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1. ACCOMPLISHMENTS

What are the major goals of the program?

The goals of the Center for Transportation, Environment, and Community Health (CTECH) are to pursue research and education innovations to support sustainable mobility of people and goods, while preserving the environment and improving community health. It leverages behavioral and economic sciences, information technology, and environmental and transportation sciences and technologies to address critical issues falling under the FAST Act's priority area of Preserving the Environment: greenhouse gas reduction, use of alternative fuels and energy technologies, environmentally responsible planning, and impacts of freight movement.

To address these challenges, the Center organizes its research activities through six thrusts: 1) Behavior, Active Transportation, and Community Health, which studies the links between travel behavior, active transportation, the built environment, and health; 2) New Transportation Technologies and Business Models, which explores how mobility-on-demand services can be used to improve environmental sustainability and human health; 3) Green Multimodal Transportation Systems, which leverages new mobility technologies to promote sustainable and health-enhancing modal integration; 4) Freight Transportation and Community Health, which explores new vehicle technologies and operation paradigms to reduce human exposure to truck exhaust; 5) Data-Driven Transportation-Health Informatics, which leverages Smart City and IoT (Internet-of-Things) technologies to develop community-based and personalized transportation-health indices for promoting healthy mobility choices; and 6) Energy, Technology and Policy Pathways, which studies the impact of different combinations of energy, technology and policy pathways on the environment and community health. The consortium, consisting of Cornell University (Cornell), University of California, Davis (UCD), University of South Florida (USF), and The University of Texas at El Paso (UTEP), aims to advance transportation sustainability in its broader human and environmental contexts through multi-level, multidisciplinary and cross-sector collaborations.

The Center leverages existing strengths of partner universities to create an innovative, multidisciplinary education program capable of training a workforce that will meet the complex challenges at the intersection of transportation, environment, and community health. Beyond the multidisciplinary curriculum designed in parallel with its research, the Center is developing programs to attract motivated undergraduates and high school students to transportation, particularly from underrepresented groups.

CTECH's research targets deliverables in the following areas:

- Advancing methods for the holistic representation of user behavior/response;
- Data-driven cyber-informatics modeling-management models/tolls accounting for built environment-users and systems interactions;
- Computationally efficient algorithmic techniques for multimodal transportation systems management and community health;
- Scientific and engineering solutions for large scale integration of community health into transportation policy and planning; and
- Improved transportation-environment-community health nexus by linking fundamental scientific discovery with innovative practices.

The unique aspect of the work is that researchers focus on informing, influencing, and changing policy (i.e., legislation, regulations, programs, ordinances, and protocols) at the nexus of transportation, environment and community health. Dissemination of research outcomes and education are critical components of technology transfer to subsequently influence policy and human behavior. The main products from our center's research activities will be in the form of insights, knowledge, tools, and models that are instrumental to our stakeholders and practitioners as well as to policy development and

analysis. The development of technologies to license and/or commercialize can also be outcomes and is highly encouraged.

What was accomplished under these goals?

While providing critical services for the mobility, health, economic well-being, and security of communities, transportation presents challenges that also define modern society, with issues such as accessibility, air quality and energy efficiency, safety, health impacts, equity, and infrastructure vulnerability that must be confronted to sustain healthy living and economic growth. Successful solutions call for innovative cross-disciplinary research and education, and integrated technologies and approaches that meet goals in mobility alongside goals in environmental and health protection. In this reporting period, focused on FAST Act's priority area of Preserving the Environment, CTECH continued to use its fundamental research activities as the driving force to create downstream innovations, practices, and to enhance education programs for workforce development. The center's activities are organized and the accomplishments reflected along three tracks: 1) the fundamental knowledge track comprises research activities, development of methodologies and tools, and collection and analyses of data; 2) new policy recommendations and innovative practical implications/guidelines that translate and promote research outcomes into transportation, environmental and community health practices/policies; and 3) education, outreach/engagement, and workforce development that trains students and professionals on the findings and insights of the research, as well as the tools used and lessons learned in best practices. We continued to engage stakeholders (government agencies, private industry, the public, etc.) in all of these processes to create broader impacts. Via accomplishments along these tracks, we progress towards our goal of building a unique platform for synergistic and multidisciplinary research and education at the nexus of Transportation, environment, and community health, where new opportunities are explored to develop methods, tools and technologies to support sustainable multi-modal transportation and promote healthy mobility choices.

Research projects accomplished during this reporting period cover topics such as behavior change in transportation for health, methodology design and technology advancement for improved transportation and environment, and project-level assessment of environmental quality and justice impacts from local transportation projects. In particular, the following research projects were completed.

- Active Transportation, Environment, and Health
- Demand-Driven Operational Design for Shared Mobility with Ride-pooling Options
- Safety Effects of the Yellow Light Border (YPB) Pedestrian Signal: An Evaluation
- Evaluation of Freeway Traffic Data Acquisition: Technology, Quality, and Cost
- Optimal driving of autonomous vehicle platoons on arterial streets to reduce fuel consumption
- Routing Traffic for Community Health: The Case with Safety-Conscious Travelers
- Design of a Hybrid Rebalancing Strategy to Improve Level of Service of Free-Floating Bike Sharing Systems
- Air pollution and equity impacts of the proposed Tampa Bay Next program from a Health in all Policies perspective
- Development and Evaluation of Porous Pavement Surface Mixtures with Biobased Epoxy Asphalt Binder
- Assessing Children's Spatiotemporal Exposures to Transportation Pollutants in Near-Road Communities

How have the results been disseminated?

Formal research related oral presentations during the period are detailed below, followed by other dissemination activities.

10-20-18 Klein, N., The 58th Annual Association of Collegiate Schools of Planning Conference, **How car donation programs change the lives of poor families**, Buffalo, NY.

2-22-19 Stuart, A.L., University of South Florida Health Research Day, **Air Pollution and Equity Impacts of the Tampa Bay Next Transportation Improvement Program for Tampa**, Tampa, FL.

3-25-19 Stuart, A.L., 2019 University of Florida Air Quality Workshop, **Air Pollution and Equity Impacts of the Tampa Bay Next Transportation Improvement Program from a Health in All Policies perspective**, Gainesville, FL.

4-17-19 Samaranayake, S., Temple University Applied Mathematics and Scientific Computing Seminar, **Improving Urban Mobility with Transit Centric On-Demand Services**, Philadelphia, PA.

4-24-19 Stuart, A.L., Florida Department of Transportation District 7 Office, **Investigating air pollution and equity impacts of a proposed transportation improvement program for Tampa**, Tampa, FL.

4-25-19 Daziano, R., Ecole Polytechnique Federale de Lausanne, **Exploring the Use of Immersive Virtual Reality Environments for Travel Behavior Analysis**, Lausanne, Switzerland.

4-26-19 Simoncini, S., Tompkins County Area Transit (TCAT), **Bus Shelter System Masterplan**, Ithaca, NY.

5-9-19 Simoncini, S., Cornell University Facilities and Campus Services, **Bus Shelter System Design**, Ithaca, NY.

5-14-19 Simoncini, S., City of Ithaca, **Ithaca Garage System Implementation**, Ithaca, NY.

5-15-19 Stuart, A.L., 2019 AEESP Research and Education Conference, **Air Pollution and Equity Impacts of the Tampa Bay Next Transportation Improvement Program from a Health in All Policies perspective**, Tempe, AZ.

5-15-19 Daziano, R., Technion, **Exploring the Use of Immersive Virtual Reality Environments for Travel Behavior Analysis**, Haifa, Israel.

5-25-19 Zhang, H.M., The Sixth Symposium on Transportation Science and Computation, **Traffic flow modeling in the era of autonomous vehicles, then and now**, An Qing, China.

6-25-19 Gao, H.O., Council of University Transportation Centers, **Future Transportation in Urban Transition – Transportation Infrastructure, Environment, and Health**, Norman, OK.

6-25-19 Shilling, F., Council of University Transportation Centers, **Sustainable and Climate-Resilient Transportation**, Norman, OK.

7-2-19 Lu, Q., 2019 4th International Conference on Transportation Infrastructure and Materials, **Pavement Overlay Rehabilitation Policy for Reduced Life-cycle Cost and Environmental Impact**, Jinan, China.

7-6-19 Gao, H.O., Chinese Overseas Transportation Association, **Paradigm shift towards smart and healthy cities – systems innovation at the nexus of transportation, environment, and public health**, Nanjing, China.

7-8-19 Samaranayake, S., Workshop on Control for Networked Transportation Systems, **Humans in Network Transportation Systems**, Philadelphia, PA.

7-8-19 Zhang, H.M., Workshop on Control for Networked Transportation Systems, **Traffic Control and Routing in a Connected Vehicle Environment**, Philadelphia, PA.

7-9-19 Samaranayake, S., American Control Conference 2019 Workshop: A Sociotechnical Systems Approach for Energy-Efficient Mobility in Smart Cities, **Improving urban mobility with transit centric**

on-demand services, Philadelphia, PA.

7-23-19 Daziano, R., Catholic University of the North-Department of Economics, **Using Virtual Reality Environments for the Analysis of Cycling Behavior**, Antofagasta, Chile.

8-9-19 Daziano, R., National Graduate Institute for Policy Studies, **Exploring the Use of Immersive Virtual Reality Environments for Travel Behavior Analysis**, Tokyo, Japan.

9-4-19 Samaranayake, S., KTH Royal Institute of Technology, **Automatic Control Laboratory Seminar**, Stockholm, Sweden.

9-16-19 Gao, H.O., State University of New York at Cortland, **Future Transportation in urban Transition – Scalability, Sustainability and Effectiveness of Urban Infrastructure, Environment, and Health**, Cortland, NY.

9-27-19 Gao, H.O., Environmental Defense Fund (EDF), Webinar, **Future Mobility in Urban Transition: Systems Integration of Transportation, Environment, and Health Planning: Models, Tools, and Insights**, Ithaca, NY.

Dr. Amy L. Stuart, USF, participated in the Hillsborough Metropolitan Planning Organization's Community Advisory Board Meeting in Tampa, Florida on April 30, 2019 and spoke about Investigating air pollution and equity impacts of a proposed transportation project to approximately forty attendees including participants from the public, industry, state/local governments, and academia.

A CTECH Ph.D. student at UTEP, Mayra Chavez, presented topics related to Transportation Engineering and traffic data collection methods to 9th-11th graders from various high schools in El Paso, Texas as part of the ExciTES Summer Camp, organized by the UTEP College of Engineering. She reached approximately 20 students, of which approximately 75% were from underrepresented minority groups.

As part of the UTEP Summer Program on Sustainable Engineering, Dr. Kelvin Cheu, presented to 18 exchange students from Peru in El Paso, Texas.

Dr. Cheu was also involved in UTEP's freshman orientation in late July 2019, speaking to approximately 100 incoming students about transportation and civil engineering, exposing them early in their academic careers to opportunities to learn and contribute in this field. The majority of the students, 90%, were underrepresented minorities, which will hopefully support an increase in the diversity of our future transportation workforce.

What do you plan to do during the next reporting period to accomplish the goals?

No change.

2. PARTICIPATING AND COLLABORATING ORGANIZATIONS

Listed below are organizations that CTECH has partnered with during the reporting period.

Air Sage	Atlanta, GA	Collaborative Research
Atkinson Center for a Sustainable Future	Ithaca, NY	Collaborative Research
Associated Asphalt	Tampa, FL	Other – materials provided for laboratory testing
California Department of Transportation (Caltrans)	Sacramento, CA	Financial Support, Facilities, Collaborative Research
Center for Urban Transportation Research, USF	Tampa, FL	Financial Support, Facilities, Collaborative Research
City of El Paso	El Paso, TX	In-kind Support

City of Ithaca	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
City of Tampa, Department of Transportation and Stormwater Services	Tampa, FL	In-kind Support, Collaborative Research, Other – provide information on their green infrastructure implementation plan
City of Temple Terrace	Tampa, FL	Other – provided stormwater GIS data for the Temple Terrace area
Cornell University – Transportation, Facilities, and Campus Services	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
El Paso Metropolitan Planning Organization	El Paso, TX	Collaborative Research
Environmental Defense Fund (EDF)	Washington, DC	Collaborative Research
Florida Department of Health	Tampa, FL	Other – project contributions
Florida Department of Transportation Central Office	Tallahassee, FL	In-kind Support
Florida Department of Transportation District 7	Tampa, FL	Other – project contributions
Hillsborough County MPO	Tampa, FL	In-kind, Collaborative Research
Hillsborough County Public Works Department	Tampa, FL	Other – provided GIS data and input on the modeling process
Indian Institute of Science	Karnataka, India	Collaborative Research
Joint Advisory Committee for improving the air quality in El Paso Sunland Park, and Ciudad Juárez	El Paso, TX	Personnel Exchanges, Other – data source, feedback, potential implementer
Kohn Pederson Fox Architects	New York, NY	Collaborative Research
NYMTC (The New York Metropolitan Transportation Council)	New York, NY	Collaborative Research
Optimus Technologies	Pittsburgh, PA	Collaborative Research
Tampa Pavement Constructors	Tampa, FL	Other – provide aggregate samples for laboratory testing
Tompkins Consolidated Area Transit (TCAT)	Ithaca, NY	Other – task giver, data source, feedback, potential implementer
USF Water Institute	Tampa, FL	Other – data exchanges
Weill Cornell Medicine/NewYork-Presbyterian Hospital	New York, NY	Collaborative Research

Other collaborators or contacts with involvement in CTECH are listed or described below.

C2SMART	New York, NY	Partner (UTEP)
Cornell-Unibo Center for Vehicle Intelligence	New York, NY	H. Oliver Gao is Co-PI of Cornell-Unibo Center
John Swanson	The Villages, FL	Donor – Biodiesel Project

H. Oliver Gao is working with Yiye Zhang at Weill Cornell Medicine in New York City to carry out studies examining relationships between built environment and health outcomes.

Gao is also working with Miguel I. Gómez, Associate Professor at the Charles H. Dyson School of Applied Economics and Management, on a joint manuscript on *A systems approach to carbon policy for fruit supply chains: carbon tax, technology innovation, or land sparing?*

Dr. Amy L. Stuart had a Master's student who was partially supported on a project entitled *Air pollution and equity impacts of the proposed Tampa Bay Next program from a Health in all Policies perspective*, with funding from the Turkish Petroleum Institute in Ankara, Turkey.

Dr. Shanjun Li is collaborating with Dr. Jing Wu from the China Center for Economic Research at Peking University on a project examining the impact of transportation policy on the housing market in Beijing, China. He also is collaborating with Dr. Yatang Lin, an Assistant Professor at the Hong Kong University of Science and Technology, on a project to examine the impact of high-speed rail expansion in China.

Dr. Ricardo Daziano traveled to the United Kingdom to tour the Virtual Reality (VR) facilities at the University of Leeds. Their research complements Daziano's in the area of analyzing cycling behavior. In addition, he is collaborating with Mauricio Sarrias in Antofagasta, Chili, co-authoring an R package for the estimation of discrete choice models that will be used to analyze the data from the discrete choice experiments from the VR research project, and Owen Waygood and Zachary Patterson in Montreal, Canada about understanding how individuals process emission information of transportation activities.

3. OUTPUTS

Bike travel is often considered a healthy and environmentally friendly mode of travel and promoted by cities. While it is of no debate that bike travel is good for the environment, bike accidents and exposure to toxic air pollutants also negatively affect bikers' physical wellbeing. The net health benefits of bike travel are therefore not clear cut, and are worthy of study case by case. Our research at UCD studies an example of a bike-sharing program in New York City (NYC) called Citi Bike, and finds that the implementation of Citi Bike produces an enormous health benefit for NYC citizens. As a result of this study, procedures were developed to integrate and analyze transportation and health data, and a manual on how to implement these procedures and how to use the transportation health assessment program ITHIM for similar studies is being prepared. Conventional transportation planning does not pay enough attention to the health aspects of transportation, partly because of a lack of ready-to-use tools for health impact assessment. This manual can serve as a useful guide for transportation planners and policy makers who want to assess how their policies affect public health.



Figure 1 The Citi Bike bikes in NYC (Courtesy of Wikipedia).



Figure 2 Citi Bike station locations (green, red, and yellow dots) in New York City.

Another project at UTEP, Assessing Children's Spatiotemporal Exposures to Transportation Pollutants in Near-Road Communities, conducted traffic and air quality measurements as well as emission and air dispersion modeling of transportation emission impacts in a near-road community. The MOVES emission model was used to generate emissions estimates for all highways and streets in the model domain. The traffic data were used to generate vehicle emissions factors for AERMOD air exposure concentration estimates. The AERMOD modeling system includes the use of two regulatory components, a meteorological preprocessor (AERMET), and an air dispersion processor (AERMOD). Limited traffic data was collected at three locations (hourly volume, speed and classification) and at U.S. Route 54 (hourly volume and classification) within the study site. Air quality, specifically, NO₂, PM_{2.5}, PM₁₀ and O₃ concentrations, was measured at three locations with the study site. In addition, PM_{2.5} concentration estimates resulting from traffic emissions from U.S. Route 54, generated using AERMOD. We learned that air pollution concentration in near-road communities resulting from traffic-related emissions are dominated by regional background concentrations. For PM_{2.5}, regional background concentrations account for 85% of the total concentrations. For the remaining 15%, the spatial and temporal variations are effected by vehicle emissions from major highways than the local traffic. These findings will hopefully impact traffic data collection methodology (sampling location, time) in traffic impact assessment. The findings provide an understanding of the impacts of traffic emissions on near-road communities and provide mitigation measures to reduce the health impacts to residents.

Publications

Journal publications

- 1) Pan, S., Roy, A., Choi, Y. Sun, S. Gao, H.O., The air quality and health impacts of projected long-haul truck and rail freight transportation in the United States in 2050, *Environment International*, 2019. Volume 130, Page 104922, DOI: [10.1016/j.envint.2019.104922](https://doi.org/10.1016/j.envint.2019.104922).
- 2) Pan, S., Roy, A., Choi, Y., Eslami, E., Thomas, S., Jiang, X., Gao, H.O., Potential impacts of electric vehicles on air quality and health endpoints in the Greater Houston Area in 2040, *Atmospheric Environment*, 2019, Volume 207, Pages 38-51, DOI: [10.1016/j.atmosenv.2019.03.022](https://doi.org/10.1016/j.atmosenv.2019.03.022).
- 3) Su, L., Kwon, C., Risk-Averse Network Design with Behavioral Conditional Value-at-Risk for Hazardous Materials Transportation, *Transportation Science*, Accepted.
- 4) Balal, E., Cheu, R.L., A metric-concept map for scoping impact studies of a transportation project on environment and community health, *International Journal of Transportation Science and Technology*, 2019, Volume 8, Pages 178-191, DOI: [10.1016/j.ijtst.2019.05.005](https://doi.org/10.1016/j.ijtst.2019.05.005).

Books or other non-periodical, one-time publications

Nothing to report.

Other publications, conference papers and presentations

Nothing to report.

Policy Papers

- 1) Potential impacts of electric vehicles on air quality and health endpoints in the Greater Houston Area in 2040 addressed emission scenarios developed that correspond to varying degrees of fleet electrification and turnover in Houston, Texas. Emission controls lead to 1-4 ppb change of ozone and 0.5-2µg m⁻³ decrease of PM_{2.5}. The change in premature deaths and other health outcomes using BenMAP was calculated. The ozone concentrations typically rose along NO_x-saturated highways but decreased significantly outside.

Website(s) or other Internet site(s)

Websites <http://ctech.cee.cornell.edu/>, <https://urbano.io/>, and <https://www.hbuddy.org/> are continuously being updated.

New methodologies, technologies or techniques

Dr. Gao's group developed a high-resolution (1-km) WRF-SMOKE-CMAQ-BenMAP air quality and health modeling tool, which helped capture urban features in higher detail. The tool was applied to analyzing relatively large fleet penetrations of electric vehicles, including a moderate fraction (35%) and

an aggressive one (70%), to on-road mobile source sectors in the Greater Houston Area for the year 2040. To predict future emissions, the researchers assess another important factor—fleet turnover—that is, the replacement of older motor vehicles with newer technology, resulting in a significant reduction in emissions. Model predictions for 2040, compared to a base year of 2013, indicate a ~50% increase in emissions in the Business As Usual (BAU) scenario, and ~50%, ~75%, and ~95% reductions in the Moderate Electrification (ME), Aggressive Electrification (AE), and Complete Turnover (CT) scenarios, respectively. The results suggest that while the increase in O₃ and PM_{2.5} concentrations for the BAU case will lead to 122 more premature deaths in 2040 than in 2013, the decrease in emissions for the control cases (ME, AE, CT) will prevent between 114 and 246 premature deaths. In addition, about 7,500 asthma exacerbations and 5,500 school loss days will be prevented in the ME case, benefiting younger individuals. The economic benefits generally follow the same trends as the health benefits. The analytical framework developed in this study can be applied to other metropolitan areas. Research results from this study have been communicated to the general public, policy makers, and practitioners via outreach to multiple channels of media to influence practice and policy. A research paper *Potential Impacts of Electric Vehicles on Air Quality and Health Endpoints in the Greater Houston Area in 2040* was recently published in *Atmospheric Environment*.

On the technology side, traffic signals, while serving an important function to coordinate vehicle movements through intersections, also cause frequent stops and delays, particularly when they are not properly timed. Such stops and delays contribute to significant amount of fuel consumption and greenhouse gas emissions. The recent development of connected and automated vehicle (CAV) technology provides new opportunities to enable better control of vehicles and intersections, that in turn reduces fuel consumption and emissions. In this research at UCD, we developed a platoon-trajectory-optimization (PTO) method to minimize the total fuel consumption of a CAV platoon through a signalized intersection. In this approach, all CAVs in one platoon are considered as a whole, that is, all other CAVs follow the trajectory of the leading one with a time delay and minimum safety gap, which is enabled by vehicle to vehicle communication. Moreover, the leading CAV in the platoon learns of the signal timing plan just after it enters the approach segment through vehicle to infrastructure communication. We compare our PTO control with the other two controls, in which the leading vehicle adopts the optimal trajectory (LTO) or drive with maximum speed (AT), respectively, and the other vehicles follow the leading vehicle with non-CAV car-following behavior. Furthermore, we extend the controls into multiple platoons by considering the interactions between the two platoons. The numerical results demonstrate that PTO has better performance than LTO and AT, particularly when CAVs have enough space and travel time to smooth their trajectories. The reduction of travel time and fuel consumption can be as high as 40% and 30% on average, respectively, in the studied cases, which shows the great potential of CAV technology in reducing congestion and negative environmental impact of automobile transportation.

Researchers at UTEP developed a methodology that incorporates emissions and dispersion modeling to estimate traffic air pollutant concentrations in near-road communities.

At USF, researchers developed a mathematical optimization model and a computational method for designing roadban policies for regulating hazardous materials transportation to avoid catastrophic consequences from accidents. The method considers behavioral uncertainties from hazmat carriers.

The Daziano research group at Cornell developed a protocol for running behavioral experiments for the study of cycling perceptions that makes use of VR experiences and then goes through a more standard online survey with a discrete choice experiment in which the traffic and built-environment cycling conditions are presented as screenshots of the VR reality videos. The protocol includes formal steps, from provision of consent to participate in the study and a calibration/trial VR experience that also includes

calibration of the tools used to monitor physiological measures, a VR experience, and then completion of the online survey right after the VR experience.

Dr. Qiong Zhang at USF developed a GIS-based approach to creating a green stormwater infrastructure inventory by identifying their footprints and types. In addition, she developed a GIS-based approach to determining candidate green stormwater infrastructure sites for future implementation according to the terrain, land cover, land use, and the necessity of stormwater control. She also improved the application of EPA's hydrological model (SWMM) to a larger scale that can address issues at city scale or watershed level.

Dr. Qing Lu's research group developed an initial formula to modify asphalt binder with biobased epoxy (epoxidized soybean oil) for porous asphalt mixtures. Laboratory tests showed improved performance related to pavement surface functions compared to mixtures with unmodified asphalt binder.

Inventions, patents, and/or licenses

Nothing to report.

Other products, such as data or databases, physical collections, audio or video products, application software or NetWare, analytical models, educational aids, courses or curricula, instruments, equipment, or research material

Additional products include:

- Developed an integrated modeling framework for estimation of exposures to traffic-related air pollution in the Tampa area. The framework combines the DaySim activity-based travel demand model, the MATSim dynamic traffic assignment model, the MOVES mobile source emissions estimator, and the R-LINE dispersion model.
- Developed a software tool (in R) for the calculation of several measures of overall and comparative inequality in exposures to air pollution. These include the variance, coefficient of variation, Gini index, Atkinson index, Thiel index, subgroup inequality index, comparative environmental risk index, and the toxic demographic quotient index.
- Generated data on the spatiotemporal distributions of daily individual human activity, roadway emissions, pollutant concentrations, and individual exposures to traffic pollution for the Tampa project. Also generated was data on the social distribution of traffic pollution exposures, including measures of inequality for several racial, ethnic, and income groups.
- Generated data on the potential effects of a real locally-prioritized metropolitan-scale transportation infrastructure case study program on air pollutant emissions, concentration, exposures, and exposure inequality.
- Emissions inventory, air quality, and exposure estimation data was produced for Houston for various transportation electrification scenarios. These scenarios considered increased vehicle activity and various configurations of emissions controls in comparison of the base year of 2013, model predictions for 2040 for the Business As Usual (BAU) case, the Moderate Electrification (ME), Aggressive Electrification (AE), and Complete Turnover (CT) cases, respectively.
- GHG emission estimation data from transportation sector for New York Metropolitan Transportation Council for its transportation conformity years.
- During the Science, Technology, Infrastructure concentration meeting session with the Cornell Institute for Public Affairs students learned about the importance of integrating infrastructure and environment, and health policy.
- H.O. Gao is a participating member of the Cornell Master of Public Health (MPH) degree program and, during the Internal Advisory Committee meeting on June 7, 2019, CTECH relevant topics were discussed for the MPH program. In particular, his lecture on air pollution, PM_{2.5}, the health impacts of transportation systems, and the public health externalities of various practices,

provides a great example of integrating CTECH research into a lecture in the MPH Program. His topic also nicely combines the biophysical and social determinants of health.

- Dr. Shanjun Li, introduced Environmental Economics students to the concept of congestion pricing and other instruments to address traffic congestion.
- Dr. Nicholas Klein incorporated environment and health impacts in teaching the design of transportation planning in the Introduction to Sustainable Transportation course.
- The Garage M.Eng. project team is a recent addition to the Sustainable Mobility group advised by Sirietta Simoncini. The team has been tasked by the City of Ithaca with redesigning the City 3-garage system user interface and wayfinding. The goal is to optimize the system and reduce unnecessary car traffic and gas emission. In Spring 2019, the Garage team conducted well organized fieldwork, and the revealing results and first set of recommendations were presented to the City of Ithaca. The City was enthusiastic and tasked the project team with further developing and testing the design concepts presented at the meeting.
- Dr. Wen-Whai Li's research group generated new air quality data for communities immediately adjacent to interstate highways and produced traffic data for near-road communities at selected sites.
- Dr. Daziano's VR research resulted in preliminary data of the responses to the cycling preferences survey that was collected with pre-testers of the VR experiment protocol. He also invited students from Engineering Economics and Management to participate in the VR experiment as pre-testers. In addition, case studies regarding the environment and health impacts of transportation were incorporated in lectures throughout the semester. The idea of the case studies is to, in addition to covering methodological aspects of engineering economics, to also share the importance of the role of engineers in addressing and helping to solve environmental and health externalities of transportation.
- Dr. Qiong Zhang developed GIS databases of 1) implemented green stormwater infrastructure inventory relevant to the road system in the City of Tampa, and 2) candidate green stormwater infrastructure for future implementation in the City of Tampa. She also developed a SWMM-based hydrological model incorporated with green stormwater infrastructure for the City of Tampa.
- A CTECH webinar entitled Transforming Hillsborough County's Transportation Future was broadcast on April 24, 2019. It was a panel discussion led by Pat Kemp, Hillsborough County District 6 Commissioner. The focus was on the current opportunities in Hillsborough County to create a safe, sustainable transportation network and build the kind of vibrant, walkable places that bring opportunity, economic development, and support a higher quality of life for our residents. Commissioner Kemp joined other female leaders in transportation in Hillsborough County for a conversation about how they can work together to accomplish these goals. She was joined by Jean Duncan, P.E. Director of Transportation and Stormwater Services for the City of Tampa, Cassandra Borchers, AICP, Chief Development Officer of PSTA, and Beth Alden, AICP, Executive Director of Hillsborough County MPO.

T2 Plan Output One - dissemination activities - number of oral and/or poster presentations (without publication) – goal of 25 annually.

Collectively, there were 23 oral presentations (detailed above) and nine poster presentations during the reporting period. One of the posters was Dr. H. Oliver Gao's when he participated in the 2019 UTC Spotlight Conference for the United States Congress and other stakeholders on May 14, 2019. The poster he presented was entitled *Advancing transportation sustainability in the broader human and environmental contexts*.

T2 Plan Output Two – breadth of researchers’ engagement with stakeholders – number of CTECH researchers on stakeholder committees and/or boards – goal of 8 annually.

17 CTECH faculty researchers hold positions on 44 committees and/or boards, a list is provided below.

Bertini, Robert	USF	Chair, TRB AHB00 Committee (Operations Section)
Chang, Carlos	UTEP	Chair of the Infrastructure and Systems Committee, American Society of Civil Engineers (ASCE), Transportation and Development Institute (TDI)
Chang, Carlos	UTEP	Chair of the Research Subcommittee of the AFD 10 Pavement Management Systems Committee, Transportation Research Board
Chang, Carlos	UTEP	Member, AHD18 Pavement Preservation Committee, Transportation Research Board
Chang, Carlos	UTEP	Vice-President of the North-American Region of iSMARTi
Cheu, R. (Kelvin)	UTEP	Editor-in-Chief, International Journal of Transportation Science & Technology
Cheu, R. (Kelvin)	UTEP	Member, TRB Committee on Artificial Intelligence and Advanced Computing Applications
Cheu, R. (Kelvin)	UTEP	Member, Editorial Advisory Board, Journal of Intelligent Transportation Systems
Daziano, Ricardo	Cornell	Member, TRB ADB40 Committee (Transportation Demand Forecasting)
Daziano, Ricardo	Cornell	Elected Regular Board Member, International Association for Travel Behavior Research (IATBR)
Daziano, Ricardo	Cornell	Member, North American Chapter, International Steering Committee for Travel Survey Conferences (ISCTSC)
Daziano, Ricardo	Cornell	Guest Editor, Journal of Choice Modeling for a special issue on estimation of complex models
Fan, Yueyue	UCD	Executive Member, TRB ADB30 Committee (Transportation Network Modeling)
Jaller, Miguel	UCD	Member, TRB ABJ40 Committee (Travel Survey Methods)
Jaller, Miguel	UCD	Chair, TRB ABJ40(2) Sub-Committee (Freight Surveys)
Jaller, Miguel	UCD	Member, TRB AT025 Committee (Urban Freight Transportation)
Jaller, Miguel	UCD	Young Member, TRB AT065 Standing Committee (Logistics of Disaster Response and Business Continuity)
Klein, Nicholas	Cornell	Member, TRB ADD20 Standing Committee (Social and Economic Factors of Transportation)
Kwon, Changhyun	USF	Vice-Chair, Urban Transportation Planning and Modeling SIG of the INFORMS Transportation Science and Logistics Society
Kwon, Changhyun	USF	Member, TRB ADB30 Committee (Transportation Network Modeling)
Li, Xiaopeng	USF	Member, TRB ADB30 Committee (Transportation Network Modeling)
Li, Xiaopeng	USF	Member, TRB AHB45 Committee (Traffic Flow Theory and Characteristics)
Lu, Qing	USF	Member, EMI Mechanics of Pavements Committee, American Society of Civil Engineers (ASCE)
Lu, Qing	USF	Editorial Board, Transportation Research Part D: Transport and Environment
Lu, Qing	USF	Member, TRB AFD90 Committee (Pavement Surface Properties and Vehicle Interaction)
Mannering, Fred	USF	Founding Editor and Editor-in-Chief, Analytic Methods in Accident Research
Mannering, Fred	USF	Editorial Advisory Board, Accident Analysis and Prevention
Mannering, Fred	USF	Editorial Advisory Board, Transportation Research Part C: Emerging Technologies
Samaranayake, Samitha	Cornell	Member, TRB ADB30 Committee (Transportation Network Modeling Committee)
Stuart, Amy	USF	Member, Lectures Committee, Association of Environmental Engineering and Science Professors
Villanueva Rosales, Natalia	UTEP	Guest Editor, Semantic Web Journal, Special Issue on Semantic eScience
Zhang, H. Michael	UCD	Member, TRB AHB45 Committee (Traffic Flow Theory and Characteristics)
Zhang, H. Michael	UCD	Member, International Advisory Committee - International Symposium of

		Transportation and Traffic Theory
Zhang, H. Michael	UCD	Associate Editor, Transportation Research, Part B: Methodological
Zhang, H. Michael	UCD	Area Editor, Networks and Spatial Economics (NETS)
Zhang, H. Michael	UCD	Associate Editor, Transportmetrica A: Transport Science
Zhang, H. Michael	UCD	Associate Editor, Transportation Science
Zhang, Qiong	USF	Ph.D. Dissertation Awards Committee, Association of Environmental Engineering and Science Professors (AEESP)
Zhang, Yu	USF	Chair, TRB AV060 Committee (Airfield and Airspace Capacity)
Zhang, Yu	USF	Editorial Board, International Journal of Sustainable Transportation
Zhang, Yu	USF	Editorial Board, Transportation Research Part C: Emerging Technologies
Zhang, Yu	USF	Editorial Board, International Journal of Transportation Science & Technology
Zhang, Yu	USF	Immediate Past President, Chinese Overseas Transportation Association (COTA)
Zhang, Yu	USF	Editorial Board, Journal of Air Transport Management

4. OUTCOMES

Extended from previous CTECH sponsored research in bike sharing, Dr. Yu Zhang is now working with the City of Tampa to evaluate the performance of pilot e-scooter sharing program that was launched in May 2019. Developing an effective regulation for sharing micromobility is very challenging. The objectives of this project are (1) constructing suitable performance metrics for e-scooter sharing; (2) performing different data collection methods to generate a database for performance metrics computation, visualization, and operational reporting; (3) offering recommendations on administrating and regulating e-scooter sharing. The study looks into economic, environmental, safety and health, and equity aspects of the sharing program. By designing and disseminating survey questionnaires, as well as collecting detailed operational data from service providers, the research team is performing quantitative and qualitative analysis, and extract insights and endorsed recommendations to the City of Tampa. Recently, the City of St. Petersburg also contacted Dr. Yu Zhang to request a similar study for their forthcoming e-scooter sharing program.

The study *Development and Evaluation of Porous Pavement Surface Mixtures with Biobased Epoxy Asphalt Binder* led by Dr. Qing Lu, aimed to develop and evaluate formula of asphalt modification with biobased epoxy resin and the design of porous asphalt mixtures with such modified asphalt. The study advanced knowledge in the features and properties of biobased epoxy materials and closed a gap between research in chemical engineering and civil engineering. From well-designed experiments, the best curing agent was identified and a procedure for epoxidized soybean oil asphalt binder was developed. It showed improved performance in the laboratory compared to mixtures with unmodified asphalt. The study advanced the development of biobased pavement construction materials and their application in environment and health friendly pavement surface mixtures.

Software tools developed through the *Air pollution and equity impacts of the proposed Tampa Bay Next program from a Health in all Policies perspective* research led by Dr. Amy L. Stuart, have made possible the study of impacts of transportation infrastructure and policy alternatives in the Tampa area on air pollution exposures and exposure inequality. Through the data generated and disseminated through publications, the body of knowledge has been expanded on the current state of air pollution exposure and exposure inequality in the Tampa area, as well as the potential effects of the Tampa Bay Next toll lane expansion on exposures, inequality, and health. Through presentations at scholarly conferences, this knowledge has been transferred to a broad array of researchers and students interested in public health impacts of transportation infrastructure. Presentations for the Florida Department of Transportation District 7 office and the Hillsborough Metropolitan Planning Organization Advisory Board Open House have transferred knowledge to transportation and planning sector government workers and community members, and has increased their understanding of air pollution exposure, exposure inequality, and the potential effects of the Tampa Bay Next toll lane

expansion specifically. These presentations and other interactions have also increased the awareness of the local and state transportation and planning sector of the Health in All Policies decision-making paradigm and how it can be applied to transportation decisions in Tampa and Florida. Through media articles and videos related to the project, the local public have also been engaged and empowered on this important transportation infrastructure design and implementation issue for Tampa. Finally, through the involvement and interaction of masters and postdoctoral students in the fields of public health, bioinformatics, and transportation engineering on the grant work, these students have been trained with skills and mindsets for interdisciplinary evaluation of urban transportation infrastructure that spans the areas and methods of air pollution engineering, transportation engineering, exposure analysis, inequality analysis, qualitative document review, and human subjects research.

Additional outcomes include:

- Students working with Sirietta Simoncini are exposed to real world complex mobility issues that the local community is currently experiencing. They learn via a hands-on experience how to address such complexity in innovative ways, by working in an inclusive/interdisciplinary environment, by addressing both final users' needs and requirements set by local authorities/stakeholders, and by producing sustainable solutions that promote a healthy built environment. A big strength of these projects is that they are all suggested by real stakeholders and therefore they all have potential for quick implementation. Students are asked to constantly interact with the stakeholders, and use the feedback to produce relevant recommendations that can be quickly implemented and make an impact.
- Dr. Klein's research leading to an increased understanding and awareness of transportation issues and low-income households' access to car ownership over time increases in the body of knowledge about the role of subsidized car ownership can improve access to health care for low-income households.
- Dr. Wen-Whai Li's newly generated air quality and traffic data (described above) led to a new understanding of PM_{2.5} emitted from transportation on near-road communities.
- Dr. Changhyun Kwon's research increased the body of knowledge in hazmat traffic regulation which indicates that considering behavioral uncertainty of hazmat carriers when regulating hazmat traffic can make meaningful improvements in the safety of road infrastructure. On the other hand, if such behavioral uncertainty is ignored in the regulation policy design stage, the result can be much deviated from what was initially expected. This research is expected to assist practitioners increase awareness in the issue of behavioral uncertainty in designing regulation policies for safety of road networks.
- The VR experiment project protocol created (described above) will be used in the next project phase to create a shareable dataset and software code for the analysis of active transportation behaviors. It is intended to convey a best-practice tool for the use of new technology for data collection.
- Dr. Qiong Zhang's research team collaborated with stakeholders from the City of Tampa Transportation and Stormwater Services and shared the SWMM-based and the optimization models. The application of these tools will create quantifiable benefits of implementing green stormwater infrastructure at the system-level in terms of environmental, economic, and human health impacts, as well as increased knowledge in terms of spatial configuration of GIS implementation integrated with transportation infrastructure planning, and an improved process for designing stormwater management plans in surface transportation planning.
- A recent CTECH project entitled *Measuring Impact of Emerging Transportation Technologies on Community Equity in Economy, Environment and Public Health* developed an understanding and quantified skewed distributions of benefits from emerging transportation technologies and services across different demographic groups in a metropolitan area. Specifically, it developed a methodology of calculating bike sharing equity based on disaggregate travel demand data. This has led to the winning of Federal Highway Administration (FHWA) solicitation entitled

Automated Vehicle Access, Mobility, and Affordability for System Users (TOPR No HOIT190152). Based on the outputs of CTECH project and building from FHWA's previous scenario development and cost analysis for AV/CVs, this research will identify and analyze the spatial and social distribution of the AV/CV impacts on access, mobility, and affordability for different groups of users, especially vulnerable roadway users.

T2 Plan Outcome One – stakeholder support – number of stakeholder funded research projects - goal of 4 annually.

Two projects reported above as completed, *Safety Effects of the Yellow Light Border (YPB) Pedestrian Signal: An Evaluation*, and *Evaluation of Freeway Traffic Data Acquisition: Technology, Quality, and Cost*, were funded by Caltrans.

T2 Plan Outcome Two – cited works – number of reports in media - goal of 8 annually.

There were twelve media reports during the period that are described below.

Cornell Engineering published *Powerful Cornell software informs NYC's transportation planning* (<https://www.engineering.cornell.edu/spotlights/powerful-cornell-software-informs-nycs-transportation-planning>), the Cornell Chronicle published *Electric vehicles would be a breath of fresh air for Houston* (<https://news.cornell.edu/stories/2019/06/electric-vehicles-would-be-breath-fresh-air-houston>) and *Curbing diesel emission could reduce big city mortality* (<http://news.cornell.edu/stories/2019/09/curbing-diesel-emission-could-reduce-big-city-mortality>).

The Cornell Chronicle published *Electric vehicles would be a breath of fresh air for Houston* was reported by the Houston Chronicle, Public Citizen, Phys.org, Science Dailey, AAAS EurekAlert!, TexasVox, and the Houston Public Media.

The USF College of Public Health produced a news article in response to the published paper entitled *Agent-based modeling to estimate exposures to urban air pollution from transportation: Exposure disparities and impacts of high-resolution data* in the May edition of *Computer, Environment and Urban Systems*, <https://hscweb3.hsc.usf.edu/health/publichealth/news/coph-professor-studies-the-inequality-of-air-pollution-exposure-in-tampa-bay/>.

WUSF Public Media's Jessica Meszaros did a news radio interview with Professor Amy L. Stuart on September 11, 2019 entitled *Air Pollution Unequally Affects People In Tampa, Study Says*. s radio interview with Jessica Meszaros. Sept. 11, 2019, <https://wusfnews.wusf.usf.edu/post/air-pollution-unequally-affects-people-tampa-study-says>.

5. IMPACTS

Travel time is an important piece of information to both travelers and transportation service providers, such as state DOTs and local transit agencies. In the past, Caltrans has deployed its own sensors to either directly collect travel time data or collect other traffic data that can be used to infer travel times. Such efforts carry significant costs at both the deployment and maintenance stages. With the growth of private traffic data providers, such as Waze, HERE and INRIX, it becomes feasible to have partnerships with such companies or simply purchase data from them. The accuracy, reliability, and cost of private vendor data should be evaluated before any contract can be pursued. This project was designed to help Caltrans to assess the above aspects and inform their decisions on future procurement of travel time data.

The data collected from Caltrans and vendor sources were dual-loop traffic speeds, Bluetooth measured travel times, and vendor provided travel times. Through extensive analysis, we find that the vendor provided travel times are generally as accurate and reliable as the Bluetooth travel times, although travel times from one vendor systematically underestimated travel times but its time-of-day profile is very similar to those from other vendors and Bluetooth. The research concluded that forging data sharing

partnerships with vendors or signing data purchase agreements with them can be an economical way to obtain travel time data to cover the entire California freeway system. The research team also recommended that Caltrans deploy their own sensors on a limited number of locations to verify the quality of vendor data from time to time. Caltrans is currently evaluating their options of obtaining travel time data for the entire state highway system, and this study is an important reference for them to make the decision.

Travel time is of great interest to both the California Department of Transportation (Caltrans) and the traveling public, and its direct measurement or estimation is an essential element of intelligent transportation systems. Caltrans would like to compare the cost of implementing travel time detection systems by state forces to purchasing similar data directly from vendors. This research at UCD enables Caltrans managers to decide how to most efficiently and effectively impart travel time information to the motoring public. It provides an understanding of the quality, reliability and cost of travel time measurements from various sources by describing the effectiveness of various sampling rates, positions and distribution densities of potential Caltrans-deployed detectors while evaluating and comparing the costs of alternative data sources from private vendors.
John Slonaker, Project Manager of Division of Research, Innovation and System Information, Caltrans



Figure 3 a). Students and Caltrans engineer downloading data from controller box (left).
b). Detector rack inside the controller box (right).

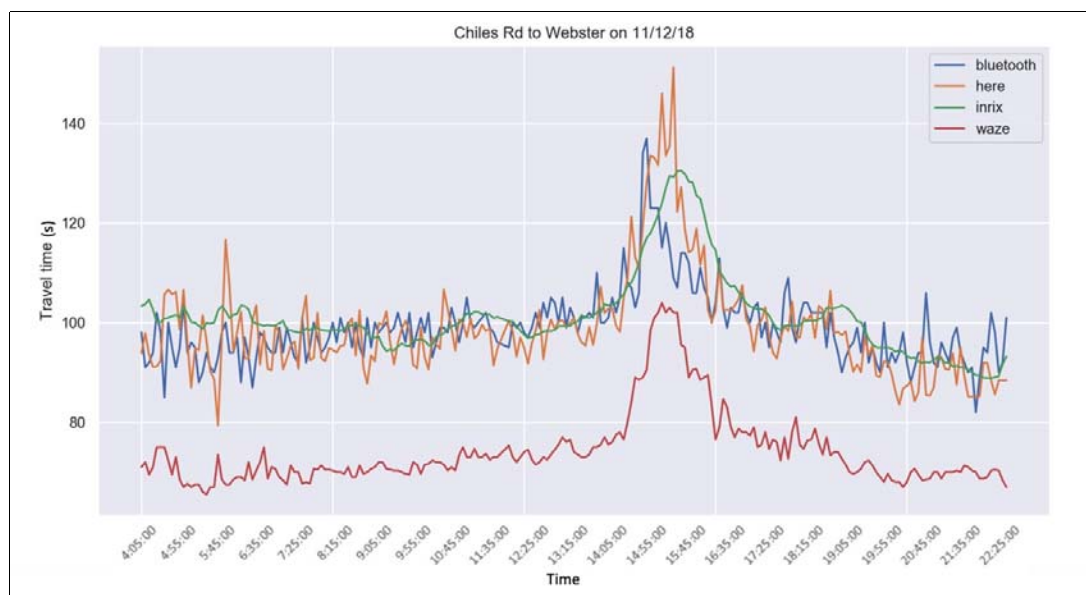


Figure 4 An example of travel times from different sources for the I-80 EB segment from Chiles Road to Webster.

The first phase of the Healthy Buddy research project at USF assessed how a community-based “buddy” program could improve transportation and health equity for transportation disadvantaged older adults in Hillsborough County, Florida. Through a comprehensive community resource assessment and in-depth interviews of adults over age 65, the first phase of the project improved the research team’s overall understanding of transportation inequity in the region and helped to identify opportunities and barriers to improving older adults’ transportation access and health knowledge. The first phase also established best practices and solidified the Healthy Buddy Program intervention model moving into Phase II of the project. For the second phase of the project, a pilot test of the Healthy Buddy program is being implemented in Hillsborough County Senior Centers in Florida to assess the impact of the adopted program model on older adults’ transportation access, quality of life, and sense of self-efficacy. Intervention and control groups will be used to analyze the level of impact on participants before and after receiving personalized transportation and health information from a trained Healthy Buddy Student Volunteer. The findings of the second phase are increasing the body of knowledge on transportation disadvantaged older adults and deepening the understanding of transportation and health inequities. Furthermore, the reported findings of the pilot test are expected to aid other communities in the development and implementation of similar community-based buddy programs for transportation disadvantaged older adults, thereby empowering others to improve the accessibility of transportation and health resources for older adults within their community. Technology transfer of the Healthy Buddy Program portal website will also assist with the localized implementation of the Healthy Buddy Program model in communities outside of Hillsborough County, Florida.

Additional impacts include:

- The study and dissemination of results on traffic-related air pollution and exposure inequality in Tampa and for the Tampa Bay Next toll lane program, this project has increased the general scientific knowledge on the impacts of transportation policies and infrastructure on exposures to air pollution, health, and inequality. Further, it provides evidence for toll lane expansion programs that can be used for comparison to studies in other areas and other transportation alternatives. Additionally, it provides a case study for the application of a Health in All Policies perspective to transportation infrastructure design, decision making, and implementation. The improved evidence base on outcomes of urban transportation infrastructure projects, increased awareness of health and equity-based perspectives and approaches to transportation projects, and education and training of students who are or will become transportation and public health practitioners, all will allow for improved future design and implementation of transportation projects in the State of Florida, throughout the US, and beyond. Furthermore, the increased awareness and empowerment of the public regarding impacts of such projects will enable healthier, equitable, and sustainable transportation decisions and thus improve societal health and well-being generally.
- The research on car donation programs will indirectly support increasing car access for low-income households which in turn, will help them access jobs, find better-paying jobs, and access healthcare.
- The green stormwater project makes the SWMM-based and the optimization models available to the City of Tampa to test its usefulness. The hydrology and sustainability assessment results will be shared with the stakeholders to increase the knowledge of the benefits of green stormwater infrastructure implemented at the system-level. Ultimately, the environmental and human health impacts will be alleviated through improved stormwater management.

T2 Plan Impact One –software applications – number of algorithms, codes, software used by practitioners – goal of 6 annually, and T2 Plan Impact Two –software applications – number of algorithms, codes, software used by researchers – goal of 7 annually.

The CU-PPS software using EPA’s Motor Vehicle Emission Simulator (MOVES) in conjunction with the

New York Metropolitan Transportation Council's (NYMTC's) Best Practice travel demand model continued to serve as the official software for transportation conformity in NYC. In particular, it was used by NYMTC modeling group for their 2019 transportation conformity analysis and for a separate study of GHG emission reduction strategy development in NYC. The tool was used by Ali Afshar, Afolabiti Aiyedun, Sangeeta Bhowmick, Thusitha Chandra, Alkhannan Faisal, Shengxin Jin, Debra Nelson, Sandeep Puppalo, Abdus Salam, Fidel Garcia, Chris Rodrigues-Moore, and Patrick Lentlie, all of the DOT, and Leo He and Mohammad Tayarani, Cornell University researchers.

6. CHANGES/PROBLEMS

None to report.

7. SPECIAL REPORTING REQUIREMENTS

CTECH Specific Metric: Overarching goals of the Center include the development of a metric for community health that incorporates mobility and health indicators; mobility on-demand models including environmental sustainability indicators; large-scale models to promote environmental sustainability, community health, and environmental justice. During the reporting period, CTECH researchers Ricardo Daziano and So-Yeon Yoon examined the active transportation and the emotion-stress-health link using virtual reality for assessing perceptual responses by pedestrians and bicyclists to the built environment. Although recognized to promote environmental and physical wellbeing of people, demand for active modes (walking and bicycling) – which require physical effort, take longer, but may be free to use – is insufficiently understood. This CTECH project aimed at analyzing the emotional response to active transportation by running experiments with a high-fidelity virtual-reality simulator that allows controlled dynamic (traffic composition and flow, pedestrian density and flow) and static (infrastructure) conditions. Researchers identified factors associated with positive feelings that can be used to encourage adoption of active transportation as well as stress-inducing conditions that deter potential users. Results from this study are being communicated to the general public as well as policy makers to help perception changes and more effective policy design for both supply-side and demand-side management. Transportation is essentially a demand-driven business. Another opportunity for transportation innovation in CTECH related areas is to develop a demand-driven approach for shared mobility operations with machine learning and math programming methods. The objective of CTECH researchers Xiaopeng Li (USF) and Samitha Samaranayake (Cornell) taking such an approach is to incorporate economic, environment and equity impacts over an entire operational cycle. Both ride-hailing systems (e.g. Lyft) and ride-pooling systems (e.g. UberPool) are investigated. Outcomes from the study include models developed and tested with real-world taxi data including detailed trajectories of vehicles and their loading states at all times.

Transportation, environment, and community health challenges require transdisciplinary approaches that develop large-scale models to promote environmental sustainability, community health, and environmental justice. Integrating land use and transportation policy is widely understood as an efficient approach to meet sustainable transport objectives, yet impacts on residential location preference may limit policy effectiveness. Incorporating the effects on residential location preference is especially important for aligning policy decisions with policy goals. Using travel survey data, matched to block group characteristics, CTECH researcher Oliver Gao worked with his Ph.D. student Christian Sprague on a study to uncover an important constraint: an integrated consumer-driven policy mix can influence households to either a more compact and accessible city or a more sprawled, revenue-generating city. They further estimate the effect of policy decisions on household exposure to road-traffic fatality and noise pollution, greenspace accessibility, and walkability and find significant differences in outcomes depending on the policy decision. By aligning policy with preference, planners can avoid the risk of mismatching policy tools and policy goals. The paper they submitted to Transportation Research Board meeting seeks to align policy with preference by uncovering the influence of residential location preference on motor fuel tax revenue, public transit accessibility, and urban compactness. They discover

that policy changes provoke a reaction in residential location preferences, which leads to contradictions between policy tools and these three policy goals. Aware of these tradeoffs, an integrated policy mix suggests using motor fuel tax and public transit policy to influence households to either a more compact, accessible city or a more sprawled, revenue-generating city. There is an intuition for each of these scenarios: cities with low urban density expect a higher travel cost per capita raising the expected tax revenue and a more compact city can achieve a higher rate of accessibility at a lower operation cost relative to its less dense counterpart.

The findings are important for two reasons. First, they are particularly relevant for land use transportation policymakers. Household preferences do not support concurrent increases in motor fuel user fee (MFT) revenue, transit accessibility, and urban density. Policymakers must define the order of importance for their policy goals and the acceptable level of loss for each outcome. Our simulations illustrate the importance of these decisions ranging from small matters - amenities and comfort - to more significant matters - health and well-being. Second, the findings contribute to an expanded research agenda, one that combines location and travel. By comparing residential location preference, MFT, transit accessibility, and urban density within a single framework, we place the interactions between urban policies at the forefront of analysis. Studying the interactions within policy bundles and their corresponding interactions with households promises to enhance our understanding of the greater urban policy context.