2011-2012 Annual Report

Old Dominion UNIVERSITY

Transportation Research Program

http://www.eng.odu.edu/transportation

Contents:

ODU Transportation Program: Graduate Program in Civil & Environmental Engineering & Virginia Modeling Analysis and Simulation Center

The transportation program at Old Dominion University grew substantially during this year. The goals were to 1) do scholarly research collaboratively across the campus and nationally, 2) work with graduate students, involving them in research, 3) enhance ODU reputation through conference presentations, editorships, and journal publications. The highlights include:

- Old Dominion University was part of a consortium that received the 2012 University Transportation Centers (UTCs) Tier 1 Grant (lead Institution: University of Idaho). The UTC is named *TranLIVE* and it will provide substantial funding for research, education, and outreach.
- A new Center for Innovative Transportation Solutions (CITS) was established in collaboration with the City of Virginia Beach, VA. The new center will start by providing transportation research and development services to the City of Virginia Beach and expand to the Hampton Roads region and nationally.
- Several refereed journal papers were published, along with presentations at international conferences (e.g., Transportation Research Board, National Academies) and technical reports to sponsors (e.g., Virginia Department of Transportation).
- ODU graduate students from Civil & Environmental Engineering attended the Transportation Research Board Annual conference and ODU sponsored a get-together lunch for the Hampton Roads group, which was very well received.
- Dr. Khattak served as editor-in-chief of *Journal of Intelligent Transportation Systems*, 4 issues were published (2011 impact factor of 0.727). He also served as Associate Editor of the *International Journal of Sustainable Transportation* (2011 impact factor of 0.750).
- Two Ph.D. students completed their dissertations.
- Substantial work was done on a collaborative project with the Virginia Modeling Analysis and Simulation Center (VMASC) to develop a commodity-based model. The study models distribution of freight in southeastern Virginia, a region including 31 counties. A unique aspect of the study, presented in a paper at the Transportation Research Board annual meeting, is using a genetic algorithm to calibrate the gravity model for distribution of freight.
- The analysis of incidents and secondary incidents in particular are problematic in the Hampton Roads area as well as Northern Virginia. A Virginia Department of Transportation (VDOT) sponsored project on the topic of secondary incidents was completed.
- Work on VDOT sponsored behavioral surveys of travelers was completed. A unique aspect of the work is the development, implementation and analysis of University students' travel behavior. The work is being done in collaboration with ODU Social Science Research Center (SSRC).
- Volume delay functions are critical inputs in travel demand models. A VDOT sponsored study analyzed alternative volume delay functions used for demand forecasting.

Notably, ODU's transportation program is also working internationally with Universities in China, South Korea and Portugal. The development of ODU's transportation program is occurring rapidly, with several graduate Ph.D. and Masters students involved in local, national and international research projects. This annual report provides a summary of the developments that have occurred during 2011-2012, including the profiles of full-time and adjunct faculty and research, educational, and service activities.

Faculty Profiles

The Civil and Environmental Engineering Department has full-time and adjunct faculty working on transportation research and education.

Faculty

Dr. Asad J. Khattak

Frank Batten Endowed Chair Professor
Department of Civil and Environmental Engineering
akhattak@odu.edu
Intelligent Transportation Systems, Transportation Safety, and Transportation Planning

Editor-in-chief Journal of Intelligent Transportation Systems
Associate Editor International Journal of Sustainable Transportation

Dr. Mecit Cetin

Assistant Professor
Department of Civil and Environmental Engineering
mcetin@odu.edu
Transportation Modeling & Simulation, Intelligent Transportation Systems, Traffic Operation, Freight, and Congestion Pricing

Dr. ManWo Ng

Assistant Professor
Department of Modeling, Simulation and Visualization Engineering
Department of Civil and Environmental Engineering
mng@odu.edu
Transportation Network Modeling, Dynamic Traffic Assignment, and Transportation Planning

Affiliated faculty

Dr. R. Michael Robinson

Research Assistant Professor
Virginia Modeling, Analysis, and Simulation Center
rmrobins@odu.edu
Transportation Modeling, Evacuation Modeling, and Decision Making

Faculty Profiles

The Civil and Environmental Engineering Department has full-time, associated, and adjunct faculty working on transportation research and education.

Affiliated Faculty

Dr. Bryan E. Porter

Associate Professor
Department of Psychology at Old Dominion University
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Traffic Psychology and Pedestrian Safety

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Hampton Roads Transportation Planning Organization (HRTPO)
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Transportation Planning, Intelligent Transportation System, and Transportation Operations Applications

Dr. Guzin Akan

Transportation Engineer
Old Dominion University, Norfolk, Virginia
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Traffic Signal Systems Operations and Design Applications

Mr. Dwight Farmer, P.E.

Executive Director
Hampton Roads Transportation Planning Organization (HRTPO)
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Transportation Policies & Planning and Travel Demand Forecasting

Mr. Robert Case, P.E.

Principle Transportation Engineer
Hampton Roads Transportation Planning Organization (HRTPO)
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Traffic Operations, Travel Demand, and Public Transit and Non-Drivers

Research Focus

Active Research Projects

The ODU research program in transportation continues to expand at a rapid pace. Our goals are to work collaboratively across the campus and nationally to obtain sponsored research projects and effectively complete the projects that are underway as well as to continue working with graduate students, involving them in research and recruit new students into the transportation program. The core faculty have been successful in bringing new transportation research projects to ODU and in completing research projects. The active research projects during 2011-2012 include:

- ***TranLIVE: Tier 1 University Transportation Center (ODU Transportation Research Institute Co-Principal Investigator: Asad Khattak and Mecit Cetin), US Department of Transportation, Consortium with University of Idaho as lead, 2012-2014:*** This is a national University Transportation Center project focusing on transportation for livability by integrating vehicles and the environment. More information is available at the website: http://tranliveutc.org/engr/niatt/tranlive. Projects underway at ODU include 1) reducing energy use and emissions through innovative community designs, 2) the impact of parameter uncertainty on the emission-based ranking of transportation projects, 3) developing real-time prediction of queues at signalized intersections to support eco-driving applications, 4) optimizing freight routes and modes to minimize environmental impacts, 5) developing vision-based systems to track and classify vehicles at high fidelity to enable estimation of emissions, and 6) new strategies for the emergency vehicle routing to reduce response time using vehicle-to-vehicle communications.

- ***Unmet Data Needs of Transportation Planners (Principal Investigator: Asad Khattak), Virginia Department of Transportation, VA. (ODU Transportation Research Institute), 2011-2013:*** The project aims to identify planning-related data needs (especially unmet data needs) of VDOT and PDC/MPO planners. It will conduct a literature review of planning data needs and solutions that have been implemented in other states. It will Identify existing data sources that meet these needs and which are accessible either now or expected to become accessible in the near term, e.g., 1 to 2 years. Finally, the project will identify potential short-term solutions for fulfilling the remaining data needs.

- ***Analysis of Virginia add-on National Household Travel Survey and Metropolitan Washington Council of Governments Household Travel Survey (Principal Investigator: Asad Khattak), Virginia Department of Transportation, VA. (ODU Transportation Research Institute), 2011-2013:*** The project aims to provide insights into differences of samples characteristics and travel behaviors between these two surveys for the overlap area in Northern Virginia by comparing Virginia National Household Travel Survey data with Metropolitan Washington Council of Governments Household Travel Survey data. Also, traveler behavior and socioeconomic variables are to be compared across the Virginia Metropolitan Statistics Areas. Moreover, the project is to develop trip generation models by trip purpose (home-based work, home-based other and non home-based, etc.) that take into account socio-demographic aspects for study areas.

- ***Investigation of New Equilibrium Assignment Methods for the VDOT Travel Demand Models (Co-Principal Investigator: Asad Khattak and Mecit Cetin) , Virginia Department of Transportation, VA. (ODU Transportation Research Institute), $199,000 for 2010-2013:*** The project will obtain Travel Demand Models for Virginia and check them for errors. Then Volume Delay Functions will be developed and their optimum parameters found. Next the project will evaluate the traffic assignment methods in CUBE Voyager. Traffic assignment methods available in TransCAD will also be tested. Finally, dynamic traffic assignment methodology for Hampton Roads will be demonstrated.

- ***Do Trip Productions Vary in Space? (Principal Investigator: Asad Khattak), Virginia Department of Transportation, VA. (ODU Transportation Research Institute), 2011-2012:*** To capture spatial variations in travel demand, this study uses Geographically Weighted Poisson Regression (GWPR)—a locally-based model as an alternative to conventional regression models used for trip generation. A behavioral dataset for Hampton Roads, Virginia collected in 2008-2009 (N=3151) is used to understand spatial variations in how trip productions relate to socio-economic factors that vary over space. The results will indicate whether local models provide a more accurate estimation and a better picture of how trip rates and their correlations vary across space. The recommendations for Virginia Department of Transportation will include considerations of moving toward local models in order to improve the accuracy of travel demand forecasts.

Research Focus

Journal Publications

Other goals during 2011-2012 are to do scholarly research throughout local, national, and international collaborations and to enhance ODU and BCET reputation and visibility through editorships, publications, conference presentations and marketing activities. In 2011-2012, 14 peer-reviewed scholarly papers in ISI-indexed journals were published, resulting from collaborative research efforts. Research journal publications are as follows:

- Bandeira J., T. Almeida, A. Khattak, N. Rouphail, and M. Coelho, Generating Emissions Information for Route Selection: Experimental Monitoring and Routes Characterization, Forthcoming in Journal of Intelligent Transportation Systems, Taylor & Francis Publishers, 2013.
- Zhang H., Y. Zhang, and A. Khattak, Analysis of large-scale incidents on urban freeways, Forthcoming in Transportation Research Record: Journal of the Transportation Research Board, National Academies, Washington, D.C., 2012.
- Son S., A. Khattak, & X. Wang, Transforming the telephone-based national household travel survey to the internet, Forthcoming in Transportation Research Record: Journal of the Transportation Research Board, National Academies, Washington, D.C., 2012.
- Wang X., A. Khattak, & S. Son, What can we learn from analyzing university student travel demand, Forthcoming in Transportation Research Record: Journal of the Transportation Research Board, National Academies, Washington, D.C., 2012.
- Duanmu J., P. Foytik, A. Khattak, & R.M. Robinson, Distribution analysis of freight transportation using gravity model and genetic algorithm, Forthcoming in Transportation Research Record: Journal of the Transportation Research Board, National Academies, Washington, D.C., 2012.
- Al-Deek H., L. Taylor, R. Chandra, A. Khattak, Diversion during unexpected congestion on toll roads: The role of traffic information displayed on dynamic message signs, IET Intelligent Transport Systems, 6:2, Institution of Engineering and Technology, 2012.
- Wang X. and A. Khattak, Role of travel information in supporting travel decision adaption: Exploring spatial patterns, Transportmetrika, iFirst, 2013.
- Khattak A., X. Wang, H. Zhang, iMiT: A tool for dynamically predicting incident durations, secondary incident occurrence, and incident delays, IET Intelligent Transport Systems, 6:2, Institution of Engineering and Technology 2012.
- Fan Y. and A. Khattak, Time use patterns, lifestyles, and sustainability of nonwork travel behavior, International Journal of Sustainable Transportation, 6:1, 2012, pp. 26-47.
- Shay E., and A. Khattak, Household travel decision chains: Residential environment, automobile ownership, trips, and mode choice, International Journal of Sustainable Transportation, 6:2, 2012, pp. 88-110.
- M. Cetin. Estimating Queue Dynamics at Signalized Intersections from Probe Vehicle Data: A Methodology Based on Kinematic Wave Model. Forthcoming in Journal of Intelligent Transportation Systems, Taylor & Francis Publishers, 2013.
- Ng, M.W., S.T. Waller, A Dynamic Route Choice Model considering Uncertain Capacities, Computer-Aided Civil and Infrastructure Engineering, in press.
- Ng, M.W. Synergistic Sensor Location for Link Flow Inference without Path Enumeration: A Node-Based Approach, Transportation Research Part B: Methodological, accepted.
- Ng. M.W. A Traffic Flow Theory-based Stochastic Optimization Model for Work Zones on Two Lane Highways, ASCE's Journal of Transportation Engineering, accepted.

News and Events

ODU receives the 2012 competitive University Transportation Centers Program grant as part of a consortium

The research focus of the UTC is "Transportation for Livability by Integrating Vehicles and the Environment" (TranLIVE for short). The main mission of the center is to help our nation achieve the goals of a cleaner environment and greater energy independence through developing new technologies and decision support tools. The U.S. Department of Transportation's Research and Innovative Technology Administration announced that a total of 63 University Transportation Center applications were received for a share of the $77 million in grants. A total of 22 grants, each worth $3.5 million (requiring a 1:1 match), were awarded following a review of the submitted proposals. The competition was particularly intense for the Tier 1 grants such as those received by TranLIVE with 46 university teams competing for only 10 opportunities. Notably, ODU was a new applicant to the UTC Program. The UTC Program awards grants to universities across the United States to advance transportation research and develop the next generation of transportation professionals.

Consortium members include University of Idaho (lead), Old Dominion University, Virginia Polytechnic and State University, Syracuse University, and Texas Southern University. The initial key research goals of this new Tier-1 UTC are to (1) integrate real-time data systems and advanced transportation applications to better manage congestion while minimizing environmental impacts, and (2) to develop modeling, simulation, and visualization tools that assess energy, environmental, and emission impacts of transportation systems to support transportation decision making at the local, regional, and national levels.

The ODU faculty and staff involved in these research projects are Dr. Asad Khattak, Dr. Michael Robinson, Dr. Mecit Cetin, Dr. ManWo Ng, Dr. Khan Iftekaruddin, Dr. Chung-Hao Chen, Dr. Xin Wang, Mr. Peter Foytik, Mr. Craig Jordan, and Mr.Semuel Rompis. Several graduate students will be involved in conducting the research. The applied research projects undertaken by ODU faculty and staff under the TranLIVE initiative will include the following:

- ***Reducing energy use and emissions through innovative community designs: methodology and application***
  (Principal Investigator: Dr. Asad J. Khattak. Co-PI: Dr. Mecit Cetin, and Dr. Michael Robinson)
- ***The impact of parameter uncertainty on the emission-based ranking of transportation projects***
  (Principal Investigator: Dr. ManWo Ng)
- ***Develop real-time prediction of queues at signalized intersections to support eco-driving applications***
  (Principal Investigator: Dr. Mecit Cetin)
- ***Optimize freight routes and modes to minimize environmental impacts***
  (Principal Investigator: Dr. Michael Robinson)
- ***Develop vision-based systems to track and classify vehicles at high fidelity to enable estimation of emissions***
  (Principal Investigators: Dr. Khan M. Iftekharuddin & Dr. Chung-Hao Chen)
- ***New strategies for the emergency vehicle routing to reduce response time using vehicle-to-vehicle communications***
  (Principal Investigator: Dr. Mecit Cetin)

News and Events

ODU launches the Center for Innovative Transportation Solutions in agreement with Virginia Beach Development Authority

The Center for Innovative Transportation Solutions (CITS) is a new transportation research initiative hosted by the City of Virginia Beach. In an agreement with the Virginia Beach Development Authority, Old Dominion University is launching CITS, propelling the City and University to the forefront of transportation research - regionally, nationally, and internationally. While working towards improving mobility in the City of Virginia Beach, the CITS partnership will also provide creative transportation solutions for residents and industry throughout Hampton Roads.

The center will focus on developing and applying innovative techniques, including the expansive use of modeling and simulation, to address a broad variety of transportation challenges and issues facing the region, state and nation. Transportation models and simulations produced by CITS will enable decision-makers to visualize the impact that proposed projects will have on traffic congestion, neighborhoods and businesses, safety, and on the environment. The unbiased non-partisan scientific research performed by the Center will ultimately result in more informed decisions and more successful projects for the region's transportation.

Where appropriate, CITS will integrate planning/operations and analysis; it will facilitate deliberation and consensus building, especially on contentious transportation issues that affect the city and the region. In such situations, CITS can bring together stakeholders to improve planning and through analysis capabilities and potentially avoid antagonistic situations. CITS will provide the analysis and knowledge-bases needed to make informed decisions.

Areas of research include:

- Multimodal transportation planning, including signal light timing, public transportation planning and analysis, and simulation of future traffic patterns;
- Applications of intelligent transportation systems, including Advanced Traveler Information Systems, advanced sensors analysis, and vehicle-to-vehicle communications;
- Safety and security, including driver and passenger behaviors, outcomes of safety interventions and evacuation transportation plans; and
- Transportation evacuations, climate change, and sea level rise.

CITS is housed in One Columbus Center in Town Center, Virginia Beach, VA. Central to the City, this location provides greater accessibility and visibility, ease of access to city officials and regional clients, as well as healthy potential for the Center's growth.

OLD DOMINION UNIVERSITY

THE CENTER FOR INNOVATIVE TRANSPORTATION SOLUTIONS

IDEA FUSION

2012 Transportation Research Board Presentations

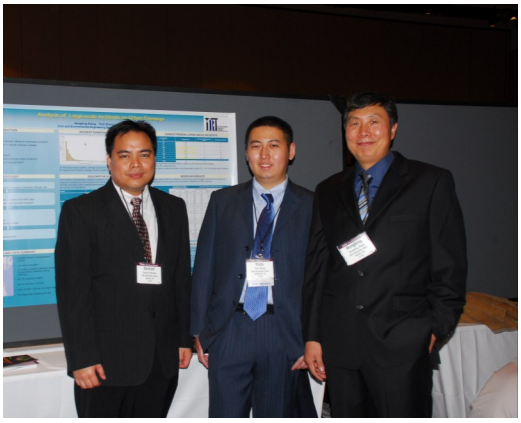
ODU Civil and Environmental Engineering faculty, Drs. Khattak, Cetin, and Ng presented 15 research papers at the 2012 TRB Annual Meeting

Transportation Research Board

ODU Civil and Environmental Engineering faculty participated in the 91st Annual Transportation Research Board (TRB) held in January in Washington, D.C. The presenters included Dr. Asad Khattak, Dr. Mecit Cetin, and Dr. ManWo Ng and several graduate students. ODU faculty and students presented 15 research papers/posters, reflecting collaborations between various ODU entities, e.g., Transportation Research Institute and Virginia Modeling, Analysis, and Simulation Center, and other universities. At the conference, the Fourth Annual Lunch for related faculty, researchers, students and transportation partners was held at the Lebanese Taverna, with participation from colleagues at various universities, Virginia Department of Transportation, and the Hampton Roads Metropolitan Planning Organization.

The TRB Annual Meeting covered all transportation modes, with thousands of presentations on a diverse set of transportation topics. The TRB 91st Annual Meeting attracted nearly 11,000 transportation professionals from around the world to Washington, D.C., in January, 2012. ODU's Dr. Khattak co-chaired the Advanced Traveler Information Systems sub-committee meeting, and Dr. Mecit Cetin presided over the Artificial Intelligence Applications for Travel Time and Demand Forecasting session.

Photos at TRB



2012 Transportation Research Board Presentations

We are pleased that the transportation faculty presented 15 research papers at the 2012 Transportation Research Board annual meeting in Washington, D.C. Some of the papers involve graduate students as co-authors—reflecting the emphasis that we place on developing a workforce that is exposed to research and a solid curriculum. The following papers were presented:

Operations, Intelligent Transportation Systems, and Safety

- Exploring the Transition of Traffic Flow Conditions in Aggregated Sensor Data (12-0134), Son, Sanghoon, Cetin, Mecit, Khattak, Asad J.
- Estimating Queue Dynamics at Signalized Intersections from Probe Vehicle Data: Methodology Based on Kinematic Wave Model (12-0135), Cetin, Mecit
- Comparing the Performance of Neural Networks and Bayesian Models in Solving the Vehicle Reidentification Problem (12-0133), Cetin, Mecit, Rashid, Tanweer
- Investigating Benefits of Vehicle-to-Vehicle Communications in Emergency Response: Conceptual Methodology (12-0131), Jordan, Craig A., Foytik, Peter, Norfolk, Cetin, Mecit
- Distribution Analysis of Freight Transportation Using Gravity Model and Genetic Algorithm (12-2782), Duanmu, Jun, Foytik, Peter, Khattak, Asad J., Robinson, Robert Michael
- Analysis of Large-Scale Incidents on Urban Freeways (12-3734), Zhang, Hongbing, Zhang, Yichi, Khattak, Asad J.
- A Comparative Empirical Analysis of Eco-Friendly Routes During Peak and Off-Peak Hours (12-0570), Bandeira, Jorge Filipe Marto, Carvalho, Dário Oliveira, Rouphail, Nagui M., Khattak, Asad J.

Network Modeling

- Determining Network-wide Link Flows Through Strategic Sensor Deployment Without Path Enumeration (12-1231), Ng, ManWo
- Optimizing Work Zone Traffic Flow on Two-Lane Highways (12-1222), Ng, ManWo
- Generalizing FHWA's Ramp Counting Procedure for Arbitrary Network Topologies: Some Examples of How to Count More with Less (12-1228), Ng, ManWo
- Emissions Modeling in Transportation Networks with Stochastic Dependencies: Copula Approach (12-1230), Ng, ManWo

Planning and Traveler Behavior

- Transforming the Telephone-Based National Household Travel Survey to the Internet (12-1488), Son, Sanghoon, Khattak, Asad J., Wang, Xin, Chen, Juyin
- What Can We Learn from Analyzing University Student Travel Demand? (12-2783), Wang, Xin, Khattak, Asad J, Son, Sanghoon
- Evacuee Route Choice Decisions in Dynamic Hurricane Evacuation Context (12-3167), Robinson, Robert Michael, Khattak, Asad J.
- Calibration of Volume-Delay Functions for Traffic Assignment in Travel Demand Models (12-0132), Cetin, Mecit, Foytik, Peter, Son, Sanghoon, Khattak, Asad J., Robinson, Robert Michael, Lee, Jaesup

In addition, Mr. Robert Case from the Hampton Roads Planning District Commission and graduate student at ODU presented a dissertation paper titled The Role of Accessibility in Reducing Auto Travel Disbenefits (P12-6884). Mr. Case is currently pursuing a Ph.D. in Civil & Environmental Engineering at Old Dominion University.

2012 Transportation Research Board Presentations

The ODU Transportation Program was well-represented at the 2012 TRB Annual Meeting, with 15 papers presented. The TRB Annual Meeting is an excellent opportunity for the program to share its most innovative research, while receiving valuable input from colleagues in transportation. Some highlights of 2012 are discussed here.

What Can We Learn from Analyzing University Student Travel Demand?

Xin Wang, Asad J. Khattak, and Sanghoon Son

To improve regional travel demand models, transportation engineers and planners desire appropriate representation of sub-populations. University students are a relatively neglected group of the population that are often missed in regional behavioral surveys and are not well represented in travel demand models. Many students attending a university reside, take classes, work, and perform other activities in the university environment, which is often mixed use, alternative mode friendly, higher density, and livable. The purposes of this paper are to understand travel behavior of university students and model associations with their attributes that include personal characteristics, residential location (residing on-campus or off-campus), and academic status. The data used in this study are from a unique internet-based survey (N=1,468) conducted in 2010 at Old Dominion University in Virginia, which was part of the University National Household Travel Survey supplement. Using behavioral data combined with spatial data, rigorous models of automobile and walk/bicycle trip rates are estimated to explore associated factors. Results show that students living on-campus or near-campus are significantly more likely to walk/bicycle and less likely to drive, indicating the value of living in a campus environment with greater accessibility to activities and a walk/bicycle friendly network. The behavioral models provide helpful information that can be used to better represent the behavior of university students in regional travel demand models and to improve strategic planning.

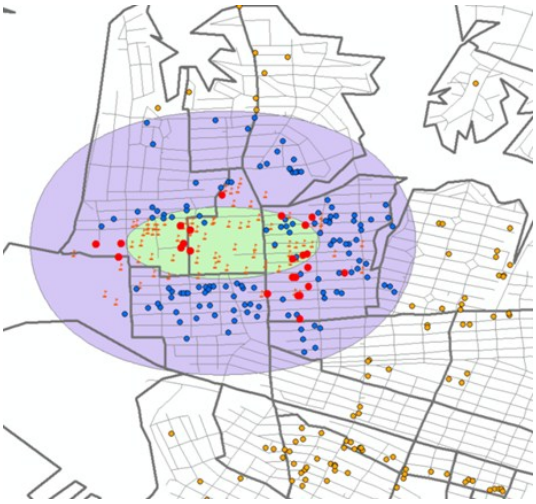


Figure 1. Residential locations of on-campus and near-campus university students

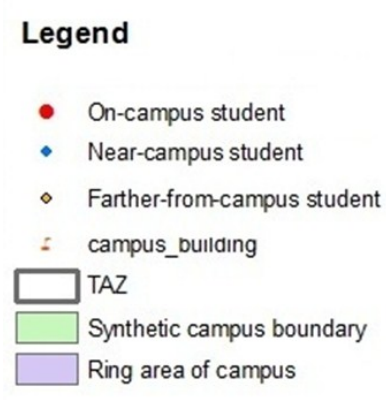
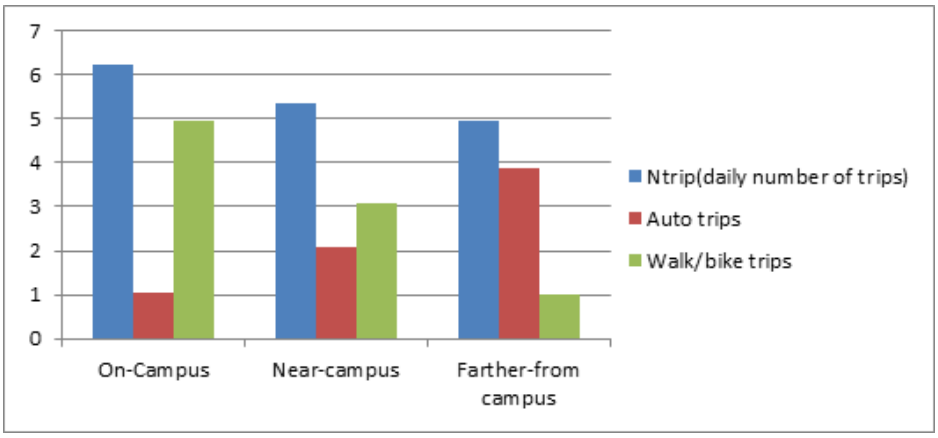


Figure 2. Trip frequencies by mode for ODU students with different proximity to campus



2012 Transportation Research Board Presentations

The TRB Annual Meeting highlights...

Comparing the Performance of Neural Networks and Bayesian Models in Solving the Vehicle Reidentification Problem

Mecit Cetin and Tanweer Rashid

Vehicle re-identification methods can be used to anonymously match vehicles crossing two different locations based on vehicle attribute data. In this paper, both Neural Network (NN) and Bayesian models are applied to a large dataset to understand the relative performance of these techniques in solving the vehicle re-identification problem. The analyses are performed by employing NN and Bayesian re-identification algorithms in order to match commercial vehicles that cross upstream and downstream pairs of weigh-in-motion (WIM) sites that are separated by long distances. The data to support this research come from various fixed WIM sites in Oregon. Data from four different pairs of WIM sites are used to evaluate the accuracy of the NN and Bayesian models in correctly matching vehicles. The results from the testing datasets showed that both methods can be effective in solving the re-identification problem while the Bayesian method yields more accurate results.

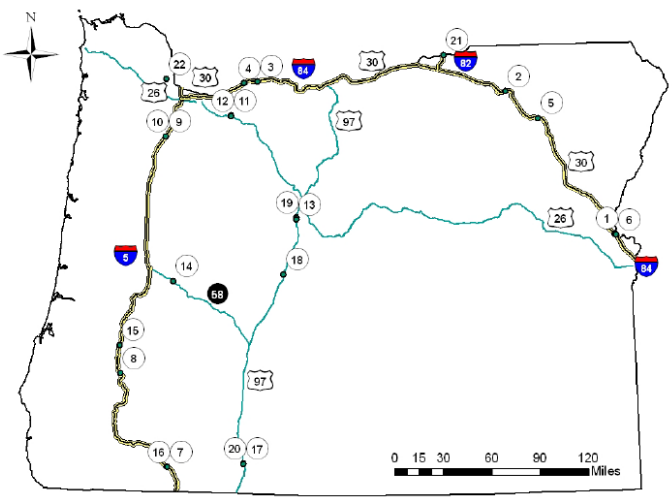


Figure 1. Map of WIM station locations in Oregon used in this study

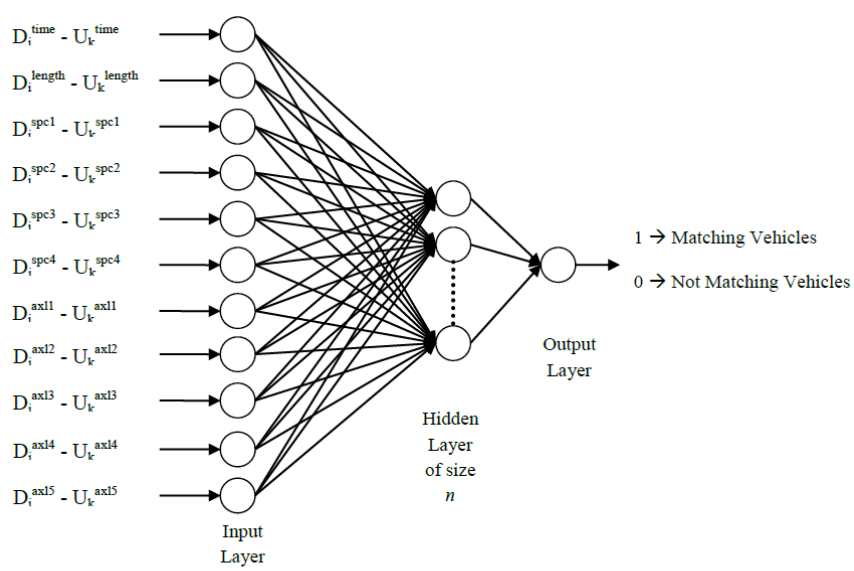


Figure 2. Diagram of the multilayer perceptron used for re-identification

2012 Transportation Research Board Presentations

The TRB Annual Meeting highlights...

Emissions Modeling in Transportation Networks with Stochastic Dependencies: Copula Approach

ManWo Ng

The air quality levels in various regions around the world remain a large public concern. Transportation is known to be a major contributor to reduced air quality levels. Until now, the modeling of the regional impact of transportation on air quality has been based on the assumption of determinism. On the other hand, it is well recognized that transportation systems are subject to both demand and supply uncertainties. In this paper, we relax the assumption of determinism and allow for capacity and link flow uncertainty. We introduce a probability measure – coined the conformity probability – to capture the full probabilistic behavior of vehicular emissions. Moreover, stochastic dependencies are modeled using copulas, generalizing other commonly used dependence modeling techniques in the transportation network modeling arena. In a case study we demonstrate that such a generalization is critical as the ranking of capacity expansion projects to improve air quality is shown to be dependent on the hypothesized dependence structure.

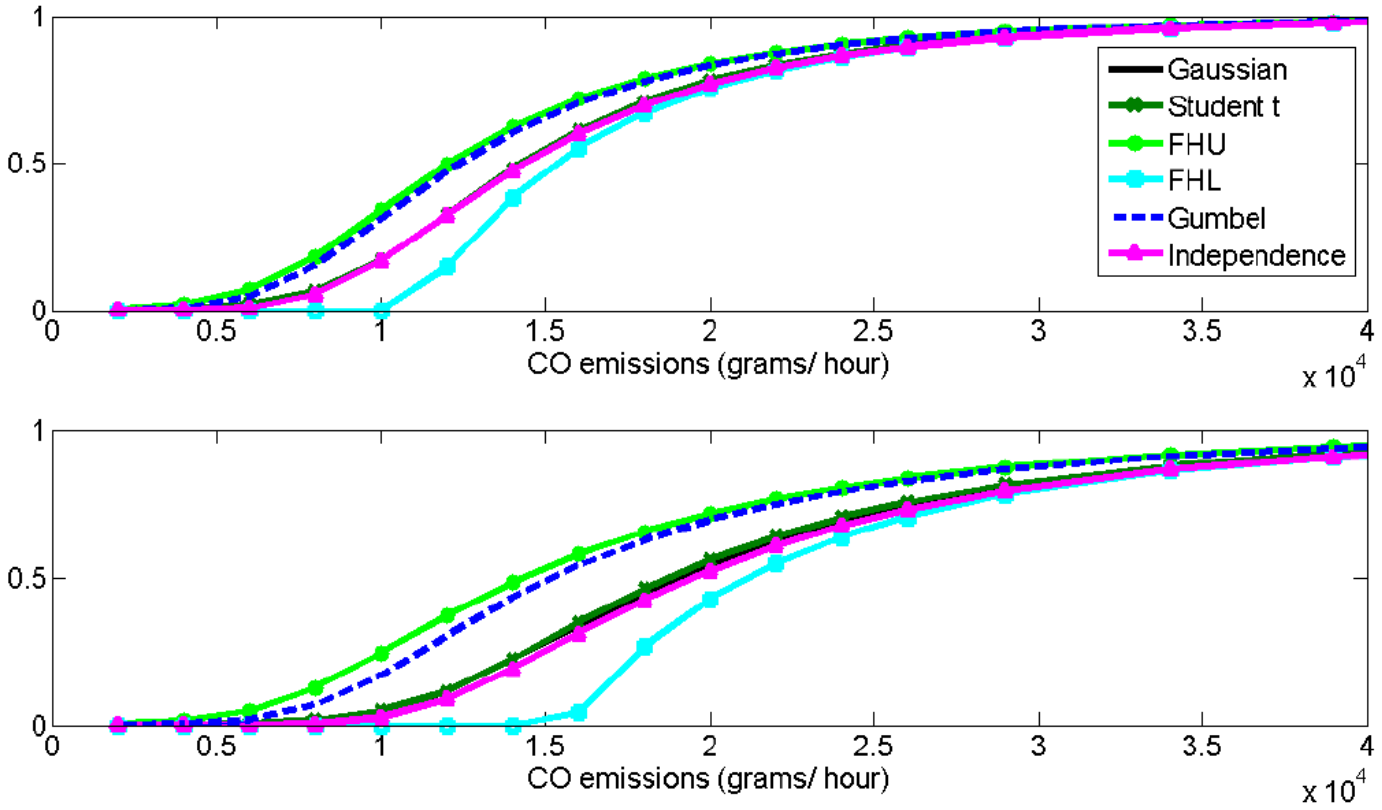


Figure 1. CDFs of the conformity probability for base demand (upper figure) and high demand (lower figure)

Thesis/Dissertation of ODU graduates

In 2011-2012, three MS students (Mr. Rahul M. Rajbhara, Mr. Afi Anuar and Mr. Craig Jordan) and two Ph.D. students (Dr. Xin Wang and Dr. Hongbing Zhang) have graduated. Dr. Khattak, Dr. Cetin, and Dr. Ng have advised their work, focusing on traffic operations and transportation planning. Their thesis and dissertations are presented as follows:

Demand Responsive Signal Control Strategy (DRSC): Incorporating Queue Length Information In Real-time Signal Control
Mr. Rahul M. Rajbhara

Most of the existing vehicle detection systems, namely inductive loops, video cameras etc. are incapable of measuring the queue lengths at signalized intersections. However, with the advent of modern technology, newer detection methods such as probe vehicles equipped with wireless communications (Connected Vehicles), particularly under the Vehicle Infrastructure Integration, and radar detection currently provide this capability. This thesis presents a Demand Responsive Signal Control Strategy (termed as DRSC) for an isolated signalized intersection. The control strategy incorporates real-time queue length information (obtained from probe vehicles) into the signal control logic. This information thereby helps in computing the maximum green times for the active phases every cycle. Moreover, the use of variable maximum green times from cycle to cycle enables efficient allocation of the intersection capacity when traffic demand fluctuates. The proposed methodology is implemented for a single isolated typical 4 legged intersection and then evaluated in a microscopic traffic simulation environment (VISSIM). To assess the robustness of the proposed method, three demand scenarios are tested. In each scenario, a demand surge is induced at one or more approaches of the intersection. The proposed model (DRSC) is evaluated against an eight phase typical actuated signal control using three strategic performance measures – the average delay, average queue size and the number of stops. The simulation results indicate the potential of the proposed method (DRSC) in improving the intersection performance under varying traffic demand conditions.

Integrating Probe Vehicles and Stationary Detector Data to Construct Accurate Cumulative Curves to Study Bottlenecks
Mr. Afi Anuar

Advancements in sensors technologies have given researchers and practitioners access to an immense amount of traffic data from multiple types of sensors. However, because of the diversity of the data types, developing a relationship between the different data sources can be challenging. To further complicate the issue, the presence of error or noise makes it difficult to infer any reliable conclusions from the data. To develop a relationship between different data sources, a new methodology is proposed in this thesis for fusing stationary detector data and probe vehicle data to construct an accurate cumulative curve. To remove or to reduce any error in the stationary detector data (which can be found in the form of bias or white noise), the fusion of data was performed by minimizing the difference between the arrival curve (determined from a stationary detector) and the arrival times of the probe vehicles. A nonlinear optimization tool was used to correct for the unknown bias. To demonstrate the application of the methodology, sample data were generated from VISSIM, a microscopic traffic simulation. VISSIM was used to create a link from which stationary and probe vehicle data were generated. The sensor data from the simulation were artificially contaminated with bias and white (Gaussian) noise to reflect error that can be present in real-world detectors. To analyze the effects of error and other potentially known or unknown parameters, a factorial design was performed. The analyses were performed based on data from five different VISSIM runs. Within each VISSIM run, thirty random replications were generated for each different level of noise. The analysis of the result of the factorial design indicates that the proposed methodology was able to fuse the stationary and probe vehicle data effectively. The proposed methodology was then applied to field data collected from the Hampton Roads Bridge-Tunnel (HRBT) corridor. However, due to lack of detectors on the ramps along the corridor and gross error in the traffic data, the cumulative curve for the HRBT could not be constructed.

Clearing Paths for Emergency Vehicles Using Shock Wave Theory and Vehicle-to-Vehicle Communication
Mr. Craig Jordan

A new strategy to enable an EV to navigate through congestion at signalized intersections more efficiently has been developed and is presented in this thesis. The proposed strategy involves communicating control messages to vehicles to change their driving behavior and to traffic signals to change their timing plans so that EVs can proceed through

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congested intersections as quickly as possible. To achieve this, specific vehicles are instructed to hold their positions to create a split in the vehicle queue at a critical location in one lane. The split allows the EV to change lanes and proceed unimpeded at its desired speed through the intersection while minimizing the disruption to background traffic. The proposed method uses shock wave theory to determine the critical split point in the vehicle queue. A microscopic traffic simulator is used for evaluating the effectiveness of the developed strategy. The results indicate that implementation of this strategy can reduce the response time of EVs.

Spatial Analysis of Travel Behavior and Response to Traveler Information
Dr. Xin Wang

Transportation planners have long recognized that it is urgent to integrate emerging spatial analysis with travel behavior studies. A clearer understanding of the spatial interactions among travelers and the complex environment they face has the potential to reap benefits of the ongoing technologies of travel behavior, spatial analysis and Advanced Traveler Information Systems (ATIS).

Considering that spatial patterns have been overlooked in the literature of travel behavior and ATIS, the main objective of this research is to use robust methods of spatial analysis to enhance the understanding of how the associations between traveler decisions, built environment and socio-demographic characteristics are organized spatially. This dissertation takes a significant step towards filling this gap by using innovative spatial data description methods, e.g. Geo-imputation, dynamic buffer analysis, spatial statistics to model the travel behavior of both the general population and university students.

This study starts by developing a unique database from extensive behavioral data combined with a variety of spatial measurements, taking advantage of increased GIS capabilities. Five different activity-based databases from different regions are use, combined with their related socio-demographic and land-use data. Among them, two general population travel surveys are from North Carolina, which were conducted at Charlotte in 2003 and at the Greater Triangle in 2006, respectively, the Virginia Add-on for the general population was conducted in 2008, while two waves of the Virginia University Student Travel Survey (USTS) were conducted in 2009 and 2010. The general population and the university students are compared with each other in terms of how they traveled and responded to ATIS.

Issues addressed in this dissertation include two aspects. The first one is how to describe data in space more accurately. When there is a need to know the exact locations of residences (geo-coordinate) but such information is unknown, Geo-imputation is used as a fundamental method of assigning synthetic locations randomly to these residences, based on available zonal information. After locating the residences by using Geo-imputation, dynamic buffer analysis is used to capture local built environment characteristics around residences, which place emphasis on capturing accessibility.

The second issue is modeling travel behavior in space. Particular emphasis is placed on modeling associations between trip making, trip decision changes and their associated explanatory variables. The general population is compared with the university students who represent an energetic and technology-savvy subgroup of population. Different spatial scales are used for these two groups: regional level is used for the general population; the university campus is used as a special trip generator for the university students.

At the regional level, a unique model structure, i.e. Geographically Weighted Regression (GWR), is used to allow associations to change across space, referred as spatial heterogeneity. And significant spatial heterogeneity is found in the associations between trip-making and built environment, as well as in the model of travelers' information acquisition behavior and their travel decision adjustments. The spatial heterogeneity in the trip-making models suggests that there is higher spatial variability in favor of the statement that better land use design can help reduce auto trips. It is important to note that these potentially useful insights would have remained uncovered if using a non-spatial model that does not take spatial heterogeneity into account.

At the special trip generator level, when local models don't work well, the university campus is studied as a case which represents a combination of livable environments and group of people who have different life cycles compared with the general population. Particular spatial analysis is applied to capture the association between trip-making and students' residential proximity to campus. The models confirm there are rings of mobility around the campus. Different from the traditional travel demand model for the general population, this varied level of mobility of students based on their residential proximity of campus is important and must be considered in the students' travel demand model.

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Analysis of Primary-Secondary Incident Events on Urban Freeways
Dr. Hongbing Zhang

Traffic incidents are a major source of congestion on urban freeways. Especially for large incidents, they typically block all or part of roadway facilities, cause traffic backup and increase the risk of secondary incidents occurring in their proximity. Approximately 2% to 15% of all incidents are secondary incidents. They further complicate the traffic conditions, stretch response resources and result in responders' and travelers' severe injuries or fatalities. These significant operational and safety concerns have drawn national and international attention. However, relatively little is known about the characteristics, occurrence, correlations and associated traffic delays of primary and secondary incidents. The objective of this study is to understand the nature of primary and secondary incidents, assess their impacts and explore the implications in traffic operations, safety, and planning. Ultimately, the advances and findings in this research will contribute to promoting an effective incident management strategy to restore disrupted traffic flow as quickly and safely as possible and assist in the planning process to conduct a more accurate impact/cost evaluation for non-recurrent congestion on urban freeways.

To achieve the objective, a queue-based secondary incident identification method was developed and applied based on detailed incident, traffic and geometric data sets from Hampton Roads, Virginia. This identification method can overcome the limitations in earlier studies and identify secondary incidents in both road directions. An innovative event categorization defines the term "primary-secondary incident event", as one characterized by a primary incident and one or more associated secondary incidents in both directions to capture traffic impact and incident adversity. Primary-secondary incident events are categorized on a three-point ordinal scale as: (1) an independent incident, i.e., an incident not associated with any secondary incidents; (2) one primary-secondary incident pair; and (3) one primary with two or more secondary incidents in the same or opposite directions. Several key analyses were conducted to explore different aspects of primary-secondary incident events.

To observe distributing pattern differences of primary-secondary incident events, two major interests: event frequencies in different categories and durations of primary incidents have been analyzed spatially and temporally. Frequencies of primary-secondary incident events and duration distributions of primary incidents both show considerable spatial and temporal differences across different event categories. The hotspots (i.e. locations that have higher frequency of primary-secondary incident events) were identified. To understand the occurrence of primary-secondary incident events, two proportional odds models were estimated to explore associations with various factors. In particular, the partial proportional odds model can relax parallel lines assumption and capture unequal contributions of explanatory variables across the event categories. The model suggests that with multiple-vehicle involvement, lane-blockage in a primary incident makes unequal contributions to the occurrence of different primary-secondary incident events, and they are particularly prone to multiple secondary incidents.

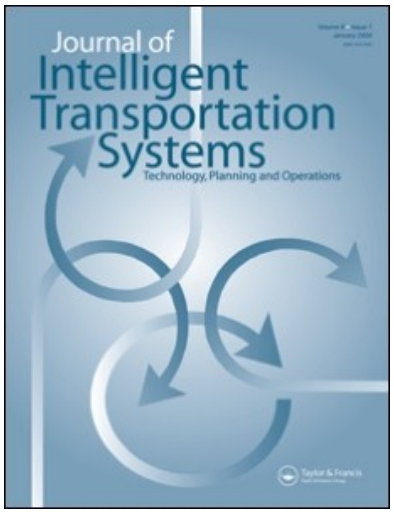
This study sought to answer how soon does a secondary incident happen after a primary incident; how far is the secondary from the primary incident; and what factors are associated with near versus far secondary incidents. The appropriate methods and models have been developed to examine the spatio-temporal patterns of cascading incident events and identify associated factors. Time gaps were found to be positively associated with crashes, longer duration of primary incidents, and heavier traffic. In terms of distance, primary crashes, fires, lane-blockage and longer duration are associated with secondary incidents that occur at longer distances after its primary incident. The study found that distance and time vary systematically with characteristics of primary incidents.

Regarding the clearance time of primary-secondary incident events, the event duration is defined and such events were further categorized as either contained events (i.e. clearance time of the secondary is earlier than that of primary incident) or extend events (i.e. clearance time of the secondary extends that of primary incident). The associated major factors were estimated and identified through rigorous statistical models. These two types of events show substantially different incident characteristics and operational response patterns. Primary incident characteristics are dominant in contained events while secondary incident characteristics play a substantial role in extended events, requiring substantial resources from response agencies.

To quantify the total delay associated with primary-secondary incident events, the joint impacts of primary and secondary incidents have been taken into account. Shock wave analysis and microscopic simulations were used to understand and evaluate the associated critical parameters. Three critical contributing factors were evaluated: time gap, physical distance and traffic demand level. The analysis shows the traditional method which treats each incident independently will over- or under- estimate the actual delay of primary-secondary incident events. For those secondary incidents that end after their associated primary incidents, total delays increase as time gap increases and distance decreases.

The study took a major step forward in the research of secondary incidents and expanded the knowledge of secondary incidents. Analyses provide valuable information to evaluate route performance, reduce the likelihood of secondary incidents, improve response to the complex associated incidents, manage traffic queues and minimize the traffic delay. The findings have been translated to the practical tools to support operational decisions and more informed planning.

Journal Editing



Submissions Welcome
The Journal of Intelligent Transportation Systems accepts submissions of original work. A complete list of instructions for the preparation of manuscripts is available on the journal's website: (http://www.tandf.co.uk/journals/titles/15472450.asp)

Journal of Intelligent Transportation Systems: Technology, Planning, and Operations

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Dr. Asad Khattak is the editor of Journal of Intelligent Transportation Systems. The Journal of Intelligent Transportation Systems is devoted to scholarly research on the development, planning, management, operation, and evaluation of intelligent transportation systems. Characterized by the application of information and communication technologies to transportation, such systems provide innovative solutions to contemporary transportation problems. They encompass the full scope of information technologies used in transportation, including control, computation and communication, as well as algorithms, databases, models, and human interfaces. The emergence of these technologies as a pathway for transportation is a relatively new field of research. The Journal of Intelligent Transportation Systems is particularly interested in research that leads to the development of such systems and improved planning and operation of the transportation system through the application of these new technologies. The journal also publishes papers that add to the scientific understanding of ITS impacts on accessibility, congestion, pollution, safety, security, noise, and energy and resource consumption. The journal is interdisciplinary and multi-modal, dealing with research in the fields of engineering, economics, planning, policy, business, and management, and in all forms of ground, air, and water transportation. Example topics include:

- Role of information systems in transportation, traffic flow and control, vehicle control, routing and scheduling
- Traveler response to dynamic information
- Planning for ITS innovations
- Evaluations of ITS field operational tests
- ITS deployment experiences
- Automated highway systems
- Vehicle control systems
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The Journal of Intelligent Transportation Systems has a 2010 Impact Factor of 1.273.

This places JITS as one of the highly ranked journals in the growing field of intelligent transportation systems. It is ranked 9th among Transportation Science and Technology Journals, based on 2010 Thomson Reuters, Journal Citation Reports. This result could not have come without the valuable contributions of the editors, authors, and reviewers. Note that a high impact factor increases the visibility and awareness of journals, and it can drive up usage and increase journal distribution. Here are five most-cited articles from 2008-2010.

- B. Balcik, B.M. Beamon, K. Smilowitz, Last Mile Distribution in Humanitarian Relief Volume 12, Issue 2, pp. 51-63.
- I. Kaparias, M.G.H. Bell, H. Belzner, A New Measure of Travel Time Reliability for In-Vehicle Navigation Systems Volume 12, Issue 4, pp. 202-211.
- A. Higatani, T. Kitazawa, J. Tanabe, et al., Empirical Analysis of Travel Time Reliability Measures in Hanshin Expressway Network Volume 13, Issue 1, pp. 28-38.
- I. Lin, R. He, A.L. Kornhauser, Estimating Nationwide Link Speed Distribution Using Probe Position Data Volume 12, Issue 1, pp. 29-37.
- N. Uno, F. Kurauchi, H. Tamura, et al., Using Bus Probe Data for Analysis of Travel Time Variability Volume 13, Issue 1, pp. 2-15.

Transportation Engineering Degrees at ODU

The goal of the transportation educational program at ODU is to provide students with the knowledge and tools that they will need to succeed in the workforce. The undergraduate program provides a solid foundation in design, operations, and planning. At the graduate level, students learn advanced analytical tools and technologies to help address transportation problems. The graduate program in transportation offers Master's and Ph.D. degrees. Qualified full-time students pursuing a Master of Science or Ph.D. degree are eligible for funding through Research Assistantships. Students interested in learning more about the program are invited to contact Dr. Khattak or Dr. Cetin.

DEGREES & COURSEWORK

Degrees The Department of Civil & Environmental Engineering offers graduate programs leading to the following degrees:

- Bachelor of Science in Civil Eng (BSCE)
- Master of Science in Civil Eng (MSCE)
- Master of Engineering in Civil Eng (MECE)
- Doctor of Philosophy in Civil Eng (Ph.D. CE)

Bachelor's and Master's students build a solid foundation in engineering by taking a courses in transportation fundamentals, transportation planning, & operations. In addition, Master's students produce a Thesis or Project. Students can also take transportation courses through ODU Extension.

The Ph.D. program provides training in research methods that enables graduates to contribute to the development of substantive theory, knowledge, and scholarship in transportation engineering.

Undergraduate Transportation Coursework Provides knowledge of transportation and the inter-relationships between multiple transportation modes. Students can take the following courses:

- Transportation Fundamentals
- Transportation Planning
- Transportation Operations I
- Transportation Operations Applications

Graduate Coursework Provides an extensive background in transportation engineering. Students may take the following courses:

- Transportation Fundamentals
- Transportation Planning
- Transportation Operations I & II
- Transportation Safety
- Intelligent Transportation Systems
- Transportation Network Models and Optimization
- Simulation Modeling in Transportation Networks

RESEARCH & INTERNSHIPS

Current Research Faculty and students conduct research in the following areas:

- Transportation operations
- Transportation planning
- Modeling and simulation of transportation systems
- Transportation safety
- Intelligent Transportation Systems

Student Publications Graduate students are encouraged to co-author articles with faculty. Additionally, students are encouraged to present their research at forums, such as the annual Transportation Research Board meeting.

Financial Assistance & Internships Research and teaching assistantships are available to full-time students. These typically pay for student stipends and partial or full tuition.

Internships provide employment experience and the opportunity to develop professional skills. Students can work for these partners:

- Virginia Modeling, Analysis & Simulation Center
- Virginia Department of Transportation
- Hampton Roads Transportation Planning Organization

Transportation at ODU

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Norfolk, VA 23529

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Mission

The mission of the ODU Transportation Program is to contribute to the advancement of transportation systems in three ways:

- The education of transportation professionals,
- The development of knowledge that stimulates applications of new strategies/technologies, and
- The dissemination of knowledge to transportation practitioners and other stakeholders.

We achieve these goals by offering students a broad curriculum, faculty with diverse backgrounds and research interests, and professional development opportunities in the Hampton Roads area.

Sponsors

The Virginia Department of Transportation directly supports research activity at the ODU Transportation Program. In addition, core ODU transportation faculty received research funding from the following sponsors:

- Virginia Department of Emergency Management
- California Department of Transportation
- Oregon Transportation Research and Education Consortium
- US Department of Transportation
- National Science Foundation
- City of Virginia Beach

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