



## Program Progress Performance Report for University Transportation Centers

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**Project Title:** NEXTRANS – Integrated and Sustainable Transportation Solutions:  
From Concepts to Deployment

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**Reporting Period End Date:** December 31, 2016  
**Reporting Frequency:** Semi-annual

Signed: \_\_\_\_\_

Ned Howell, Managing Director

## Part 1: ACCOMPLISHMENTS

**Major Goals** -- There have been no changes to program goals.

### Major Activities

*Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Revised the experiment scenarios based on the observed issues during the experiments;
- Redesigned experiment scenarios focusing on the driver's cognition load and the impacts of human machine interfaces;
- Recruited experiment participants focusing on the elderly group;
- Completed data archiving and analyses using the experiment data;
- Tested biosensors (e.g., eye tracker and EEG sensor) to capture physiological signals associated with information provision;
- Designed baseline tests and experiment procedure for the integrated biosensors.

*Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- produce two articles for Transport Policy (one published, one under review)
- develop a website to provide transportation planners with implementation tools for the methods
- conduct case studies of transportation decisions to assess the impact of mobility-based evaluation
- model the consequences of a shift to accessibility-based evaluation on transportation decisionmaking
- conduct interviews and focus groups to research obstacles to accessibility-based evaluation
- develop new graphical approaches to communicating accessibility concepts

*Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Summarized directly observed CTL OD flows for stakeholders and research efforts
- Collected CTL automatic passenger count (APC) and automatic vehicle location (AVL) data on a regular basis
- Collected directly observed CTL onboard bus route passenger origin-destination (OD) flows
- Collected bus route passenger origin-destination (OD) flows with indication of a demographic variable (gender) on a regular basis
- Developed a modification to manual CTL onboard bus route passenger origin-destination (OD) flows to include data collection on a demographic variable and pretested the modification
- Processed CTL APC data for research and outreach efforts
- Estimated CTL OD flows from processed APC data
- Developed models on attitudes toward employer-based dynamic ridesharing options using data from a stated preference survey of large number of the OSU campus community
- Investigated factors that influence the quality of bus route-level origin-destination flows obtained using data acquired with a device that captures Wi-Fi signals from mobile devices
- Estimated socio-economic and travel characteristics of a population of transit users from route-level OD flow estimates using APC and AFC data and interview-based onboard survey data
- Used CTL-derived knowledge and expertise and CTL infrastructure to assist in a complementary, externally funded project on bus-pedestrian safety
- Refined and used CTL-based education activities in one course
- Supervised efforts of a PhD student using CTL data for his dissertation research
- Made presentations based on CTL activities or infrastructure at various conferences and workshops
- Met with stakeholder of research, education, and outreach results to discuss ongoing relations and affirm continued support

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Continue to Incorporate Transportation related topics in ENE-WRM Curriculum -- Culverts and Highway runoff in Urban Water Problems WRM 4402
- Research experience to the ENE undergraduate Trenton Barnes at Purdue University (2016 Summer)
- Internship for ENE undergraduate Aquil Frost at ODOT Lebanon, OH office (2016 Summer)
- Continue to impart education in transportation to middle school and high school students, as a part of this grant and another grant from Federal Highway Administration (FHWA) 2016 Summer
- Presented at a conference -- TASME Conference, Toronto, Canada: presented on 2 July 2016 (GHG research)
- Abstract got accepted for a conference -- ASEE-National Conference, Columbus,OH; will be presented in June 2017 (outreach program)
- A DoT proposal with the collaborating consortiums got the approval for funding -- Lead-University of Michigan (CCAT) -- successful proposal (December 2016)
- A proposal for starting minor in Infrastructure Engineering -- submitted for Department of Education (Dec 2016)
- Purchased ADR1500-Dust Monitor for measuring particulates (PM<sub>2.5</sub> and PM<sub>10</sub>) from on-road vehicles.

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Literature review on how social networking services (SNS) disseminate and propagate evacuation-related information during no-notice evacuations
- Design surveys to collect data for understanding both SNS usage behavior and evacuation decision-making under emergency situations
- Conduct the surveys on students, staffs and faculty on Purdue University in West Lafayette, Indiana
- Construct a mixed logit model to describe information sharing (post/repost) patterns through SNS during no-notice evacuations
- Construct a structural equation model to understand the impacts of disaster or/and evacuation related information from different sources on people's evacuation decision-making process in a no-notice evacuation
- Build an agent-based model to explore the interrelationship between evacuation decision and decisions on SNS usage

#### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Developed a new methodology for traffic signal timing optimization under user equilibrium based traffic conditions, coupled with a case study for methodology application

#### *Tracking bicyclists' route choices, case study*

- This project has two main parts. Part 1 is conducting an online survey on bicyclist preferences, attitudes and behavior. This part was conducted prior to summer 2016. During this reporting period (July 2016 to December 2016) we focused on the second part of the project: collecting GPS data on bicyclist trips using CycleTracks Smart Phone Application. We sent emails to over 20,000 Ohio State University affiliates (students, faculty and staff) to download and use this app while bicycling. We collected data through September to December 2016.

#### *Truck Activity and Wait Times at International Border Crossings*

- Received additional geo-fence based time and location data for trucks using the Ambassador Bridge and Blue Water Bridge border crossing facilities
- Wrote and submitted final report

#### *Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Collected additional geo-fence based time and location data for trucks using the Ambassador Bridge and Blue Water Bridge border crossing facilities
- Produced queuing time and inspection time statistics for various quarters and time-of-day and day-of-week combinations at Ambassador Bridge and Blue Water Bridge border crossing facilities
- Determined corrections to be applied to data collected to determine Michigan-to-Ontario inspection times at Blue Water Bridge after inspection facilities were moved
- Began drafting final report

#### *Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- The research revealed a Highway Capacity Manual heavy truck passenger car equivalent of 3.37 for roundabouts. This value is 69% higher than the currently published value of 2.0.

#### *Roadway Traffic Data Collection from Mobile Platforms*

- Collected additional data from sensing platform
- Collected data manually from two bus routes
- Processed sensing platform data
- Processed manually collected data
- Continued discussions about regular future data collection with OSU's Transportation and Traffic Management (a potential stakeholder)

#### *Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Adjusting for LiDAR motion using external motion sensors - Algorithm developed, motion sensors bought, system integration and evaluation done.
- Detecting moving objects - Algorithm developed and tested to remove background from raw data and clustering the remaining points to detect moving objects in spherical coordinates. More sophisticated algorithm in XYZ coordinates developed.
- Tracking objects with measuring their dimensions - Tracking phase with backtracking for improved accuracy.
- Classifying the tracked objects - Based on speed, path, dimensions, and other features.
- User interface - Setting the system and accessing the results.
- Engineering application for counting turning movements - This application eliminates costly manual counting.
- Demonstrating counting traffic conflicts with SSAM. This application allows using SSAM for field data.

#### *Standardized Metrics for Accessibility: Establishing a Federal Policy-Relevant Knowledge Base*

- Completed the writing and editing of final report.

#### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Additional sensor units fabricated
- Modified design of housing for sensors designed
- Made arrangements to mount first housing unit onto an OSU bus
- Sensors deployed on "simulated" bus routes (sampling via personal automobile) on two CABS routes
- Preliminary data analysis of automobile sampling underway

#### *A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- GIS analysis on the location and commuting distance of CSU employees and students was completed.
- Statistical analysis of student transportation survey analyzed.
- Results were presented at the Illinois GIS Association meeting

#### *A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Three research assistants hired
- Research assistants received IRB training
- Connections to Endealeo, a local community development organization that will assist with focus groups, was made
- Focus group questions were finalized
- IRB application drafted for focus group
- Faculty/staff transportation survey drafted
- IRB application for Faculty/staff transportation survey drafted
- Grant pays for three students to attend Illinois GIS Association meeting

#### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Began drafting final report.

#### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Developed a preliminary methodology to determine an appropriate number of clusters.
- Assessed the refined models using empirical data on routes with familiar flow patterns and passenger trip purposes.
- Prepared a presentation for an international conference.
- Presented at an international conference.
- Continued writing peer-reviewed journal papers.
- Began drafting final report.

### **Specific Objectives**

#### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Provide a robust environment for driving simulator experiments to address driver behavior under real-time travel information provision.
- Explore the role of human factors in driver's perception and cognition of the provided information in the context of driver route choice decision and safety concerns.
- Using the collected data, construct reliable models to better assess the comprehensive value of real-time travel information beyond (including) the benefits of travel time savings.
- Integrating the biosensors into the driving simulator experiments to explore and quantify driver's workload in processing the real-time information.
- Establishing models to quantify the impacts of the content, amount and modality of real-time information on travelers' decision-making process.
- Investigating advantages and disadvantages of physiological and psychological measurements in analyzing drivers' decision-making process with real-time information provision.
- Provide transportation policy makers and public/private transportation information providers' better performance measures of the benefits of real-time travel information with consideration of qualitative aspects of information process.
- Through driving simulator experiments, provide graduate and undergraduate students an opportunity to better understand the present state-of-the-art in human factor-related research on travel behavioral modeling and safety in transportation.

#### *Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- To research—
  - the impact of mobility-based evaluation on transportation outcomes
  - the impact of a shift to accessibility-based planning
  - obstacles to such a shift
  - approaches to overcoming those obstacles
  - approaches to bringing accessibility-based evaluation to the level of the individual project or plan

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Sustain, develop, and showcase the CTL as a living lab infrastructure supporting research, education, and outreach
- Archive and process data on passenger flows, vehicle locations, and community perceptions and travel patterns related to a technology-enhanced transit service
- Exploit CTL to develop seed research investigations, modules for coursework, training of students in data collection, and focused studies of immediate interest to service operators
- Develop collaborations with transit, transportation, and planning agencies and other investigators based on CTL-related activities

*Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Understand people's SNS related behaviors in a no-notice evacuation, and the factors that influence these behaviors
- Explore evacuees' evacuation decision-making process when disaster or/and evacuation related information comes from different sources
- Predict potential evacuees based on personal characteristics and SNS usage based on the results of agent-based model

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Footprints*

- Completing the inventory of current GHG emissions from on-road vehicles using traffic data
- Estimating the GHG emissions from the selected alternative transportation scenarios that could reduce the GHG emissions
- Completing the adoption of the transportation related educational components into Urban Water Problems course
- Continue to mentor and train undergraduate students in transportation related air quality research

*Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Completing the development of a new methodology for traffic signal timing optimization under user equilibrium based traffic conditions

*Tracking bicyclists' route choices, case study*

- The collected data will be used to develop models to understand the determinants of bicycle trip generation and route choices

*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Obtain geo-fence-based truck time and location data for trucks crossing the Ambassador and Blue Water bridges
- Process data into information on times trucks incur at various activities at and near the Ambassador Bridge and Blue Water Bridge border crossing facilities
- Interpret processed information into results of general and targeted interest

*Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- The objective of this research was to analysis the flows for periods of time when only passenger cars were present and the flows for periods when heavy trucks were present and compare.

*Roadway Traffic Data Collection from Mobile Platforms*

- Investigate and demonstrate ability to obtain meaningful traffic flow and speed estimates from a mobile platform emulating transit bus service
- Determine reliable uncertainty quantifications for the traffic flow and speed estimates that can lend insight for use in an operational setting
- Generate interest among potential stakeholders

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Improve tracking by adjusting LiDAR motion with external motion sensors.
- Improve background removal using object properties in xyz.
- Measure vehicle dimensions.
- Classify moving objects including vehicles, pedestrians, and bicycles.
- Develop a user interface and demonstrate the TScan results.
- Develop initial specs for developing a prototype.

*Standardized Metrics for Accessibility: Establishing a Federal Policy-Relevant Knowledge Base*

- Propose a means of assembling a reliable and trustworthy data set for evaluating accessibility performance, but to do so while minimizing the burden on current agencies and without suppressing the creativity and distinctiveness of initiatives at the local and regional level.

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Identify key sensor components required for mobile air quality monitoring unit
- Develop and implement air quality monitoring unit on a mobile platform
- Collect ambient and transportation-related air quality data using the unit mounted on a mobile platform and stationary sensors
- Investigate the value of the air quality data collected using the mobile platform in relation to the data collected using stationary sensors

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Analyze results of the student transportation survey and GIS analysis.
- Present results of the student transportation survey and GIS analysis.

*A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Hire and train staff
- Developed community connections
- Draft focus group questions
- Draft IRB applications
- Draft Faculty/staff transportation survey

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Improve transit passenger OD flow representation and estimation.
- Quantify the achieved improvements with respect to other state-of-the-practice and art methods.
- Demonstrate the feasibility of the new model and methods and their ability to produce interpretable results.

#### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Improve transit passenger OD flow representation and estimation; quantify the achieved improvements with respect to other state-of-the-practice and art methods; demonstrate the feasibility of the new model and methods and their ability to produce interpretable results.

#### *Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Quantify the magnitudes of the impacts that changes in certain variables have on CO2 emissions in select US urbanized areas.
- Identify the policy implications of the findings.
- Document findings based on US data in the form of papers.

### **Significant Results**

#### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Cognitive load is the most significant human factor that affects driver perception of real-time travel information.
- Information cognitive load is impacted by Information provision modalities, including visual and verbal modalities.
- Drivers' individual attributes (such as demographical and socio-economic characteristics) are important to determine the attitude toward the provided real-time travel information.
- To enhance the reliability of physiological data, comprehensive biosensors, including electroencephalogram, are preferred.
- The calibration of biosensors is required for each participant to have reliable assessment of driver's physiological measurements.
- The driver's mental workload during information processing is identified and will be quantified by leveraging eye tracker together and EEG.
- The real time mental signal output from EEG can enhance the stated preference (SP) data-based psychological quantification results.

#### *Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- -mobility-based evaluation shapes transportation and land-use outcomes through via both formal and informal routes
- -land use impacts can magnify the accessibility effects of some transportation investments but can negate others.
- -Interests outside of established transportation institutions can be important allies in policy reform towards accessibility.
- -Project level accessibility differs substantively from regional scenario based accessibility in a number of substantive ways; the project-level problem is inherently different from the regional-scenario problem.
- -Accessibility can be analyzed through an accessibility-elasticity metric (developed and demonstrated for this project).

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- OD flow data were manually collected and summarized to support research investigations
- Ten undergraduate students were hired for CTL data collection
- In conjunction with OSU administrators and Battelle investigators, CTL personnel identified a set of potential CTL bus stops that could serve as sites for testing a bus-pedestrian safety system being developed and evaluated in an externally funded project
- Analysis of survey data on stated willingness to participate in hypothetical employer-based ride sharing based on stated preference survey of a large number of the OSU campus community support several findings found in other studies and indicate new findings
  - It appears that those who presently travel in automobiles are more likely than those who do not travel in automobiles to participate in ridesharing. Also, those who walk or use transit seem to be less willing to participate in a ridesharing program than those who do not use these alternative modes.
  - Those who do not have a car available to them appear to be more interested in being rideshare passengers than those who have a car available to them.
  - Although those living with younger dependent children are more likely to reject ridesharing participation, among those who are interested in ridesharing, individuals living with children are more willing to drive in a ridesharing program than those who do not live with children.
- Empirical analysis of bus trip-level origin-destination (OD) flows determined using a variety of data sources on the CTL indicate that
  - The quality of OD flows determined only from Wi-Fi signals emitted from mobile devices is inferior to the quality of OD flows determined using only automatic passenger count (APC) data
  - The quality of OD flows determined using a combination of Wi-Fi and APC data is superior to the quality of OD flows obtained using either source alone
  - The quality of the OD flows determined from Wi-Fi data depends on route structure as well as expected effects, such as the quality of the Wi-Fi detection device and the numbers of passengers using mobile devices emitting Wi-Fi signals

### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Different trust levels on disaster- and evacuation-related information depending on different sources, SNS users, and the reputations of the organizations, institutions or authorities are observed.
- SNS posting/reposting frequency during a no-notice evacuation is highly related to their socio-economic characteristics, SNS usage behavior, level of trust of information from SNS, and level of trust of information from sources other than SNS.
- People's socio-economic characteristics, SNS usage behavior, level of trust towards information on SNS, SNS checking behavior, and level of trust towards information from sources other than SNS have strong statistically significant correlation with people's posting/reposting frequency during a no-notice evacuation.
- The source of disaster or/and evacuation related information determines the trust level of information.
- The trust level of information and personal characteristics have statistically significant correlation with people's evacuation decision-making.
- During the no-notice evacuations, people are more likely to evacuate with people they know or people in uniform.

### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Footprints*

- On-road vehicle GHG emission hotspots were found along the interstate and state highways and in urban counties
- Using alternative fuels and hybrid vehicles has the potential to reduce the GHG emissions
- ENE curriculum was enhanced with transportation related topics
- Middle and high school students from underrepresented communities were introduced with transportation related careers

### *Tracking bicyclists' route choices, case study*

- We have collected data through December 2016. We are now in the process of cleaning, organizing and analyzing the data.

### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Developed a new methodology for traffic signal timing optimization under user equilibrium based traffic conditions to significantly reduce intersection vehicle delays

### *Truck Activity and Wait Times at International Border Crossings*

- Obtained new data with refined geo-fences

### *Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Produced queuing and inspection time statistics for multiple quarters

### *Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- The passenger car equivalent (PCE) was found to be 3.37 for heavy trucks navigating roundabouts.

### *Roadway Traffic Data Collection from Mobile Platforms*

- Bus-based (manual) data were collected and processed
- Preliminary automatically collected, van-based data were collected and processed

### *Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- TScan research unit developed by integrating the Velodyne HDL-64E laser scanner within the existing Purdue University Mobile Traffic Laboratory.
- The motion of the LiDAR sensor located at the top of the mast accounted for with the readings from an inertial sensor.
- An efficient signal processing method to extract the useful traffic information developed.
- The developed TScan method identifies and extracts the background with a method applied in both the spherical and orthogonal coordinates. The moving objects are detected by clustering data points, tracking clusters and fitting rectangles to the clusters. Detected moving objects are classified as heavy and non-heavy vehicles, bicycles, and pedestrians. The resulting trajectories of the moving objects are stored for future processing with engineering applications. The developed signal-processing algorithm is supplemented with a user interface for setting and running and inspecting the results during and after data collection.
- One engineering application was developed in this study for counting moving objects at intersections. Another existing application, the Surrogate Safety Analysis Model (SSAM), was interfaced with the TScan method to allow extracting traffic conflicts and collisions from the TScan results. A user manual was developed to explain the operation of the system and the application of the two engineering applications.
- The TScan performance was evaluated by comparing to the best available method: video frame-by-frame analysis with human observers.
- It was concluded that the TScan performance is sufficient for measuring traffic volumes and speeds, classifying moving objects, and counting traffic conflicts. Nighttime conditions, light rain, and fog did not reduce the quality of the results. Several improvements of this new method are recommended and discussed in this report.

### *Standardized Metrics for Accessibility: Establishing a Federal Policy-Relevant Knowledge Base*

- If moving accessibility to a more central position in transportation policy is to proceed, then the diffusion of accessibility metrics in transportation planning practice will be greatly assisted by the standardization and standardized reporting of data. The data framework proposed demonstrates how a standardized set of data generated by regional planning agencies might be collected in a repository to facilitate consistent and dependable accessibility-based analysis among places and through time.

#### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- For carbon monoxide (CO), preliminary data analysis indicates that spatial patterns appear to be relevant and are somewhat correlated across trips
- For ozone (O<sub>3</sub>) and nitrogen dioxide (NO<sub>2</sub>), preliminary data analysis suggests that there are no discernable localized trends, and the data series reflect a low signal-to-noise ratio (which is positive from an air quality perspective)
- Additional sensor units have been fabricated

#### *A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Students generally drove alone to school (77.5%)
- 15 students (out of 352 answering) used Metra...most likely (given Metra's counts) not every day
- 99 students (out of 321 answering) said they had considered using Metra...a good sign
- Mean Commuting Time: 36 Minutes
- Using Public Transportation: 55 minutes
- Not using Public Transportation: 29 minutes

#### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Numerical investigations conclusively confirm that the variational Bayes aspect of the developed estimation method determine overall flow patterns that are superior in accuracy to those determined by state-of-the-practice and -art methods when only one cluster is present.

#### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Empirical investigations where multiple OD travel patterns are known to follow different trip purposes confirm the value of assuming the presence of multiple OD flows in estimating the overall flows from APC data.

#### *Modeling CO<sub>2</sub> Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- For urbanized areas with automobile inspection programs, seen as proxies of the presence of GHG-reducing policies or environmentally favorable travel behaviors, the variable that is found to have by far the largest impact on CO<sub>2</sub> emissions based on a given percentage change across all the variables considered is freeway lane-miles per capita.
- For urbanized areas without automobile inspection programs, again seen as proxies of the effects discussed extensively in this paper, the variable that is found to have the largest impact on CO<sub>2</sub> emissions based on a given percentage change is average private vehicle occupancy.
- The relative magnitudes of the impacts corresponding to the different variables are found to vary appreciably across urbanized areas, implying that policies aimed at reducing CO<sub>2</sub> emissions should focus on different sets of variables depending on the overall characteristics of the specific urbanized area and any existing policies aimed at reducing CO<sub>2</sub> emissions.

### **Key Outcomes and Other Achievements**

#### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Driving simulator hardware including larger monitors with thinner bezel is installed to enhance the realism in screen display.
- Structural equation modeling analysis using information perception data and driving simulator data was conducted.
- The driving simulator experiment data have been analyzed to investigate the role of real-time travel information in traveler satisfaction.
- The driving simulator experiment scenarios with biosensor integration is developed.
- A pilot test of driving simulator experiments is being carried out.
- Research findings and experiences have been summarized and presented in relevant international conferences.

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Directly observed CTL OD flows were summarized for stakeholders and research efforts
- CTL infrastructure, data, and context were successfully used in two OSU transportation courses
- One MS thesis and one MS project report using CTL infrastructure and data were completed
- Several presentations of research studies using CTL infrastructure were made
- Seven undergraduate students collected data on a regular basis, and nine new undergraduate students were trained for data collection

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Two sets of online surveys to understand SNS usage behavior and evacuation decision-making under emergency situations are conducted for students, staffs and faculty members in Purdue University.
- A mixed logit model is developed to explore the contributing factors that affect people's posting/reposting behavior on SNS during a no-notice evacuation.
- Structural equation model is used to capture how information from different sources (e.g. official information dissemination channel, people nearby, and SNS) affect people's evacuation decision-making.

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Footprints*

- Final technical report on GHG emissions from on-road vehicles in the Midwest states
- CeSU student internships in the transportation related fields at partnering institution, Purdue university and ODOT
- Recruitment of undergraduate students in Environmental Engineering and other STEM programs
- Successful collaboration with the Midwest institutions on transportation related grant proposals
  - Funding of USDOT Center for Connected Automated Transportation (CCAT) at University of Michigan as a Regional University Transportation Centers (UTC) program, reauthorized by Sec. 6016 of the Fixing America's Surface Transportation Act (FAST Act, P. L. 114-94). **Central State University**, Purdue University, University of Akron, University of Illinois at Urbana-Champaign, Washtenaw Community College

*Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Completed a case study for methodology application as documented in a Ph.D. dissertation containing details of literature review, methodology development, and a case study, as well as summary and conclusion

*Truck Activity and Wait Times at International Border Crossings*

- Final report was submitted

*Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Determined and applied adjustments that needed to be made to Blue Water Michigan-to-Ontario inspections times to allow comparisons across years; adjustments were needed because of changes in locations of inspection facilities and inspection geo-fences

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- TScan research unit.
- User manual.
- Specs of a stand-alone prototype unit.

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Meetings with CABS administrators reinforced their commitment to using their buses as platforms for empirical data collection and their enthusiasm for this project
- One OSU bus is ready for deployment of a sensor unit
- Preliminary data analysis is encouraging (see above)
- The PI has written a successful proposal using the sensor prototype design that is co-funded through the NSF Environmental Engineering and Big Data Hubs programs

*Roadway Traffic Data Collection from Mobile Platforms*

- OSU Transportation and Traffic Management agreed to pursue configuring video that would be added to its bus fleet so that it could be used for regular data collection

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Preliminary statistical analysis of transportation survey completed
- Preliminary GIS analysis of staff/student commuting completed
- Results presented at professional conference

*A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Connections to Endeleo (local community organization) lead to agreement to assist with focus groups
- Three students attend Illinois GIS Association meeting

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Present aspects of research at a national conference.
- A presentation at an international conference was accepted.
- Results show that the method developed to determine the number of clusters is promising.
- Validation of the methodology using empirical data confirms value of the model and methodology.

*Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Quantified the magnitudes of the impacts that changes in certain variables have on CO2 emissions in select US urbanized areas.
- Identified the policy implications of the findings.

## Efforts to Disseminate Results

### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Presentation at an international conference
  - D. Song, S. Peeta, and Y Hsu, "Psychological effects of real-time travel information on traveler route choice decision-making process", 96th Transportation Research Board Annual Meeting, January 2017, Washington, D.C.
- Abstract submitted to an international conferences
  - S. Peeta, S. Agrawal, J. Wang, I. Benedyk, Y. Guo, and D. Song. "Quantifying the physiological impacts of real-time travel information on route choice behavior: a driving simulator-based study", 8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017).
  - D. Song and S. Peeta. "Analyzing traveler satisfaction under real-time travel information provision: placebo effects of information", 8th International Conference on Applied Human Factors and Ergonomics (AHFE 2017).
  - D. Song and S. Peeta. "Effects of attitude towards real-time travel information on traveler route choice decisions", International Choice Modelling Conference 2017
  - D. Song, S. Peeta, Y. Hsu, and S. Agrawal. "Role of psychological effects of real-time travel information provision on en route traveler route choice decisions", 9th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.

### *Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- produce two articles for Transport Policy (one published, one under review)
- develop a website to provide transportation planners with implementation tools for the methods
- A book under contract with Cornell University Press

### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Multiple presentations were made that used or connected to CTL infrastructure, data, or expertise
- One MS thesis based on CTL infrastructure was completed

### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- National and International Conferences

### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Submitted a technical paper to Journal of Network Economics for review and possible publication

### *Tracking bicyclists' route choices, case study*

- We already have a paper that was presented at TRB (January 2017), "Factors Affecting Bicycle Commuting: The Role of Individual Attitudes and Neighborhood Environments", Authors: Yujin Park and Gulsah Akar
- We are in the process of revising and submitting this paper for publication.
- We will work on a new paper based on the new data collected through the smart phone app.

### *Truck Activity and Wait Times at International Border Crossings*

- Final report was submitted

### *Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Final report was begun

### *Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Indiana Department of Transportation (2016), TScan description on the Employee Resource Internal News. June 2nd 2016.
- Presentation of the results at the 4th International Symposium on Transportation Safety, July 10, 2016, Shanghai, China.
- Two submitted conference papers for the 2017 Annual TRB Transportation Meeting, Washington, D.C., January, 2017.
- User documentation delivered to INDOT.
- Feature article in the INDOT newsletter.
- Presentation of system at 2016 Purdue Road School and the Indiana ITE meeting.
- Three journal papers being developed to present the results and accomplishments of the project.

### *Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- The research was just recently completed, but publication effort will be pursued in 2017.

### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Results to-date were presented at an environmental sensor symposium hosted by Ohio University during October 2016
- Results to-date were presented at the Ohio Transportation Engineering Conference during October 2016
- The project was described in part to a group of non-science/engineering freshman students as part of a seminar series entitled "The Air We Breathe" (instructed by Prof. Heather Allen at OSU)

### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Prepared a presentation for an international conference.
- Presented at an international conference.
- Continued writing a peer-reviewed journal paper on the clustering methodology and the corresponding numerical validation.

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Prepared a presentation for an international conference.
- Presented at an international conference.
- Continued writing a peer-reviewed journal paper on the clustering methodology and the corresponding numerical validation.
- Continued writing a peer-reviewed journal paper on the variational Bayes methodology and the corresponding numerical validation.
- Continued writing paper on the empirical validation and results.

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Results presented at Illinois GIS Association conference

*Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Improve the understanding of the nature of the contributions of passenger urban travel to greenhouse gas (GHG) emissions, which in turn has the potential to inform transportation related policy-making aimed at possibly reducing such emissions.

**Plans for Next Reporting Period (January 1, 2017 – June 30, 2017)**

*Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Complete design of experiment scenarios to quantitatively investigate the cognitive load in the driving simulator experiments by using the integrated biosensors.
- Recruit participants to complete driving simulator experiments with biosensors.
- Collect data of participant's gaze points and focusing patterns in relation to real-time information using eye-trackers.
- Integrating the biosensor data and driving log data (temporal points of information provision and decision-making) to create a comprehensive data set related to information perception and cognitive load.
- Collect data from biosensors to analyze driver's cognitive load associated with receiving and processing real-time travel information.
- Analyze the experiment data to identify critical factors in traveler decision-making process and the psychological effects of travel information provision.
- Construct analytical model to characterize driver's cognitive load in processing real-time travel information.
- Summarize research findings into journal papers and research reports and present our research findings at international research conferences.

*Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Data collection: Collect automatic vehicle location (AVL), automatic passenger counter (APC), Wi-Fi derived OD flow, and directly observed OD flow data
- Research: Exploit manual, web-based, and automatic data-driven investigations to generate and investigate research hypotheses
- Use CTL-based modules in OSU courses
- Develop analytical and methodological skills of graduate students; offer data collection opportunities for graduate and undergraduate students
- Discuss results and future efforts with transit, transportation, planning, and other agencies, and prepare and submit/deliver articles and presentations

*Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Validate the structural equation model to analyze the effects of heterogeneous information through multiple dissemination sources on evacuation travel decision-making during no-notice evacuations.
- Develop an agent-based model to explore interactions between SNS usage behavior and evacuation decision-making process under no-notice evacuation situations.
- Develop a multi-layer network to capture the dynamic evolution and propagation of evacuation information from the multiple sources of information.
- Presenting at a peer reviewed national or international conference

*Tracking bicyclists' route choices, case study*

- We will develop empirical models to better understand the factors associated with bicycling route choice and bicycle trip generation using data on land use, bicycle facility provision, road and built environment characteristics along these routes.
- We will work on the final report.

*Roadway Traffic Data Collection from Mobile Platforms*

- Investigate processed data; collect and process data on a regular schedule; develop validation protocols

*Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Complete and submit final report

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Continue data collection via automobile along bus routes
- Continue efforts towards data analysis
- Deploy sensor units initially on one CABS bus and expand to multiple buses following the fabrication and installation of additional housing boxes
- Deploy stationary sensors along the bus route for comparison
- Analyze spatiotemporal patterns against controlled stationary observations considering contributing factors

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Report will be given to Chicago State University Institutional Research and Community Organizations

*A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Apply for IRB approval for Faculty/Staff Transportation Survey
- Apply for IRB approval for Community Focus Groups
- Conduct surveys
- Conduct focus groups
- Analyze surveys
- Analyze focus groups
- Present results to campus and community member.

## **PART 2: PRODUCTS**

*Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Publications, conference papers, and presentations
  - D. Song, S. Peeta, and Y Hsu, "Psychological effects of real-time travel information on traveler route choice decision-making process", 96th Transportation Research Board Annual Meeting, January 2017, Washington, D.C.
- Websites
  - Experiment website is available at: [www.purdue.edu/drivingsimulator](http://www.purdue.edu/drivingsimulator)
  - The experiment website provides participants a brief description of the driving simulator experiment, an online survey, and an experiment registration and scheduling system

*Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- Publications, conference papers, and presentations
  - Levine, Jonathan, Louis Merlin, and Joe Grengs. (2017). Project-Level Accessibility Analysis for Land-Use Planning. *Transport Policy* 53(2017):107-119.
  - Merlin, Louis, Jonathan Levine, and Joe Grengs. Accessibility Analysis for Transportation Projects and Plans. Under review at *Transport Policy*.
  - Getting There: From Mobility to Accessibility in Transportation and Land-Use Planning. Book proposal accepted by Cornell University Press.
- Websites -- <http://aim.fau.edu/developments/>

*Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Publications, conference papers, presentations
  - McCord, M.R., and R.G. Mishalani, Determining Transit Passenger Boarding-to-Alighting Flows using Mobile Device Wi-Fi Signals: Empirical Results, Ohio Transportation Engineering Conference, Columbus, OH, October, 2016 (acknowledgement of federal support: yes)
  - May, A. A., G. Sivandran, R.G. Mishalani, M.R. McCord, Y. Zou, T. La Susa, S. Liyanaarachchi, E. Van Dommelen, and B. Wildey, Using a Transit System as a Mobile Platform for Air Quality Monitoring in Urban Areas, Ohio Transportation Engineering Conference, Columbus, OH, October, 2016 (acknowledgement of federal support: yes)
  - May, A. A., G. Sivandran, R.G. Mishalani, M.R. McCord, Y. Zou, T. La Susa, S. Liyanaarachchi, E. Van Dommelen, and B. Wildey, Using a Transit System as a Mobile Platform for Air Quality Monitoring in Urban Areas, Innovative Environmental Monitoring Technology Symposium, Athens, OH, October, 2016 (acknowledgement of federal support: yes)
  - Mishalani, R.G, and M.R. McCord, Sensitivity of Transit Onboard Survey Passenger Socioeconomic & Travel Characteristic Sample & Response Bias Corrections Using OD Flows Determined from APC & AFC Data, TransitData2016: 2nd International Workshop on Automatic Data Collection Systems, Boston, MA, August 2016 (acknowledgement of federal support: yes)
  - Landgraf, A.J., Mishalani, R.G., McCord, M.R., Goel, P.K., 2016. Variational Bayes Method for Estimating Transit Route OD Flows using Boarding and Alighting Data in the Presence of Multiple Latent Flow Patterns: Methodology, Evaluation, and Validation. Proceedings of the World Conference on Transportation Research, Shanghai, China.
  - Ji, Y. Mishalani, R.G., McCord, M.R., 2016. Transit Route-level Passenger Alighting Probability, Probability OD Flow and Expected OD Flow Matrices: Estimates from Boarding and Alighting Counts and Relationships among the Representations. Proceedings of the World Conference on Transportation Research, Shanghai, China.
- Websites -- A website includes among other things, activities and results from this project: <http://transitlab.osu.edu/campus-transit-lab>
- Websites -- includes among other things, activities and results from this project: <http://transitlab.osu.edu/campus-transit-lab>
- Technologies or techniques -- Commercial-grade state-of-the-practice automatic vehicle location technologies, passenger information systems, and automatic passenger counter technologies implemented on an operational bus service provide data that are regularly downloaded and stored
- Databases -- Databases that include bus location, position, and speed data, bus passenger boarding and alighting data, estimated and observed bus passenger origin-destination flows are developed and updated
- Physical collections -- Bus passenger origin-destination flows are manually collected

- Software or NetWare -- Various codes for archiving, processing, and analyzing the rich and large datasets collected through the Campus Transit Lab are used
- Educational aids or curricula --
  - Data obtained from the CTL, as well as the physical infrastructure, are used in classes
  - Data are provided to students conducting independent research or project activities not associated with the project
  - Hands-on experience in transit data collection is provided to graduate and undergraduate students associated with the project
  - Experience with practical transit planning and operations issues is provided to graduate students through outreach activities
- Instruments or equipment -- Collaboration with bus service operators is undertaken to maintain the sensing equipment on the bus fleet, the storage of data on the buses, the communication of the data to the server, the accompanying software to manage these processes, and the real-time passenger information system
- Data and Research Material -- Data that include bus location, position, and speed data, bus passenger boarding and alighting data, and estimated and observed bus passenger origin-destination flows are collected and stored
- Models -- Models needed to investigate preliminary hypothesis are developed, and validation studies are conducted for models developed under other projects

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Websites
  - [https://purdue.qualtrics.com/SE/?SID=SV\\_died8aIRw4GW6z3](https://purdue.qualtrics.com/SE/?SID=SV_died8aIRw4GW6z3) (Instruction and questionnaire on SNS usage)
  - [https://purdue.qualtrics.com/SE/?SID=SV\\_bp9O15m57GBx3cF](https://purdue.qualtrics.com/SE/?SID=SV_bp9O15m57GBx3cF) (Instruction and questionnaire on evacuation decision making process)
- Databases
  - Questionnaire on SNS usage: a total of 305 completed surveys (5 parts, consisting 29 questions).
  - Questionnaire on evacuation decision making process: a total of 311 completed surveys (5 parts, consisting 29 questions).
  - Participants who answer both the questionnaires: 259 completed surveys

#### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Publications, conference papers, and presentations
  - Ramanitharan Kandiah, Subramania Sritharan and Ndao Gorgui. 2017. Recruitment and Retention: Summer Transportation Institute for Secondary School. 2017 ASEE Annual Conference & Exposition. Columbus, OH. June 25–28, 2017 (Abstract approved for Oral Presentation & Paper)
  - Ramanitharan Kandiah, Krishna Kumar Nedunuri and Benjamin Rives. 2016. Estimation of Greenhouse Gas Releases from major highways in Ohio. 20th Technological Advances in Science, Medicine and Engineering Conference (TASME). Toronto, Canada. July 2-3, 2016. (Oral)
- Databases
  - Gathering of processing of Traffic Data for six Midwestern states
- Educational aides or curricula
  - Teaching materials for highway runoff and culvert design
- Instruments or equipment
  - Thermoscientific ADR-1500 Dust Monitor
- Data & Research Material
  - Derived data of GHG emission database

#### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Publications, conference papers, and presentations -- presented a technical paper at 2016 Annual TRB meeting, and submitting a technical paper to Journal of Network Economics for review and possible publication
- Models -- Developed a new model for traffic signal timing optimization under user equilibrium based traffic conditions

#### *Tracking bicyclists' route choices, case study*

- Conference paper:
  - Yujin Park and Gulsah Akar "Factors Affecting Bicycle Commuting: The Role of Individual Attitudes and Neighborhood Environments", presented at the Annual Meeting of the Transportation Research Board, January 2017, Washington DC
- Data & Models -- We collected data through an online survey and smart phone app. These data are considered confidential, therefore they will not be shared. We will be developing statistical models to explain bicycle trip generation and route choice using these data.
- Websites: This website was created to provide information on our project and invite respondent -- <https://u.osu.edu/cycletracks/>

#### *Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- Data & Research Material -- the Passenger Car Equivalent value is an important parameter in highway capacity analysis and will be shared with the publishers (Transportation Research Board)..

*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Technologies or techniques -- Vehicle location and timing technologies in use on operating trucks and virtual geo-fences are combined to produce unique datasets.
- Databases -- Aggregated longitudinal and disaggregated, truck trip-level databases are developed for truck times incurred in multiple activities. (Data are received from private trucking company, and truck trip-level data are not presently available for public dissemination.)
- Software or NetWare -- Various codes are developed to process raw data into times truck incur at various locations and to process truck trip-level times into summary measures
- Data and Research Material -- Unique aggregated longitudinal and disaggregated, truck trip-level data are amassed

*Roadway Traffic Data Collection from Mobile Platforms*

- Technologies or techniques
  - Integrated sensing and mobile platform systems for automated collection of data that can be used for traffic flow and speed estimation is developed.
  - Algorithms for transforming raw data into traffic flow and speed estimates are refined.
- Databases -- databases that include vehicle locations and traffic flows are developed
- Physical collections -- bus-based (manual) and platform (semi-automated) data are collected
- Educational aids or curricula
  - Hands-on experience in data collection and flow estimation is provided to student(s) associated with the project
  - Results obtained are used in classes
- Instruments or equipment -- upgraded sensor platform to detect vehicle presence and speeds is developed
- Data and Research Material
  - LiDAR data that can be processed into vehicle locations and speeds are collected and stored
  - Manually collected data on observed vehicles and moving observer times are collected and stored

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Engineering application for counting vehicles by maneuvers based on TScan output files
- User interface for Scan Data Collection
- Developed technique of tracking objects with low-end LiDAR
- Built a research unit integrated with the Purdue mobile lab
- Estimated statistical models for classifying objects

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Publications, conference papers, and presentations
  - A.A. May, G. Sivandran, R.G. Mishalani, M.R. McCord, Y. Zou, T. La Susa, S. Liyanaarachchi, E. Van Dommelen, and B. Wildey. Using a Transit System as a Mobile Platform for Air Quality Monitoring in Urban Areas. Presentation at the Ohio Transportation Engineering Conference, Columbus, OH, October 2016. (acknowledgement of federal funding: yes)
  - A.A. May, G. Sivandran, R.G. Mishalani, M.R. McCord, Y. Zou, T. La Susa, S. Liyanaarachchi, E. Van Dommelen, and B. Wildey. Using a Transit System as a Mobile Platform for Air Quality Monitoring in Urban Areas. Presentation at the Innovative Environmental Monitoring Symposium, Athens, OH, October 2016. (acknowledgement of federal funding: yes)
- Technologies or techniques -- A prototype air quality sensor unit has been developed and deployed for data collection
- Databases -- A spatiotemporal database of CO, O<sub>3</sub>, and NO<sub>2</sub> data is being established
- Physical Collections - Empirical data has been and will continue to be collected on campus
- Software or NetWare -- Data processing algorithms are being developed
- Educational aides or curricula -- A high level overview of the project has been presented to a freshman colloquium of non-science/engineering majors at OSU
- Instruments or equipment -- Sensing equipment has been configured

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Publications:
  - Block D, Gala T. A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at CSU. Illinois GIS Association Annual Conference, October 2016, Lisle, IL.

*Modeling CO<sub>2</sub> Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Databases -- transportation supply and demand, population density, environmental policy, and passenger travel related CO<sub>2</sub> emissions in urban areas.
- Software or NetWare -- Various codes for summarizing and analyzing the various datasets.
- Data and Research Material -- Urban transportation supply and demand, population density, environmental policy, and CO<sub>2</sub> emissions data.
- Models -- models relating urban passenger travel related CO<sub>2</sub> emissions to transportation demand and supply, population density, and environmental policy variables.

### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Publications, conference papers, presentations:
  - Landgraf, A., Mishalani, R.G., McCord, M.R. Goel, P.K. Variational Bayes Method for Estimating Transit Route OD Flows using Boarding and Alighting Data in the Presence of Multiple Latent Flow Patterns: Methodology, Evaluation, and Validation. Presented at the 14th World Conference on Transport Research, Shanghai, China.
  - Landgraf, A., Mishalani, R.G., McCord, M.R. Goel, P.K. Variational Bayes Method for Estimating Transit Route OD Flows using Boarding and Alighting Data in the Presence of Multiple Latent Flow Patterns: Methodology, Evaluation, and Validation. Proceedings of the 14th World Conference on Transport Research, Shanghai, China.
- Technologies, techniques -- new techniques are developed that improve upon the estimation of transit passenger OD flows using APC data.
- Software or NetWare -- various codes for applying the new estimation methods and for conducting the numerical and empirical investigations.
- Models -- model for better representing transit passenger OD flows considering clusters of flow patterns across bus trips.

### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Publications, conference papers, presentations:
  - Landgraf, A., Mishalani, R.G., McCord, M.R. Goel, P.K. Variational Bayes Method for Estimating Transit Route OD Flows using Boarding and Alighting Data in the Presence of Multiple Latent Flow Patterns: Methodology, Evaluation, and Validation. Presented at the 14th World Conference on Transport Research, Shanghai, China.
  - Landgraf, A., Mishalani, R.G., McCord, M.R. Goel, P.K. Variational Bayes Method for Estimating Transit Route OD Flows using Boarding and Alighting Data in the Presence of Multiple Latent Flow Patterns: Methodology, Evaluation, and Validation. Proceedings of the 14th World Conference on Transport Research, Shanghai, China.
- Technologies, techniques -- new techniques that improve upon the estimation of transit passenger OD flows using APC data.
- Software or NetWare -- various codes for applying the new estimation methods and for conducting the numerical and empirical investigations.
- Models -- model for better representing transit passenger OD flows considering clusters of flow patterns across bus trips.

## **PART 3: PARTICIPANTS & COLLABORATING ORGANIZATIONS**

### **Partnership Organization Information**

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Clever Devices, Woodbury, New York – In-kind support

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Jin-Hyuk Chung, Professor (Co-PI) -- Department of Urban Planning and Engineering, Yonsei University, Seoul, Korea -- Collaborative research – Pedestrian behavior and flow modeling in emergency situations.

#### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- City of Chicago, Department of Transportation-- In-kind support of city of Chicago's traffic signal timing design procedure, field deployed signal plans, and traffic counts

#### *Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Indiana Department of Transportation -- Financial support

#### *A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Endeleo, Chicago, Illinois – facilities, collaborative research

#### *Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Michigan Tech Research Institute, Ann Arbor, Michigan – In-kind support, facilities, collaborative research, personnel exchanges.
- CEVA Logistics – In-kind support – truck location and timing data

### **Other Collaborators and Contacts**

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Civil Engineering and City and Regional Planning researchers and students collaborate on various project activities
- A faculty member at Tongji University (China) uses CTL data for education and research purposes at his institution. NEXTRANS researchers are collaborating with same individual on activities of value to the project

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Yu-ting Hsu, Professor, National Taiwan University  
Professor Yu-ting has a background of traveler behavior modeling under evacuation situations. A two-stage evacuation decision-making model is under development. The model includes (i) an evacuation participation decision model that determines whether an individual evacuee will evacuate under heterogeneous information at the current time, and (ii) an evacuation route choice model that determines the route/destination taken by individual evacuees if he/she decides to evacuate.

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Ohio Department of Transportation (ODOT) -- Summer Research Training for Central State undergraduate; Summer Transportation Institute (together with Federal Highway Administration (FHWA)).  
*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Civil Engineering and Geography researchers collaborate on project activities
- Michigan Tech Research Institute is a subcontractor and provides valuable services because of its close proximity to the border crossing facilities
- Data are obtained from international carriers, with focus on Canada-U.S. cross border trips.

*Roadway Traffic Data Collection from Mobile Platforms*

- Civil Engineering and Electrical Engineering researchers collaborate on various project activities

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Collaboration with professor Kartik Ariyur from the School of Mechanical Engineering
- Indiana Department of Transportation - co-sponsor, future user of the developed product, potential future support to develop a prototype and to implement the method to engineering practice
- Consortium of 6 European universities within a research program InDev, lead - Lund University in Sweden, exchange of data and results
- International Laboratory of Transportation Safety, Tongji University, Shanghai, China

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Civil Engineering and Statistics researchers and students collaborate on various project activities.:

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Undergraduate students in civil engineering, environmental engineering, and computer science and one environmental engineering graduate student have collaborated with transportation and environmental engineering faculty to develop the prototype unit and design the box for housing the unit on the CABS bus. The graduate student has led the work towards sensor calibrations and conducted the testing with a high school intern. Undergraduate students have also been involved in the preliminary data collection via personal automobile.

*Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Civil Engineering and Statistics researchers and students collaborate on various project activities.

*Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Civil Engineering and Statistics researchers and students collaborate on various project activities.

#### **PART 4: IMPACT**

##### **Impact on the Development of the Principal Discipline(s) of the Program**

*Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- In recent years there have been growing moves to shift transportation planning from a mobility to an accessibility basis. The project developed technical and institutional approaches to support this shift.

*Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Add to the body of knowledge on transit travel behavior and transit operations; motivate additional studies by the project research team and others; inspire improvements in decisions taken by transit planners and operators that allow better transit service at lower cost
- Successful implementation of course modules based on CTL activities, context, and data help promote the pedagogical use of "living laboratories" in Civil Engineering instruction.

*Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- Explicit consideration of people's information sharing preferences (SNS usage behavior) to understand information dissemination and propagation patterns.
- Better understanding of people's evacuation decision-making process under the presence of heterogeneous information from different sources can help to improve strategies for evacuation information design and dissemination.

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Environmental Engineering program was enhanced with a transportation component.

*Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- The results of case study for methodology application was found to have outperformed the existing models such as shockwave models and the model used in the commercially available software Synchro for traffic signal timing optimization

*Tracking bicyclists' route choices, case study*

- The availability of cell-phone based GPS data collection will aid in developing models, processes and procedures to improve the understanding of travel behavior with a focus on bicycling trips. The project will investigate and demonstrate the use of smartphones for collecting travel data. These data can be used for identifying the preferred routes, trip origins and destinations to guide future planning efforts

*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Unique information on times trucks incur when crossing two of the busiest and highest valued freight border crossings in North America

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Quantitative safety estimates and predictions will become possible because the availability of real data to test various hypotheses and meet specifications.

*Evaluation of Heavy Vehicles on Capacity Analysis for Roundabout Design*

- The findings of this research are significantly different than the currently accepted and used Highway Capacity Manual value. These findings warrant further investigation into the current values within the HCM.

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Anticipated project model and methods are expected to improve the richness and quality of transit passenger OD flows representation and estimation using APC data, which in turn has the potential to improve the planning for and design of transit services in urban areas carried out by metropolitan planning and transit agencies.

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Successful results could lead to effective ways to monitor air quality and new contributions of existing transit bus platforms.

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Students have had the ability to go to transportation GIS related conferences, transportation GIS has also been incorporated into GIS classes.

*A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Send students to GIS training/conferences.
- Allow transportation related projects to be included in GIS courses.

*Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Improve the richness and quality of transit passenger OD flows representation and estimation using APC data, which in turn has the potential to improve the planning for and design of transit services in urban areas carried out by metropolitan planning and transit agencies.

*Modeling CO<sub>2</sub> Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Improve the understanding of the nature of the contributions of passenger urban travel to greenhouse gas (GHG) emissions, which in turn has the potential to inform transportation related policy-making aimed at possibly reducing such emissions.

## **Impact on other Disciplines**

*Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- The findings from the driving simulator experiments would help in developing new theories and models in psychology to better understand travelers' choice behavior in a new travel environment with vehicle automation and connectivity technologies.

*Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- The findings from the survey would help in developing new models in behavioral psychology in relation to individual's information sharing behavior under emergency situations such as no-notice evacuations.

*Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Submitted a grant proposal to US Department of Education for starting a minor in Infrastructure Engineering in the Environmental Engineering. The minor includes adding transportation infrastructure to existing water infrastructure. The proposed minor will include courses in Transportation Engineering, Soil Mechanics for Transportation Engineering, Highway Materials Engineering and Pavement Design Engineering.

*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Collaboration among Civil Engineering and Geography researchers help the different disciplines better understand the use of geo-spatial and sensing technologies in addressing practical transportation issues

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Heuristic integration of data performed by computer scientists, such as in Google autonomous cars will be replaced by rigorous sensor integration with guarantees, likely using few and less expensive sensors.

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Collaboration among Civil Engineering and Statistics researchers help Civil Engineering researchers better understand data analysis techniques and Statistics researchers gain experience by working in an applied setting.

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Faculty in the OSU College of Public Health and professionals from the Columbus Public Health Department are interested in the sensor technology for applications related to pollutant exposure and the education of vulnerable populations (e.g., asthmatics).

*Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Collaboration among Civil Engineering and Statistics researchers help Civil Engineering researchers better understand data analysis techniques and Statistics researchers gain experience by working in an applied setting.

### *Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Collaboration among Civil Engineering and Statistics researchers help Civil Engineering researchers better understand data analysis techniques and Statistics researchers gain experience by working in an applied setting.

### **Impact on Transportation Workforce Development**

#### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- Driving Simulator Lab provides graduate students the opportunity to understand multiple dimensions of human factor studies in transportation including routing behavior, perception of information, distraction by information, and so on.
- Undergraduate/graduate students in transportation can learn the practical use of microscopic traffic simulation (Aimsun) and bio sensors as associated tools of the experiments.
- Undergraduate students were provided the opportunities to improve professional skills in transportation through research and internships in Driving Simulator Lab.

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Multiple undergraduate and graduate students regularly collect passenger flow information on CTL buses using manual methods and a Wi-Fi based sensing technology.
- Multiple graduate students regularly process and analyze automatically collected CTL data.
- Students in multiple classes use CTL data and CTL infrastructure for course assignments and projects.

#### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- A CeSU student is currently an intern in ODOT; This may yield possibilities for this student and the future CeSU graduates to join transportation workforce.
- Middle and high school students attended the STI in summer to learn about transportation industry, careers, and its employment opportunities.

#### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Sharing the findings of the new methodology and its application for traffic signal timing optimization within the 30+ graduate students in the transportation engineering program and 10+ undergraduate students in the Department of Civil, Architectural and Environmental Engineering at IIT

#### *Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- One graduate student applied analytical geospatial skills to a new application area

#### *Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Will facilitate data collection and several types of studies such as: pedestrian-vehicle interaction studies; traffic signals studies and intersection performance evaluation among others.

#### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- One former Ph.D. student and currently research scientist works directly with APC data and applies data to solve a pertinent transportation flow estimation problem.

#### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Six undergraduate students and one graduate student from non-transportation fields as well as one high school intern have engaged in a project that intersections transportation, environmental monitoring, and advanced sensor technologies.

#### *A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- Transportation GIS has been incorporated into Chicago State GIS classes. Research Assistants have utilized GIS for transportation related projects.

#### *A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Send students to GIS training/conferences.
- Allow transportation related projects to be included in GIS courses..

#### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- One former Ph.D. student and currently research scientist works directly with APC data and applies data to solve a pertinent transportation flow estimation problem.

### *Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- One former PhD student and one former MS student worked directly with urban transportation supply and demand, population density, CO2 emissions, and policy data to identify patterns and relationships pertinent to transportation policy-making.

## **Impact on physical, institutional, and information resources at the university or partner institutions**

### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- The Driving Simulator Lab setup is a state-of-the-art facility at the NEXTRANS Center, Purdue University. The advanced driving simulator has unique capability of replicating/mapping a large city network and creating ambient traffic via integration to microscopic traffic simulation software (AIMSUN). This is one of the most advanced driving simulator labs for understanding driver response to real-time information provision across many dimensions that have not been previously addressed in a research setting. It also has key implications for safety and effectiveness of information in the real world. With its advanced features, the driving simulator provides a robust and realistic driving experience for drivers. The driving simulator is connected to three high-performance computers, and other hardware components such as webcams, video capturing devices and high definition

### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- The Ohio State University Campus Transit Lab is a unique living laboratory that is used for research, education, and outreach. This project makes a major contribution toward providing the physical and human resource infrastructure required to develop, sustain, and take advantage of the laboratory.
- CTL results in the amassing of large datasets relating to transit passenger flows, transit vehicle operations, passenger information systems, and transit user and non-user perceptions and attitudes towards transit services.

### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Air quality laboratory acquired the equipment (ADR-1500)
- Recruitment for the environmental engineering as well as for other STEM programs increased through STI.

### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Creating a new body of knowledge in the area of intersection traffic signal timing design

### *Tracking bicyclists' route choices, case study*

- This study identifies the needs of OSU bicyclists; generate information on origins, destination and routes of bicycling trips that could be utilized for making targeted investments; and identifying the priority areas that need such investments

### *Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Amassing of a large and unique dataset on truck times when conducting multiple activities at two major border crossings

### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- Project activities rely on The Ohio State University Campus Transit Lab (CTL), a unique living laboratory that is used for research, education, and outreach. The value of CTL to this project helps motivate and justify the provision of physical and human resources to develop, sustain, and continue to take advantage of this living lab.
- The estimation results arrived at could contribute to improved planning for and designing of transit services on campus.

### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- The project will use existing transit bus platforms at the university as platforms for air quality monitoring.

### *A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- The transportation survey is the first full commuting survey in Chicago State University history, to our knowledge.

### *A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- Develop greater knowledge of commuting patterns for staff and faculty. Gather information on commuting and use of the 95th St. Metra stop from community members.

### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- The estimation results arrived at could contribute to improved planning for and designing of transit services on campus.

### *Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- A unique database that combine data from multiple sources spanning urban areas around the world is amassed and integrated in a consistent manner.

## **Impact on Technology Transfer**

### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- The results from this study will provide government and public sector transportation agencies an assurance that they are targeting their limited funds toward technologies that are most likely to improve the nation's highway system and deliver maximum benefit to travelers.
- This study will help traffic information service providers and investment decision-makers in understanding the value of real-time information and traveler behavioral response to it. Also, it will help in deciding the content and amount of information necessary for travelers to make informed and effective routing decisions.
- The ability to explicitly quantify the human behavior dimension provides a broader set of performance measures to public/private sector stakeholders relative to the evolution of the traveler information services market.

### *Accessibility-Based Evaluation of Transportation and Land-Use Planning: From Laboratory to Practice/ Implementation of Access-Based Evaluation*

- We will disseminate the website among practicing planners to assist them in accessibility-based evaluation.

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- Amassed data are already leading to results of research and practical value that are communicated via presentations and publications and external projects.

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- This study will help transportation and emergency-control agencies in designing information strategies involving information dissemination through SNS during no-notice evacuations.
- The finding of this study can provide insights to SNS companies in deciding the content of emergency information to be disseminated on SNS to help their users (evacuees) make better decisions regarding the emergency.

#### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- A methodology in estimating transportation related GHGs and comparing the uses of different fuels as part of alternative methods to improve fuel efficiency and reduce greenhouse gases.

#### *Tracking bicyclists' route choices, case study*

- Although the empirical results and data collection is based on a university campus, the methodology developed will be applicable elsewhere.

#### *Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- The overall project is focused on improving freight flow across international borders, which is essential to international competitiveness

#### *Integrating multiple sources of data for the estimation of transit origin-destination flows*

- The estimation results arrived at are also expected to contribute to improved planning for and designing of transit services more broadly in Columbus and other cities if the model and methods are adopted.

#### *Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- In the long term, the project could optimistically lead to operational use of the technology and procedures developed on a regular basis. Preliminary exploration of further use of the sensor technologies has already begun and may include other transit systems or exposure monitors for vulnerable populations.

#### *Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Estimation results arrived at are also expected to contribute to improved planning for and designing of transit services more broadly in Columbus and other cities if the model and methods are adopted.

### **Impact on Society beyond Science and Technology**

#### *Driving Simulator Laboratory: Traveler Behavior Modeling and Interactive Experiments to Address Mobility and Safety Needs*

- The study will help in developing a comprehensive understanding of the mechanism in which more benefits can be derived from real-time traffic information systems.
- This study can lead to direct benefits to the individual travelers, as it facilitates the design of personalized traffic information that can help commuters choose their routes based on their psychological benefits (which link to the quality of travel experience) in addition to travel time savings.
- The study can contribute to the development of better methods to provide information to travelers and enhance the quality and safety of the travel experience. The research accomplishments from this project can help in deciding the content and amount of information necessary for participants to make best route decisions.
- The research findings are expected to improve public access to and awareness of the positive and negative impacts of real-time travel information.
- The driving simulator lab can be used as a platform to educate middle and high school students in various dimensions related to driver performance, behavior, and safety.

#### *Research, Education and Outreach from Campus Transit Laboratory (CTL)*

- The overall project is focused on improving transit services, increasing transit utilization, and enhancing transit efficiency, all of which lead to more socially, economically, and environmentally sustainable transportation systems.

#### *Effects of Heterogeneous Information Characteristics and Sources on Evacuation Behavior*

- This study emphasizes the role of SNS as emerging information dissemination media for disaster or any other emergency situations.
- The finding of this study can lead to direct impacts on safety of the evacuees, as it contributes to the development of better information dissemination strategies on SNS.

#### *Integrated Approach to Achieving Environmental Sustainability in Transportation: Coupling Energy Efficiency Solutions with Reductions in Environmental and Climate Foot prints*

- Minority students in the environmental engineering program are trained in software (MOVES and GREET) that transportation industry and regulating agencies use. This enhances their knowledge, thus the chances for the career in the transportation industry.

#### *Signal Timing Optimization for Large-Scale Urban Networks under Dynamic Traffic*

- Implementation of new methodology for intersection signal timing design to achieve minimized vehicle delays could help improve traffic mobility in urban areas

*Tracking bicyclists' route choices, case study*

- This research will demonstrate how technology enabled new and innovative data collection methods can be used for collecting travel behavior data. It will demonstrate how these data can be used for modeling human behavior. The use of these data for future planning purposes and investment decisions will impact the quality of life for people and policy decisions. These have clear implications for creating livable communities and integration of different modes.

*Truck Activity and Wait Times at International Border Crossings and Documenting and determining distributions, trends, and relations in truck times at international border crossing facilities*

- Improving freight flow across international borders, which is essential to international competitiveness

*Guaranteed LiDAR-aided Multi-object Tracking at Road Intersections*

- Make traffic modeling, estimation, prediction, and the meeting of safety specifications a matter of systematic scalable engineering rather than heuristics with large scale human intervention as it is today. Enable policy makers to design roads and signals on a quantitative basis to meet societal expectations.

*Integrating multiple sources of data for the estimation of transit origin-destination flows*

- The overall project is focused on improving transit services, increasing transit utilization, and enhancing transit efficiency, all of which lead to more socially, economically, and environmentally sustainable transportation systems.

*Mobile air quality monitoring for local high-resolution characterization of vehicle-sourced criteria pollutants*

- Improved air quality monitoring could lead to improved quality of life; for example, information on air pollutant concentrations with higher spatial resolution than currently available may prevent negative health effects in vulnerable populations (e.g., asthmatics, the elderly).

*A Study of the Usage Potential of a Proposed Expanded Commuter Rail Station at Chicago State University*

- The project will hopefully lead to an improved station at 95th St, which is currently an underused station..

*A Study of Potential Community and Faculty/Staff Use of an Improved 95th Street Metra Stop*

- **Project will hopefully lead to an improved 95th St. Metra stop.**

*Transit Origin-Destination (OD) Flow Estimation Considering Temporal Variations based on APC Data*

- Improving transit services, increasing transit utilization, and enhancing transit efficiency, all of which lead to more socially, economically, and environmentally sustainable transportation systems.

*Modeling CO2 Emissions as a Function of Transportation, Land-Use, and Regulation Variables*

- Supporting the motivation, development, and evaluation of passenger transportation, land-use, and environmental policies aimed at reducing greenhouse gas (GHG) emissions in urban areas

**PART 5: CHANGES/PROBLEMS**

No changes or problems to report.