that, the paths preferred by travelers of different risk-taking preferences can be obtained by enumerating the corresponding SD-admissible paths, and that general dynamic programming can be employed to generate these paths. The relationship between the SD theory and several route choice models found in the literature is also discussed. These route choice models employ a variety of indexes to measure reliability, which often makes the problem of finding optimal paths intractable. We show that the optimal paths with respect to these reliability indexes often belong to one of the three SD-admissible path sets. This finding offers not only an interpretation of risk-taking behavior consistent with the SD theory for these route choice models, but also a unified and computationally viable solution approach through SD-admissible path sets, which are usually small and can be generated without having to enumerate all paths. We also introduce two applications of the stochastic dominance approach. In the first, the first-order SD is used to solve the percentile user-equilibrium traffic assignment problem, in which travelers are assumed to choose routes to minimize the percentile travel time, i.e. the travel time budget that ensures their preferred probability of on-time arrival. The second application considers the optimal path problems with second-order stochastic dominance constraints, which arise when travelers are concerned with the tradeoff between the risks associated with random travel time and other travel costs. Risk-averse behavior is embedded in such problems by requiring the random travel times on the optimal paths to stochastically dominate that on a benchmark path in the second order. For each application, we give a formulation and briefly discuss solution algorithms.

Modeling Interdependencies Among Infrastructure Systems [Speaker: Srinivas Peeta]

Short Biography: Dr. Srinivas Peeta is a Professor of Civil Engineering at Purdue University, and the Director of the NEXTRANS Center, USDOT's Region V Regional University Transportation Center. He chairs the Transportation Network Modeling Committee (ADB30) of the Transportation Research Board (TRB) of the National Academies. He is a member of the International Federation of Automatic Control (IFAC) Technical Committee on Transportation Systems. He received his M.S. and Ph.D. in Civil Engineering from Caltech and The University of Texas at Austin, respectively. Dr. Peeta is a recipient of an NSF CAREER award in 1997, ASCE Walter Huber Award for outstanding research contributions to the advancement of transportation network modeling in 2009, and many other distinguished awards. Over the past eight years, five dissertations of Dr. Peeta's students received best dissertation awards, including the CUTC Pikarsky Award and the IATBR Eric Pas Award.

Dr. Peeta has authored more than 160 technical publications, and has presented papers/talks/lectures at more than 260 invited and/or international conferences/symposiums in several countries. He is a co-editor of three books. Dr. Peeta is a member of the Editorial Advisory Board of the journals Transportation Research, Part B and the Intelligent Transportation Systems Journal. He is an Associate Editor of Networks and Spatial Economics.

Some of Dr. Peeta's research interests include: deployable dynamic traffic assignment strategies for information-based control of large-scale dynamic traffic networks, modelling human behaviour/learning to understand transportation/traffic performance, systems approaches to disaster response and management, system-of-systems paradigms for interdependencies among infrastructure systems, collaborative freight logistics, vehicle-to-vehicle communication-based traffic networks, static traffic assignment algorithms, stochastic algorithms for traffic signal control, and use of information and sensor technologies for the real-time operation of large-scale dynamic traffic networks.

Dr. Peeta has received funding of more than $20 million as PI or co-PI from a diverse set of funding sources such as the National Science Foundation (NSF), U.S. Department of Transportation (USDOT), U.S. Department of Energy (DOE), National Aeronautics and Space Administration (NASA), U.S. Department of Education, Federal Highway Administration (FHWA), Indiana Department of Trans-

portation (INDOT), and Indo-US Science and Technology Forum. Dr. Peeta served as the PI of the Purdue-led proposal for the USDOT Centre Grant competition that resulted in the establishment of the $13 million NEXTRANS Centre at Purdue University in 2007.

Abstract: Extreme events over the past decade in the USA, ranging from the 9/11 terror attacks to the 2003 Northeast power blackout to the 2005 hurricanes, have highlighted the urgent need to understand the interdependencies among civil infrastructure systems (transportation, telecommunications, power, energy, water, etc.) for more effective and efficient planning, design and operations. The need is further highlighted by the challenges arising from the capacity needs of rapid urbanization and the need to renew aging infrastructure. This study proposes a generalized modeling framework that combines a multilayer network concept with a market-based economic approach to capture the interdependencies among various infrastructure systems with disparate physical and operational characteristics. Thereby, the various infrastructure systems are modeled as individual networks connected through links representing market interactions. The market interactions capture the various types of interdependencies through supply-demand mechanisms. The modeling framework uses a multilayer infrastructure network (MIN) concept, the computable general equilibrium (CGE) theory, and its spatial extension (SCGE), to formulate the problem in the static and dynamic contexts. The mapping between the modeling framework and the real-world context is discussed, followed by a description of the various model components. Numerical experiments are conducted to illustrate the capability of the model to capture various types of interdependencies and to provide insights on the importance of these interdependencies for real-world problems.

Vehicle Miles Traveled (VMT), Gasoline Price, and Fuel Efficiency [Speaker: Cynthia Chen]

Short Biography: Dr. Cynthia Chen is an Associate Professor at the Civil and Environmental Engineering Department of University of Washington (UW). She received her PhD degree in Civil and Environmental Engineering (specialization: Transportation) from the University of California at Davis. Her research interests are travel behavior analysis, demand modeling, safety, and innovative survey techniques. Dr. Chen has published more than 30 papers in referred leading transportation and planning journals including Transportation Research Part A and Part B, Transportation, Urban Studies, Environment and Planning A, and Journal of Transport Geography etc. She chairs the Time Use and Activity Patterns subcommittee at TRB and is on the editorial board of Transportation.

Abstract: With concerns on future oil shortage and climate change, fuel-efficient vehicles including hybrid and electric cars, are being hailed as the solutions. Yet, they do not address the problem of congestion. Apart from generating emissions, congestion has a severe toll on our quality of life and economy. In fact, the rise of fuel-efficient cars may significantly aggravate congestion in the future as they not only induce demand with the potential rebound effect but also weaken the power of pricing as an effective way for behavioral change. In this study, we analyze the elasticity of VMT with respect to gasoline price (price effect) and fuel efficiency (rebound effect) separately using the 2009 NHTS dataset. Most of the existing studies assume these two effects, though in opposite directions, have the same magnitudes. We argue that the two effects do not necessarily have the same magnitudes and if the rebound effect exceeds the price effect, we are clearly looking into a more congested future. We further examine the differen-

tial price effects and rebound effects for households with different income levels. We find that the price elasticity of VMT for lower-income households is similar to that for higher-income groups—a finding contrary to our expectation. Further investigation of the dataset suggests that lower-income households face a significantly higher level of rigidity in scheduling than the higher-income households, suggesting that lower-income households are trapped in their current lives—they are unable to reduce driving even if they wanted to. This finding has important policy implications—either monetary subsidies should be provided to or policies designed to create more scheduling flexibility should be implemented for the lower-income households.

Simulation Tools for Transportation Analysis and Evaluation [Speaker: David Yang]

Short Biography: Dr. David Yang has a broad range of research, government, and industry experience in transportation, especially in areas related to traffic operations, transportation safety, and Intelligent Transportation Systems (ITS). Dr. Yang joined Federal Highway Administration (FHWA), U.S. Department of Transportation (U.S. DOT) at the beginning of 2008. He is responsible for traffic modeling and simulation research at FHWA's Turner-Fairbank Highway Research Center. David manages multiple research projects that use computer simulation tools to examine topics such as the impact of driver behavior on traffic flow and congestion; the effect of driver decision on traffic operations; and the relationship of driver performance and transportation safety. Prior joining FHWA, David worked in private consulting firms and as a research engineer at U.S. DOT's Volpe National Transportation Systems Center and conducted vehicle safety and driver behavior research.

Dr. Yang has authored/co-authored more than forty journal articles, conference papers, and government reports. David became the chair of TRB's User Information Systems Committee in 2010 and he is also a member of TRB's Traffic Law Enforcement Committee. Additionally, Dr. Yang represents FHWA on TRB's 'Strategic Highway Research Program 2' Technical Coordinating Committee. David serves on the editorial board of the Journal of Intelligent Transportation Systems and was guest reviewer for other technical journals and conferences.

David attended Purdue University and received his Bachelor of Science, Master of Science, and Doctor of Philosophy degrees in the field of civil engineering. lower-income households.

PAST SEMINARS

Intelligent Transportation Systems in The District of Columbia [Speakers: Yanlin Li and Xianding Tao]

Integrated Land Use and Transportation Model for Analyzing High Speed Rail, Greenhouse Gases, and Sustainable Development in California [Speaker: Dr. Robert A. Johnston]

Passenger Transport Demand Modeling at European Level–Political Background, Methods, and Application Examples [Speaker: Dr. Eckhard Szimba]

Impact of White House Street Closings [Speaker: Fred Ducca]

Transit Simulation for the White House Area Transportation Study: An Overview of the Analysis Issues, Methodologies, and Results [Speaker: Brian Gardner]

Exploratory Advanced Research at Federal Highway Administration [Speaker: David Kuehn]

The Role of Information Technology in Improving Transit Systems [Speaker: Nigel Wilson]

Unexpected Events and Intelligent Transportation Systems [Speaker: Asad J. Khattak]

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