Center for Integrated Transportation Systems Management

ANNUAL REPORT | 2009

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CHAPTER 1

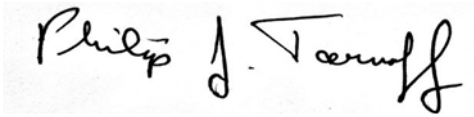
LETTER FROM THE CITSM DIRECTOR

We are proud of the significant accomplishments made by the Center for Integrated Transportation System Management (CITSM) during its first year of operation. These accomplishments which are reported here address many of the Nation's significant transportation challenges. They range from basic research associated with the development of new devices, technologies and analytical tools, to a statewide multi-faceted modeling system intended to support the high level development of transportation policy. In keeping with the CITSM emphasis on the use of a balanced multi-disciplinary approach to address the needs of the nation's transportation system, these research projects were conducted by multiple departments at the University of Maryland including Civil and Environmental Engineering, Electrical Engineering, and the University's Smart Growth Center. A total of 13 projects were funded by the Center, all of which achieved their research objectives, and many of which produced significant results.

The Center's research program has now been defined for its second year of existence. Some projects of the projects included in the program are a continuation of first year activities, while others represent new initiatives. The second year's program added the Computer Science Department as a CITSM participant.

The Center's achievements have not been limited to its ongoing research program. The CITSM hosted a meeting of its advisory board, during which much useful feedback and guidance was received. It also funded a scholarship at 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 Operations Academy is an effort to increase the focus of these agencies on transportation management and operations, a goal that is consistent with the vision of the CITSM. Perhaps most important is the fact that the CITSM has developed an effective and efficient process for the solicitation, evaluation and selection of the research projects that are included in its program. This process has been used for two successive years, and its effectiveness is borne out by the quality of the research results that have been produced.

We look forward to your review of the CITSM activities, and encourage your any comments that you might provide. Thank you for your interest and support of the Center for Integrated Transportation System Management.



GANG-LEN CHANG, Professor – Interests: Network Traffic control, Freeway traffic management and operations, Real-time traffic simulation, Dynamic urban systems

CINZIA CIRILLO, Assistant Professor – Interests: Discrete choice analysis, Advanced demand modeling, Activity based models, Revealed and Stated preference surveys, Large scale model systems, Value of Time studies

KELLY CLIFTON, Assistant Professor – Interests: interactions between land use, transportation, and human behavior

CHRISTOPHER DAVIS, Professor – Interests: Directional wireless communication systems, Communication networks, Sensor networks, Fiber sensors, Biosensors, and Characterization of antennas in the near field (*http://citsm.umd.edu/people/facstaffpic/davis.jpg*)

ALI HAGHANI, Professor & Chair of the Civil Engineering Department – Interests: Transportation network modeling, freight transportation and logistics, emergency response, dynamic fleet management, container transportation, mass transit operations

GERRIT-JAN KNAPP, Professor & Director of the National Center for Smart Growth – Interest: Smart Growth and Urban Growth Management, Land Economics and Public Finance, Environmental policy

MEDHI KALANTARI KHANDANI, Assistant Research Scientist

ELISE MILLER-HOOKS, Associate Professor – 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 multi-objective decision-making

STUART MILNER, Research Professor & Director of the Center for Networking of Infrastructure Sensors – Interests: Scalability of dynamic wireless networks and topology control in hybrid free space optical/RF directional, Wireless networks, Optical wireless sensor networks for critical infrastructure surveillance and broadband optical/RF wireless networks

PAUL SCHONFELD, Professor – Interests: Transportation Engineering

PHIL TARNOFF, Director – Interests: development of advanced technology, improved processes, and enhanced organizational structures for the integrated management and operation of transportation facilities and corridors

CHAPTER 2

CURRENT CITSM FACULTY

CURRENT ADVIORS

ANNE FERRO
President
Maryland Motor Trucking Association

RON FREELAND
Executive Secretary
Maryland Transportation Authority

NEIL PEDERSEN
State Highway Administrator
Maryland State Highway Administration

ELIZABETH BAKER
Administrator
NHTSA – Mid-Atlantic Region

PAUL WIEDEFELD
Maryland Transit Administrator
Maryland Transit Administration

ED ROWE
Senior Vice President
Iteris, Inc.

GLORIA SHEPHERD
Associate Administrator for Planning
Environment and Realty, FHWA

JIM WHITE
Executive Director
Maryland Port Administration

FORMER ADVISOR

JOHN PORCARI
U.S. Deputy Secretary of Transportation

CHAPTER 3
BOARD OF ADVISORS

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 stovepiping 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 THEME

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.

CHAPTER 5
CITSM SCOPE

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 development 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.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The Center for Integrated Transportation Systems Management granted its first awards in October of last year. Eight awards were granted in total to professors from Civil and Environmental Engineering, Electrical and Computer Engineering and Urban Studies and Planning. A brief description of each project follows.

Integration of Off-ramp and Arterial Signal Controls to Minimize the Recurrent Congestion on Capital Beltway

Gang-Len Chang - PI
Civil & Environmental Engineering

This research intends to capture the complex interaction between freeway off-ramp flows and traffic queues at neighboring arterial intersections, as several mainline segments on the Capital Beltway are often plagued by off-ramp spillback queues that significantly degrade their operational capacity. To minimize freeway congestion due to off-ramp queues but not to incur excessive arterial delay, this study will develop a multiple-objective model to first evaluate their interrelations, and then generate the optimal off-ramp and local signal controls to achieve the preset control objective such as maximizing the total throughput or minimizing the total delay. The proposed model features its ability to reliably determine when to activate such an integrated control, and how many upstream segments should be included in the control boundaries. The solution algorithm developed for this model will be sufficiently efficient to ensure its potential for use in real time operations.

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

Christopher Davis - PI
Electrical & Computer Engineering
Stuart Milner - PI
Civil & Environmental Engineering

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.

CHAPTER 6
CITSM PROJECT OVERVIEW

Modeling Violations in High-Occupancy Toll Lane Studies

Elise Miller-Hooks - PI
Civil & Environmental Engineering

States are increasingly looking to HOT lane facilities to improve mobility and reduce congestion for travelers and shippers using the nation's freeway corridors. While continuous access to HOV lanes is standard practice, due to existing toll collection technologies, access to HOT lanes must be more limited. Physical barriers in the form of concrete barricades or plastic pylons, for example, are often constructed to ensure compliance with rules for accessing HOT lanes. Increasingly, however, nonbarrier separation techniques are employed for this purpose. Such techniques may be used where the necessary space required for physical barrier separation and police activities required for enforcement is limited or construction and maintenance costs of such barriers is prohibitive. Nonbarrier separation methods, as a result, have become more common. Nonbarrier separation methods, however, permit nearly unlimited improper ingress/egress to/from the managed lanes. These violations impact free-flow speeds of both managed and general purpose lanes. Additionally, violations have a negative impact on revenue. Even with significant enforcement, violation rates related to non-barrier separated managed lanes in the U.S. are considerable. Despite this, no prior model developed for the purpose of predicting improvements in travel speeds and other traffic performance metrics and the potential revenue that can be raised through the introduction of a new HOT lane facility within an existing roadway or to assess potential practicable operational strategies and facility designs has incorporated this violation behavior. This research effort will seek to assess the importance of this omission. Specifically, the proposed research effort will quantify the impact of the various types of violations associated with HOT lanes on estimates of travel speeds and other traffic metrics obtained through simulation modeling of proposed HOT lane facility designs and determine the criticality of modeling such violations in conducting studies of proposed HOT lane facilities.

Integrating Vehicle Ownership Decisions into the Maryland Statewide Transportation Model

Kelly Clifton - PI
Urban Studies & Planning
Cinzia Cirillo - PI
Civil & Environmental Engineering

This applied research program proposes to develop a modeling framework for vehicle ownership in the State of Maryland for use in the Maryland Statewide Transportation Model (MSTM). The modeling system aims to produce the tools needed to understand and predict consumers' preferences on vehicle ownership, as a function of socio-demographic, economic, transportation system, and land development characteristics. Econometric equations relying primarily on discrete choice methodologies (joint revealed and stated preference

models) will be estimated from Maryland specific data. This framework can be used to test the outcomes of various future scenarios, including reaction to fuel efficiency, levels of congestion, land use policies, and changing economic conditions. It improves the capacity of MSTM by improving its ability to capture ownership, a key component of trip generation and mode choice, thus improving system planning capabilities for the state.

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

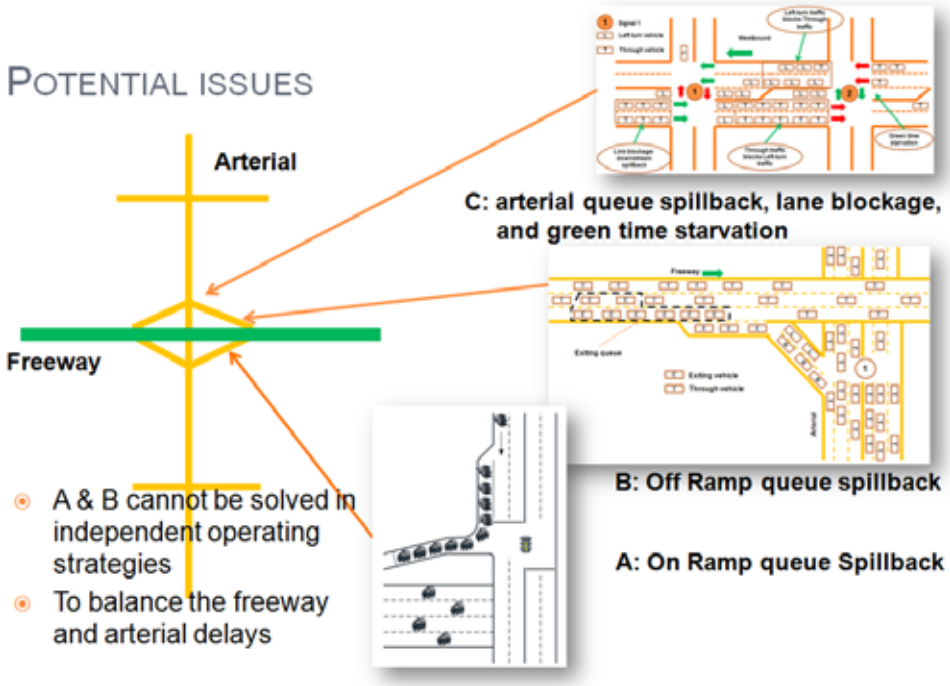
Mehdi Kalantari Khandani
Electrical and Computer Engineering

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 and Demonstration of Bluetooth-Based Traffic Monitoring to Assess Travel Time and Origin & Destination

Philip Tarnoff

The purpose of this project is to develop and deploy Bluetooth data logging devices on roadways to demonstrate its potential to measure travel time and assess origin and destination (O&D) information for ITS operations and HISD planning applications within the Maryland State Highway Administration (SHA). The goal is to fully evaluate the effectiveness of such an approach as a long term solution for SHA's traffic detection purposes. This task order concentrates on the research and deployment activities as required by the SHA Director, Office of CHART, Highway Information Services Division (HISD) and ITS Development. An interdisciplinary staff of full-time staff engineers and computer scientists, ITS Professionals, faculty, graduate and undergraduate students will support this effort as necessary.



Development of a Real-Time Traffic Simulator for I-695, Baltimore Beltway, for Traffic Operations and Incident Management

Professor G.L. Chang

The primary objective of this study is to develop a real-time traffic simulator for analysis and projection of traffic conditions on the I-695 Baltimore Beltway. The proposed simulator system shall contain the following principal components:

- *An intelligent system interface for input, output, and potential applications*
- *A GIS database for key information related to all network geometric features, driver characteristics, and traffic volume distributions;*
- *A microscopic simulation database for modeling the traffic behavior and daily evolution of traffic patterns on I-695; and*
- *An expert system module for guiding the best use of simulation results in a variety of traffic studies.*

The completed I-695 traffic simulator will be part of the Traffic Simulator System sponsored by the Maryland State Highway Administration, which can be used independently by traffic engineers for the Baltimore region or integrated with other existing simulators (e.g. I-495, I-270) for analyzing the region-wide traffic conditions between Washington and Baltimore metropolises.

Development and Operations of a Travel Time Prediction System With Variable Message Signs for the Highway Network between Salisbury and Ocean City

Professor G.L. Chang

The primary objective of this study is to extend the travel time prediction system for MD90 and US50 between Salisbury and Ocean City with the Maryland Eastern Shore emergency evacuation system. After its completion, the integrated system based on 40 traffic detectors should have the following features:

Between Salisbury and Eastern Shore:

- *Updating the information of the time-varying speed, occupancy, and flow rate along the target highway segments to the control center at an interval of 1 minute*
- *Computing the predicted travel times for the current and future time intervals for the target highway segments in real time, and update the information at a pre-specified interval;*
- *Communicating the real-time observed traffic conditions and projected traffic patterns to the control center via an intelligent interface module;*
- *Displaying the projected traffic information via the set of roadside VMS devices and a specially-designed website; and*
- *Providing historical travel time information for different times of a day and different days of a week for analysis and travel information.*

For the remaining networks in the Eastern Shore region:

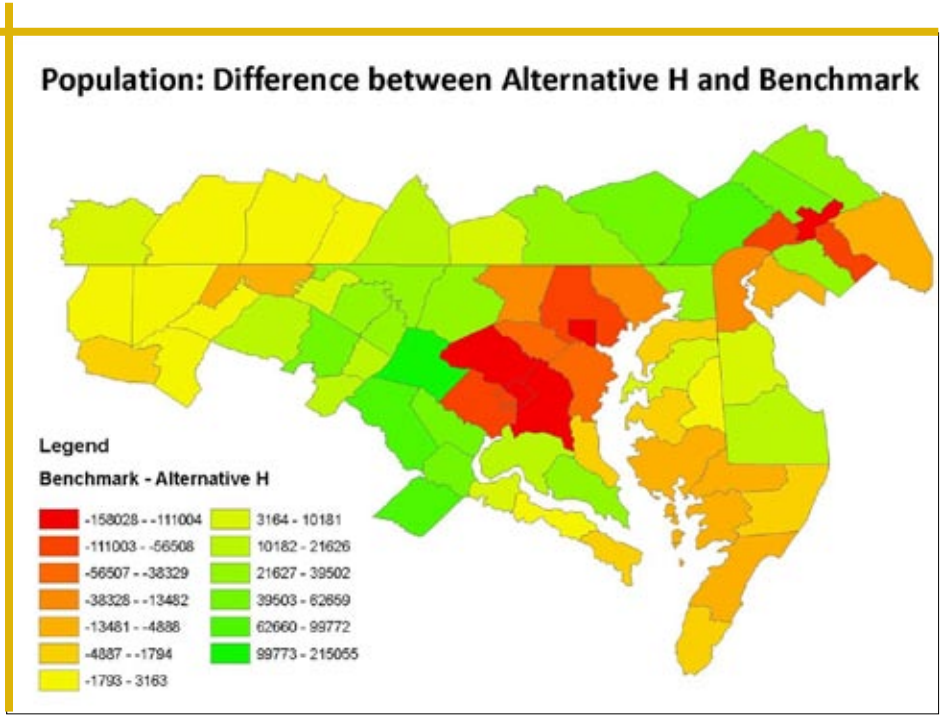
- *Detecting traffic volume, speed, and occupancy for all covered links in real time;*
- *Monitoring the evacuation flows during emergency evacuations or special events; and*
- *Providing feedback information for network traffic control operations.*

An Integrated Computer System for Analysis, Selection, and Evaluation of Unconventional Intersections

Professor G.L. Chang

Unconventional intersections with their variety of designs to accommodate the resource constraints and traffic demands has emerged as one of the most popular strategies to contend with both recurrent and non-recurrent arterial congestion. Over the past several years, MSHA and UMD researchers have devoted tremendous efforts on this vital subject, and the research results presented on the website of the ATTAP program are well recognized by nationwide highway agencies as the most informative site for learning and referencing any work related to unconventional intersections. MSHA is also well respected as one of the more experienced highway agencies at implementing unconventional intersections. However, to continue its leading role and to further convert all research accomplishments into tangible benefits, much remains to be done.

One of the priority tasks is to integrate all research products associated with various unconventional intersections as a convenient tool that can effectively assist potential users in efficiently identifying the candidate set of designs under the given constraints, comparing the resulting costs and benefits, assessing its impacts on the current traffic systems as well as on the future development. Such an intelligent tool shall also be able to advise the users regarding the list of critical factors to be taken into account in the selection process and their relative weights, and to suggest the most effective design under different selected MOEs. With its intelligent simulation module, the users of such a tool shall be able to quantify the impacts of the proposed unconventional design, and visualize its effectiveness as well as interrelations with neighboring intersections. In design of such an intelligent tool, the research team intends to develop an intelligent knowledge-based function that will allow the system to take advantage of suggestions, feedbacks, and expertise of experienced users in enhancing its functions.



It is expected that MSHA with such a tool can effectively select the most appropriate design of unconventional intersections under various constraints, substantially reduce the design efforts, and yield the maximal benefits under the diminishing resources. In addition, the proposed intelligent tool can also serve as a cost-effective system for training and educating highway engineers who are interested in this vital subject.

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

Gerrit-Jan Knaap
Urban Studies & Planning

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.

Development of Advanced Applications Using Bluetooth-Generated Traffic Flow DATA

Dr. Ali Haghani and Mr. Phil Tarnoff
Civil & Environmental Engineering

During the past 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.

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 near term (year one), the research will concentrate on determining the minimum required sample sizes to reliably portray the traffic conditions; identifying and eliminating sample outliers; and developing procedures for distinguishing between motor vehicles and pedestrians in urbanized areas. In the long term (years two and three), the research will concentrate on the development of applications that take advantage of the size and quality of the Bluetooth data. This will include automatic identification of the existence of freeway incidents; use of origin-destination data to evaluate the impact of variable message sign (VMS) (also known as dynamic message sign (DMS) messages on traffic diversions; and predicting the impacts of incidents on travel time.

TRAFFAX Traffic Detector Design and Testing

Professor Ali Haghani

The TRAFFAX project is a University partnership with private industry with the goal of developing and commercializing a Bluetooth-based traffic detector technology. The development plan includes three distinct products: a pre-production prototype, a mobile unit, and a permanent installation unit. This proposal directly targets tasks needed for the development of the latter two. The pre-production prototype was manufactured in house and is already under design, unveiled in the summer of 2008. A limited number of pre-production prototypes will be sold to initial customers and used in early demonstrations and initial deployments. The mobile and permanent-mount units will contain the functionality of the pre-production prototype but customized for use in their respective environments. The proposed project targets the specifications, design, assembly of production prototypes, and testing of these two products, as well as smaller research tasks.

Intermodal Transfer Coordination in Logistic Networks

Paul Schonfeld
Civil & Environmental Engineering

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.

Sadabadi, K.F., Hamedi, M., and A. Haghan. "Evaluating Moving Average Techniques in Short-term Travel Time Prediction Using an AVI Dataset", submitted to the 89th Transportation Research Board annual meeting, Washington, D.C., January 2010.

Haghani, A., Hamedi, M., Sadabadi, K.F., Young, S., and P. Tarnoff. "Freeway Travel Time Ground Truth Data Collection Using Bluetooth Sensors", submitted to the 89th Transportation Research Board annual meeting, Washington, D.C., January 2010.

Hamedi, M., Haghani, A., and K.F. Sadabadi. "Using Bluetooth Technology for Validating Vehicle Probe Data", accepted for presentation and inclusion in the proceedings of 16th ITS World Congress, Stockholm, Sweden, September 2009.

Sadabadi, K.F., Hamedi, M., and A. Haghani. "Real-Time Short-Term Freeway Travel Time Prediction Under an AVI Setting", paper presented at the 2nd International Symposium on Freeway & Tollway Operations, Honolulu, Hawaii, June 21-24, 2009.

Sadabadi, K.F., Hamedi, M., and A. Haghani. "Real-Time Travel Time Estimation: Filtering Raw Data in an Automatic Vehicle Identification Setting", paper presented at the ITS America Annual Meeting, Washington, D.C., June 2009.

Asudegi, M., and A. Haghani. "Optimal Number and Location of Bluetooth Sensors for Travel Time Data Collection in Networks", submitted to the 89th Transportation Research Board annual meeting, Washington, D.C., January 2010.

Asudegi, M., and A. Haghani. "Optimal Bluetooth Sensor Location for Collecting Travel Times in Urban Networks", paper presented at the CORS-INFORMS joint international meeting, Toronto, Canada, June 14-17, 2009.

Asudegi, M. "Optimal Number and Location of Bluetooth Sensors for Travel Time Data Collection in Networks", master thesis, Department of Civil and Environmental Engineering, University of Maryland, College Park, 2009.

Cirillo C. and R. Xu. "Dynamic Framework for Discrete Choice Models: An Application to Car Ownership", Optimization Day 2009, Montreal CA 2009.

Li, Z. and G. L. Chang. "Integrated Off-ramp Control Model for Freeway Traffic Management," proceedings CD, Transportation Research Board Annual Conference, January, 2009.

Liu, Y., Chang, G.L. "A Multi-objective Model for Optimal Freeway Diversion Control under Incident Conditions", the 2nd International Symposium on Freeway and Tollway Operations, June 21-24, 2009, Honolulu, USA

Li, Z. and G. L. Chang. "Optimizing Arterial Signal Plans and Off-ramp Control with an Enhanced Cell-transimission Models", submitted to TRB 2009.

Cheng-Chieh Chen, Paul Schonfeld. 2009. "Modeling and Performance Assessment of Intermodal Transfers at Cargo Terminals", submitted to Transportation Research Record (under review).

Chih-Shen (Jason) Chou, Elise Miller-Hooks and Xiaohan Chen, "Modeling Violations in Studies of Concurrent Flow Lanes," in review for publication in Transportation Research Record and presentation at the 89th Annual meeting of the Transportation Research Board.

CHAPTER 7 PUBLICATIONS

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 Traffi c 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
- Maryland 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

CHAPTER 8

TRANPORTATION PROGRAMS AT MARYLAND

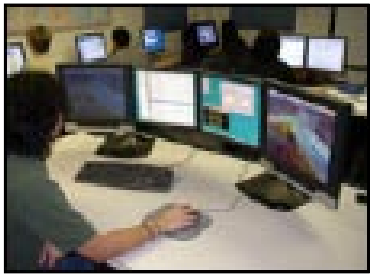
EDUCATION

- Consortium for ITS Training and Education (CITE)
- CITE Blended Learning Courses
- Maryland Transportation Technology Transfer (MD T^2) Center
- 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 Iinformation 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 Engineering, 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 VM-ware 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.

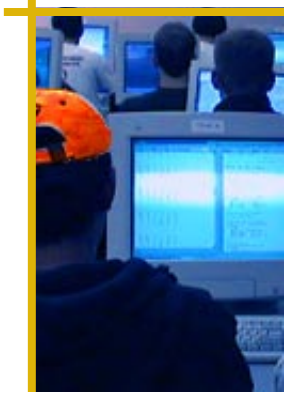
http://attap.umd.edu/

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

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

CHAPTER 9
TECHNOLOGY TRANSFER

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

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.

Media Library:
The MD T² Center maintains a library of numerous resources on topics of interest to local agencies in Maryland. Visit our 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 Maryland
- 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/

BOARD OF ADVISORS SPRING MEETING

On Thursday, March 12th, we held our first annual Board of Advisors Meeting at the University of Maryland's Riggs Alumni Center. The half day meeting was extremely productive. It started out with an overview of recently awarded projects as well as developments related to those projects. Throughout the meeting, mem¬bers of the board offered suggestions for applications of current research, directions for new research, and also suggested new partners for the Center. The day ended with a demonstration of the CATT Lab's Real-Time 3-D Traffic Monitoring System.

CITSM SEMINAR SERIES

The Center for Integrated Transportation Systems Management Seminar series hosts two speakers from the transportation community each semester. The series strives to bring prominent speakers in the field of transportation systems research to discuss current problems faced in transportation. Spring 2009 kicked off the inaugural seminar season, with Drs. Marlon Boarnet and Yanfeng Ouyang as the featured speakers. Information about the sessions and speakers can be found below.

Seminar Series - Marlon Boarnet

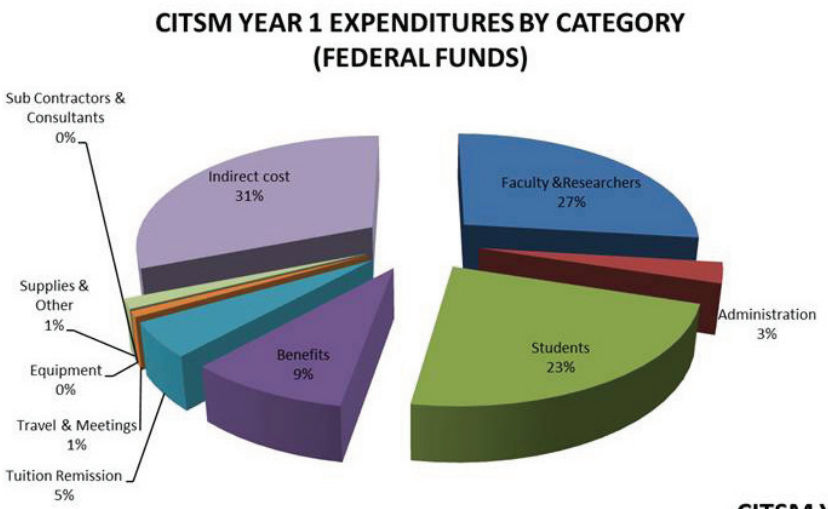
On March 4, the CITSM kicked off our first joint seminar with the National Center for Smart Growth. The talk was given by Dr. Marlon Boarnet of UC Irvine on his recent paper entitled "Transportation Planning in an Era of Expensive Mobility". The seminar was very well received, Dr. Boarnet presented to a conference room packed with engineering and urban planning faculty and graduate students. More information on Dr. Boarnet can be gathered from his web¬page at: http://socialecology.uci.edu/faculty/mgboarne/

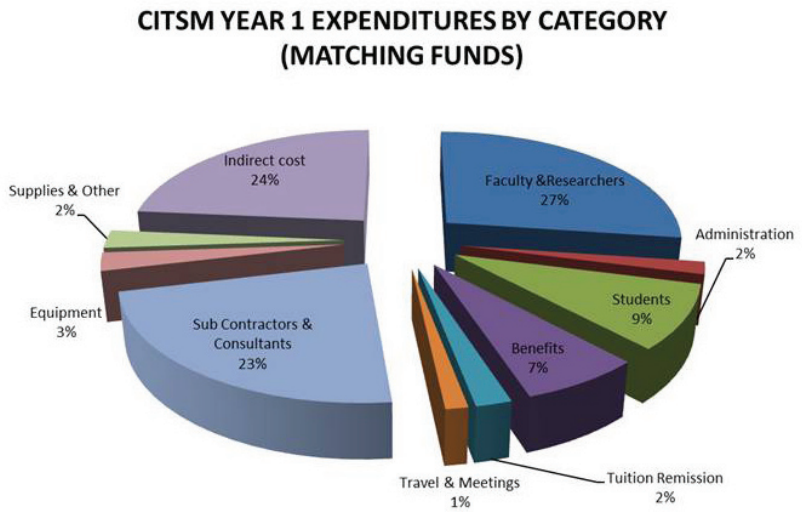
Seminar Series - Yanfeng Ouyang

CITSM and the National Center for Smart Growth had their second successful seminar series with the invited speaker Dr. Yangfeng Ouyang, assistant professor of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign. Dr. Ouyang discussed his research on "Reliable Facility Location Planning under Probabilistic Disruptions". More information regarding Dr. Ouyang's research and interests can be found at his institutional webpage: https://netfiles.uiuc.edu/yfouyang/www/

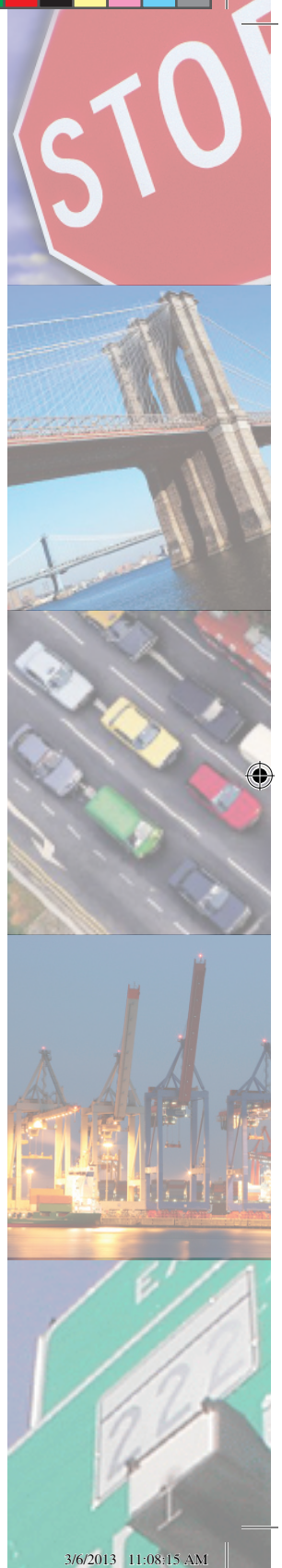
CHAPTER 10
NOTABLE EVENTS


TRAILER TRAIN
THIS CAR
EXCESS HEIGHT

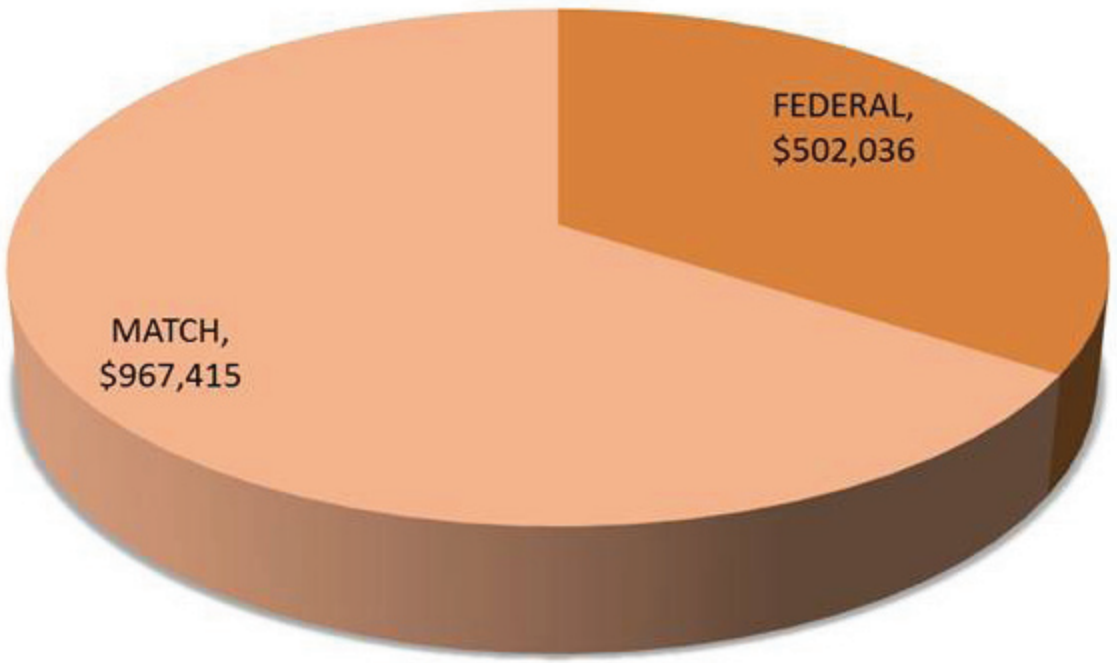




CHAPTER 11
FINANCIAL REPORT



CITSM YEAR 1 FUNDING SOURCES



Total Expenditures: $1,469,451

CITSM

Center for
Integrated Transportation
Systems Management
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