Program Progress Performance Report for University Transportation Centers

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- Project Title**: Center for Transportation, Environment, and Community Health (CTECH)**
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- Recipient Identifying Number: **OSP #79841**
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- Signature of Submitting Official:

Name of Submitting Official: **H. Oliver Gao**	Telephone: 607.254.8334 Email: hg55@cornell.edu
Signature of Submitting Official: 	Date Report Submitted: April 30, 2018

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 heathy 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), has assembled a team of renowned researchers to collaboratively advance these research activities and goals.

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 a summer, pre-college program to attract motivated undergraduates and high school seniors to transportation, particularly from underrepresented groups. Through multi-level, multidisciplinary and institutional collaborations, CTECH is advancing transportation sustainability in its broader human and environmental contexts.

What was accomplished under these goals?

Under the major program goals described in the previous section, CTECH completed the following during the nine-month period from July 1, 2017 to March 31, 2018.

Administrative:

1) Established the Technical Advisory Board (http://ctech.cee.cornell.edu/technical-advisory-board/) and the Student Council Leadership group (http://ctech.cee.cornell.edu/student-council-leadership/) as well as engaged the first three members of our Executive Advisory Board (http://ctech.cee.cornell.edu/advisory-board/).
2) Created a call for proposals for CTECH New Research Initiative Funds (NRIF) for projects to be carried out in years two and three. Twelve projects were funded with $650,000 in award funds (~$1 million with 50% match).
3) Established the CTECH Ph.D. Dissertation Award and solicited applications for 2018. The USF awardee was Natalia Barbour. Her Ph.D. dissertation is on *Understanding Adoption Patterns of Shared Mobility and Its Interaction with Health Perception*.
4) Per the CTECH Data Management Plan, established the initial framework and archived to-date

information using Cornell's Digital Repository, eCommons.

5) Nominated 2017 CUTC Student-of-the Year, Natalia Barbour, who was recognized at the CUTC Awards Dinner on January 6, 2018 in Washington, DC. Director, H. Oliver Gao, Yu Zhang, Lead PI and Ms. Barbour's advisor from USF, and Center Manager, Celia Szczepura-McLean, attended the dinner to support Ms. Barbour!
6) Established the Student Council with approximately 80 post docs, graduate and undergraduate students who are either working on, or interested in, CTECH related research projects to work together in sub-groups at their respective universities to move forward CTECH initiatives.
7) Established a framework with potential options to engage, which we posted on our website and can also use to begin discussions with industrial collaborators.
8) The following individuals (plus nine students noted in addendum) represented CTECH at the TRB Annual Meeting in Washington, DC, January 7-11, 2018: Cornell – H. Oliver Gao, Samitha Samarayanake, and Celia Szczepura-McLean; UTEP – Carlos Chang, Ruey (Kelvin) Cheu, and Wen-Whai Li; UCD – YueYue Fan, Miguel Jaller, and Fraser Shilling; and USF – Robert Bertini, Siwon Jang, Xiaopeng Li, Qing Lu, and Yu Zhang.

Research:

Across the four partner institutions, progress continues on CTECH research projects and publications as summarized below.

Table 1: Research projects.

University	Ongoing Projects	Status
Cornell	Active Transportation, Environment, and Health	Active
Cornell	Aerodynamic Equilibrium and Stability in Ventilation and Air Quality Control of Complex Urban Tunnels	Active
Cornell	Designing Cross-subsidy Mechanisms for Sustainable Multi-modal Transportation Systems	Active
Cornell	Examining Individual Health and Healthcare Utilization Patterns at the Intersection of Transportation, Environment, and Communities	Active
Cornell	Mobility-Aware Integrated Urban Design	Active
Cornell	Redesigning Mass Transit Systems to better integrate with Mobility-on-Demand Systems	Active
Cornell	The Economic and Health Impacts of Subway Construction: evidence from Beijing	Active
UCD	A Study of the Integrated Parking and Ridesharing Pricing/Incentives and their Social and Environmental Impacts in Metropolitan Areas	Active
UCD	Estimating Activity and Health Impacts of First and Last Mile Transit Access Programs for Work and Shopping Trips Using Shared Mobility Services in a Metropolitan Area	Active
UCD	Evaluating the Efficiency and Health Impacts of Next-Generation Transit System Design with Integration of Shared Mobility Services	Active
UCD	Routing Traffic for Community Health: The Case with Safety-Conscious Travelers	Active
UCD	Tracking Shoreline Conditions to Protect Infrastructure	Active
USF	Health Perception on Adoption and Acceptance of Shared Mobility: From Now to Future	Active
USF	Improving Quality of Life for Transportation Disadvantaged Older Adults through Community-Based Healthy Buddy Program	Active
USF	Measuring Impact of Emerging Transportation Technologies on Community Equity in Economy, Environment, and Public Health	Active
USF	Pavement Rehabilitation Policy for Reduced Life-Cycle Cost and Environmental Impact Based on Multiple Pavement Performance Measures	Active
USF	Reducing Airport Pollution and Consequent Health Impacts to Local Community	Active
USF	Spatial Sustainability Assessment of Green Stormwater Infrastructure for Surface Transportation Planning, Phase II	Active
UTEP	Assessing Children's Spatiotemporal Exposures to Transportation Pollutants in Near-Road Communities	Active
UTEP	Characterization of University Parking Systems	Active
UTEP	Smart Sensors to Reduce Pollutant Emissions in Transportation	Active

UTEP	Vulnerable User Road Safety Enhancements for Transportation Management	Active

Table 2: Publications and related presentations.

University	White Papers/Research Papers	Status
Cornell	Optimizing the dynamic switching in fixed and flexible transit services with an idle-vehicle relocation strategy and reductions in emissions	Submitted
Cornell	An approximation queuing problem for designing an intelligent emergency response system to minimize traffic incident impacts	Submitted
Cornell	Ubiquitous air quality monitoring using existing cell-phone tower signals – Science or fiction	Submitted
Cornell	Traffic stability under provision of real-time en-route air pollution information	Submitted
Cornell	A systems approach to carbon policy for fruit supply chains: Carbon-tax, innovation in storage technologies or land-sparing?	Under revision
Cornell	The effects of control technologies, fleet turnover, and electrification on transportation in Houston and its associated air quality, health endpoints, and benefits changes in 2040	Submitted
Cornell	The air quality and health impacts of projected long-haul trucks and rail freight transportation in the United States in 2050	In progress
Cornell	Commercial microwave links as a sustainable sensor network for reconstructing the moisture filed	In submission
Cornell	Saved by the Bell? Cell-Phone Tower Signals can Help Fight Malaria in Africa	In submission
Cornell	Discrete-time system optimal dynamic traffic assignment (SO-DTA) with partial control for horizontal queuing networks	Accepted
Cornell	Computing Shortest-Paths at Scale	In submission
Cornell	The Price of Fragmentation in Mobility-on-Demand Services	In review
Cornell	Urbano: A new tool to promote mobility-aware urban design, active transportation modeling and access analysis for amenities and public transport	Accepted
Cornell	Hybrid Model Predictive Control based Dynamic Tolling of Managed Lanes with Multiple Accesses	Accepted
Cornell	A scalable non-myopic dynamic dial-a-ride and pricing problem for competitive on-demand mobility systems	Accepted
Cornell	Revenue-risk-sharing approaches for public-private partnership provision of highway facilities	Accepted
Cornell	Bayesian Inference for Static Traffic Network Flows with Mobile Sensor Data	Accepted
UTEP	Development of a Comprehensive Metric for Transportation, Environment, and Community Health	In progress
UTEP	Screening of infectious disease among international travelers at airports	In progress 2018 TRB Presentation
UTEP	Comparison of Accessibility to Public Transit Station by Ridesourcing and Its Competitors	In Progress (Master Thesis)
UCD	On-demand Ride-sharing Transit Access Program	In Progress STEPS Symposium Presentation
UCD	Evaluation of mode choice behavioral preferences for ride-sharing in a Metropolitan Area	In Progress
UCD	Modeling ride-sharing using activity-based and agent-based framework	In Progress
UCD	Estimating ride-sharing market share potential in the Bay Area: A Simulation approach	In Progress

UCD	Policy Brief: Using Zero-Emission Vehicles and Other Strategies to Improve Last Mile Deliveries	Submitted
UCD	Policy Brief: Keeping Vehicle Use and Greenhouse Gas Emissions in a Driverless Vehicle World	Submitted
UCD	Shared-Use Mobility Alternatives to Transit in Rural Disadvantaged Areas in the San Joaquin Valley (CS)	In progress
UCD	Opportunities for Shared-Use Mobility Services in the San Joaquin Valley	In progress 2018 TRB Presentation
UCD	Simulation of Ride-sourcing Using Agent-Based Demand and Supply Models Regional: Potential Market Demand for First Mile Transit Travel and Reduction in Vehicle Miles Traveled in the San Francisco Bay Area	In progress 2018 TRB Presentation
UCD	The Morning Commute Problem of Heterogeneous Ridesharing Travelers	In review
UCD	Routing traffic for safer travel	In progress
UCD	Capturing the potential transit demand in a multi-modal network	In progress
USF	Electrical Sharing Vehicles Planning and Operation	In progress
USF	Mobility Patterns and Insights on Free-Floating Bike Sharing Operation	In progress
USF	Hybrid Rebalancing Strategies for Free-Floating Sharing Systems	In progress
USF	Risk-Averse Network Design with Behavioral Conditional Value-at-Risk for Hazardous Materials Transportation	Submitted
USF	A GIS-based framework creating green stormwater infrastructure inventory relevant to surface transportation planning	In progress
USF	Electric Vehicle Sharing Based "Energy Sponge" Service Interfacing Transportation and Power Supply	In progress
USF	An Integrated Framework for Electric Vehicle Relocation and Staff Rebalancing in One-Way Carsharing Systems: Model Formulation and Lagrangian Relaxation-based Solution Approaches	Under revision
USF	Agent-based modeling to estimate exposures to urban air pollution from transportation: exposures disparities and impacts of high-resolution data	Submitted

Engagement:

Engagement activities during the reporting period are summarized in the Tables 3-6 below.

CTECH was proud to host the 2017 "Built Environment and Sustainability" activity as part of the Cornell College of Engineering Diversity Program's CATALYST Academy. 48 dynamic junior and senior high school students participated in this one-week, summer residential program intended to advance diversity in engineering and its related disciplines. In addition to networking and experiencing life on a university campus, these students listened to lectures on different aspects of built environments and then worked on design or discovery-oriented activities. They participated in team activities with students from across the country conducting surveys, experiments and computer simulations on topics of crowding; co-meeting in planning, design and management of transit systems, transportation emissions and monitoring real-time exposure to air pollution; 3-D printing of test plates subject to ballistic impacts; and seismic design and testing. More details are available at http://ctech.cee.cornell.edu/built-environment-sustainability/.

In December 2017, Professor Gao participated the "Look to the future day" event at the DeWitt Middle School in Ithaca, New York and gave a presentation on transportation and public health to eighth graders.

Professor Yu Zhang established a USF Chapter of the Women in Transportation Society (WTS). Their first seminar was held on October 27, 2017. WTS International seeks to promote lifelong careers in transportation—attracting, retaining, and advancing women in the industry. Its vision is to be recognized worldwide as a network of transportation subject matter experts who are organized in chapters of

transportation professionals and university students throughout the United States, Canada, and the United Kingdom, with strategic plans to expand further throughout the globe.

The award is supporting The University of Texas at El Paso's Student Chapter of the Institute of Transportation Engineers (ITE) on a project that is intended to allow students to gain real-world experience using a traffic simulation software. The Chapter was divided into two teams, each team competing to model the best campus evacuation plan using CORSIM simulation software. They assumed an emergency during an event at the UTEP football stadium, the Sun Bowl. The members only have to model one parking lot, due to feasibility and time. Other vehicles enter the system (e.g. RV's to tailgate) and half of all the vehicles leave the campus to head to west El Paso while the other half leave the campus to head to east El Paso. The CTECH $600 will provide the winning team a plaque and monetary prize. The students must prove that their model is better than the other team's model with respect to Transportation, Environment, and Community Health. For Transportation this means the team with the better model/design, which has the last vehicle exiting the system in the least amount of time. For Environment it means the team with the model that has the least amount of $C0_2$ emissions. For Community Health, the team that can prove their model is better than the other team's model with respect to community health will prevail.

In addition, the ITE members developed a Traffic Bowl question bank, which consists of 75 questions based on coursework from Transportation Engineering (undergraduate), Traffic Engineering (graduate), Traffic Simulation (graduate), and Urban Transportation Planning (graduate). Questions were designed so that any student who has taken Transportation Engineering (i.e. all members) could answer a majority of the questions, and the graduate level students would still have difficulty answering the more challenging questions.

CTECH's living lab for transportation innovation is part of a University wide effort towards a carbon-neutral campus, for which transportation/mobility can play an important role. There is an array of exciting initiatives in transportation and mobility that Cornell is taking the lead on at the University and in the surrounding communities in meeting both mobility and sustainability challenges. They were shared at the December 4, 2017 Campus Sustainability Summit - Transportation Workshop (detailed in Table 3).

Professor Michael Zhang has been mentoring a newly formed undergraduate student club on the UC Davis campus, the Autonomous Vehicles Club (8 student members), and supported their activities using his NSF REU grant. The club has developed a prototype autonomous model car and plans to show it in the UC Davis Engineering Design Showcase event. CTECH funds will be used to support further activities of this club in this, and in the next, academic year.

Table 3: Meetings and presentations.

Date	Title	Speaker(s) or Participant	Event /Organization	Location	Stakeholder Group	Attend/ URMs
March 2017	Impacts of transit-oriented growth on air pollutant concentrations and exposures in the Tama Region	Sashikanth Gurram, USF	5th Air Quality Workshop	Gainesville, FL	Academic	
April 2017	Technology Development Trainee Panel Discussion	Alexander Travis, Cornell	American Society of Andrology Annual Meeting	Miami, FL	Academic	
Spring 2017	A One Health/Planetary Health Approach to Public Health in Times of Conflict	Alexander Travis, Cornell	New York Regional American Mock World Health Organization	Ithaca, NY	Academic	

June 2017	Air quality design for sustainable and healthy urban communities	Amy L. Stuart, USF	AEESP Research and Education Conference	Ann Arbor, MI	Academic	
Summer 2017	Food Systems and Health	Alexander Travis, Cornell	Summer session course lecture	Ithaca, NY	Academic	
8/31/17-9/2/17	Atmospheric monitoring using commercial microwave networks	Noan David, Cornell	15th International Conference on Environmental Science and Technology	Rhodes, Greece	Academic	
9/1/17	Introduction of CTECH	Yu Zhang, USF	Transportation Research Seminar	Tampa, FL	Academic	35
9/5/17	Sustainable Freight Transportation Challenges and Opportunities	Miguel Jaller, UCD	Seminar at Chalmers University	Gothenburg, Sweden	Academic, Industrial	
October 2017	Impacts of community design and commute behavior on exposures to traffic-related air pollution	Amy L. Stuart, USF	International Society of Exposure Science, 27th Annual Meeting	Research Triangle Park, NC	Academic	
October 2017	Leading Near and Far: Cornell's Extended Reach in One Health	Alexander Travis, Cornell	Cornell University Trustee-Council Annual Meeting	Ithaca, NY	Academic	
10/23/17	Mobility Pattern Analysis of Free-floating Bike Sharing and Insights on System Operations	Yu Zhang, USF	INFORMS Annual Meeting	Houston, TX	Academic, Public, Industrial	56
10/23/17	Preventative Maintenance and User Pattern Analysis for Free-floating Bike Sharing System	Yu Zhang, USF	INFORMS Annual Meeting	Houston, TX	Academic, Public, Industrial	45
10/23/17	Joint Electric Vehicle Sharing and Vehicle2grid Service System Operations	Dongfang Zhao and Xiaopeng Li, USF	INFORMS Annual Meeting	Houston, TX	Academic, Public, Industrial	20
10/24/17	Dynamic Trip-Vehicle Assignment for Large-Scale On-Demand Micro-Transit	Samitha Samarayanke, Cornell	INFORMS Annual Meeting	Houston, TX	Academic, Public, Industrial	
10/23-24/18	Benders Decomposition for Inventory Routing Problem with perishable products	Faisal Akaabneh, Cornell	INFORMS Annual Meeting	Houston, TX	Academic, Public, Industrial	
10/30/17	Transportation and Health	H. Oliver Gao, Cornell	Public Health Foundation I	Ithaca, NY	Academic	16
11/7/17	Connected Vehicle Pilot Deployment and Smart Columbus	Kate Hartman, USDOT	Smart Cities in a Connected World Forum	Ithaca, NY	Academic, Public, Industrial	63
11/7/17	Social Cost Accounting	H. Oliver Gao, Cornell	Smart Cities in a Connected World Forum	Ithaca, NY	Academic, Public, Industrial	63
11/7/17	Enhancing Urban Mobility with On-Demand Transit Services	Samitha Samarayanke, Cornell	Smart Cities in a Connected World Forum	Ithaca, NY	Academic, Public, Industrial	63
11/16/17	Electric Vehicle Sharing Based "Energy Sponge"	Dongfang Zhao and	5th Annual UTC Conference for the	Gainesville, FL	Academic, Public,	20

	Service Interfacing Transportation & Power Supply	Xiopeng Li, USF	Southeastern Region		Industrial	
11/19/17	Enhancing Urban Mobility with Large-Scale On-Demand Micro-Transit Systems	Samitha Samarayanke, Cornell	3rd NYUAD Transportation Symposium	Abu Dhabi, UAE	Academic	50
12/1/17	Transportation and Public Health	H. Oliver Gao, Cornell	Look to the Future Day, Dewitt Middle School	Ithaca, NY	Academic K-12	10
12/4/17	CTECH Living Laboratory for Mobility Innovation towards Carbon-Neutral Cornell	H. Oliver Gao, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Why Target Transportation?	Jared Hibshman, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Biodiesel Engine Feasibility	Gregory Brumberg and Manisha Kunala, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Electric Vehicle Charging Stations	Srajal Raizada, Apurti Marodia, Srajan Shety, Bakulesh Singh, and Simon Yu, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Electrifying Cornell Fleet	Nilesh Deshpande, Ye Lin Kim, JD Paff, and Daniel Sachs, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Optimization of Cornell EV Rental	Yue Wang, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Mini Electric Shuttle System	Zelin Linghu, Yingqing Chen, Ran Gao, Siran Jia, and Chenxi Yang, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25
12/4/17	Simulation Modeling, and Optimization Tools for Transit Network Design	Robert Gurnee, Cornell	Cornell Campus Sustainability Summit - Transportation Workshop	Ithaca, NY	Academic	25

1/7/18	CTECH Executive Committee Meeting	H. Oliver Gao, Yu Zhang, R. (Kelvin) Cheu, Celia Szczepura-McLean	2018 TRB Annual Meeting	Washington, DC	Academic, Public, Industrial	4
1/8/18	A Spectral Risk Measure in Hazardous Materials Transportation	Liu Su, USF	2018 TRB Annual Meeting	Washington, DC	Academic, Public, Industrial	
1/8/18	Challenges and Opportunities for Automated Trucking	Miguel Jaller, UCD	2018 TRB Annual Meeting	Washington, DC	Academic, Public, Industrial	
1/7-11/18	Dynamic congestion tolling and taxing in large urban regions using the network macroscopic fundamental diagram	Mahyar Amirgholy, Cornell	2018 TRB Annual Meeting	Washington, DC	Academic, Public, Industrial	
1/12/18	From Human Drivers to Robot Cars: Traffic Flow in the Era of Autonomous Vehicles	Michael Zhang, UCD	Invited talk The Irvine Symposium on Emerging Research in Transportation (ISERT)	Irvine, CA	Academic	50
1/14/18	Impact of Autonomous Vehicles on Airport Plan, Design, and Operations	Yuan Wang, USF	2018 TRB Annual Meeting	Washington, DC	Academic, Public, Industrial	32
2/16/18	Modeling Traffic Flow as System of Conservation Laws	Michael Zhang, UCD	Invited talk UC, San Diego	San Diego, CA	Academic	35
2/23/18	Freight System Disruptions: E-commerce, Automation, Electrification, and Shared Mobility	Miguel Jaller, UCD	3 Revolutions Conference	Davis, CA	Academic, Public, Industrial	
3/6/18	4 Revolutions in Freight: E-Commerce, Automation, Electrification & Shared Mobility	Miguel Jaller, UCD	STEPS Seminar	Davis, CA	Academic	
3/19/18	The Impacts of E-commerce, Automation, Electrification, and Shared Mobility in Urban Freight	Miguel Jaller, UCD	Invited Webinar for Iowa State		Academic	
3/21/18	Creating Green Stormwater Infrastructure Inventory	Schreiber, Dylan, USF	USF Graduate Research Symposium	Tampa, FL	Academic	
3/23/18	Creating Green Stormwater Infrastructure Inventory	Xiaofan Xu, USF	AEESP Distinguished Lecture Poster Session	Orlando, FL	Academic	

Table 4: Events/Activities

Date	Event Name	Description	Organizer	Location	Stakeholders	Participants/ URMs
7/16-22/17	CATALYST Academy – Built Environment	A one-week, summer residential program for approximately 50 rising high school juniors and seniors.	CTECH, CEE and DPE	Ithaca, NY	Non-profit, high school	48/34

	and Sustainability					
9/22/17	UTC Site Visit to CTECH	USDOT site visit for the CTECH kickoff meeting	USDOT and CTECH	Ithaca, NY	Federal and Academic	14
10/27/17	Women in Transportation Seminar and Lunching Ceremony, Dr. Sisinnio Concas	The Performance Evaluation and Assessment of the Tampa Connected Vehicle Pilot Deployment	USF	Tampa, FL	Academic and Industry	36
11/30/17	USF Special Seminar, Nikolas Geroliminis	Dynamic clustering, congestion propagation and perimeter control in large-scale urban networks	USF	Tampa, FL	Academic	26
1/8/18	CTECH Community Gathering at 2018 TRB Annual Meeting	Overview of activities to-date to CTECH members	CTECH	Washington, DC	Academic	13

Table 5: Meetings

Date	Purpose and Description	Location
7/11/17	Jon Peterson, Uber, to present research and learn about industry needs	San Francisco, CA
Fall 2017	CTECH Living Lab Bi-weekly meetings with multiple stakeholders (including Cornell Transportation and Delivery Services, Grounds, etc.)	
8/17/17	Dr. Shawn Landry, Director of USF Water Institute for data acquisition	Tampa, FL
9/25/17	FDOT Tampa Bay Next Project Community Workshop Group Meeting	Tampa, FL
10/19/17	Luis Everett & Claudia Garcia, Planners in Sun Metro to discuss how to promote transit among UTEP students	El Paso, TX
1/17/18	Michael Kelley, Vice President of Paso del Norte Health Foundation to introduce CTECH and explore common interest	El Paso, TX
1/17/18	David Erickson, Associate Dean for Research and Graduate Studies, Cornell College of Engineering – to explore possible partnerships and collaborations	Ithaca, NY
1/26/18	California Air Resource Board Policy and Research Dialogue on new mobility and other emerging technologies' impact on VMT and climate change	Sacramento, CA
2/8/18	Multiple stakeholders (TCAT, Hyper Commute, Tompkins County Representative, etc.) to discuss Mobility on Demand (MOD)	Ithaca, NY
2/16/18	Engaged Cornell – to explore possible partnerships and collaborations	Ithaca, NY
2/28/18	Cyclehop Bike Sharing Management Collaboration Discussion	Tampa, FL
3/6/18	Sacramento Regional Transit and Civic Lab - First/Last Mile Roundtable	Sacramento, CA
3/8/18	Way2Go Team Leader, Cornell Cooperative Extension – to build partnerships and collaborations	Ithaca, NY
3/13/18	Didi Chuxing Carpooling Group Potential Collaboration Discussion	Ithaca, NY
3/26/18	Hillsborough County Environmental Protection Commission Potential Collaboration Discussion	Tampa, FL
3/27/18	CSSI Inc. Potential Collaboration Discussion	Tampa, FL

Table 6: Media and Online Engagement Activities

Media and Online Engagement	
Web Page	Expanded website (http://ctech.cee.cornell.edu/).

Videos	The first two project related videos (Cornell and UTEP) and several short videos from the 2018 CATALYST Academy are completed and on the Center's website.
Webinar	CTECH is working on starting a CTECH webinar series
Online Engagement	Three active social media accounts (Facebook, LinkedIn and Twitter) that facilitate the dissemination of research results, news, events, and other important updates; and engage in discussion with policymakers and practitioners who are active on these social media platforms.

Education:

Participation and efforts to influence and enhance the educational programs of consortium universities in the transportation field with respect to environment and community health are detailed below.

Table 7: Curricula enhancements, how and number of students impacted.

Course Name	Description of Contribution	Institution	Number of Students Served
R1 – Public Health Foundations I	H. Oliver Gao gave a guest lecture on transportation, air pollution, and public health.	Cornell	16
Fall 2017 Regional Science, Planning and Policy Analysis Seminar Series	H. Oliver Gao gave a seminar talk on transportation infrastructure and environment systems.	Cornell	50
Fall 2017 CEE 4640/6648: Transportation Systems Design	Dr. Frances Vanek included modules on 1) three dimensions of sustainability: ecology, economy, society, 2) energy efficiency and emissions education benefits of hub-and-spoke networks in freight and passenger transportation, and 3) high-speed rail networks as an environmentally-friendly alternative for intercity travel; introduction to the MOVES emissions model from the USEPA.	Cornell	26
CEE 4620/6620 Analysis and Control of Transportation Systems and Networks	Samitha Samaranayake covers the development and application of mathematical models and optimization techniques for the analysis and control of transportation systems and networks, with a focus on urban mobility. Also being covered are topics related to network routing, dynamic traffic models, static and dynamic traffic assignment, traffic control mechanisms and mobility-on-demand systems (including their connections to mass transit).	Cornell	13
Spring 2018 CEE 3610Transportation Systems Design	Dr. Frances Vanek incorporated modules on 1) overall energy use and emissions from transportation sector in the USA and in other countries, 2) urban mass transit systems (e.g. subways) as an alternative to cars, 3) pricing to reduce congestion on heavily used urban roads, and 4) impact of vehicle design and operating speed on energy consumption and emissions from vehicles.	Cornell	63
VTPMD 6101 Public Health Foundations	Alexander Travis co-founded course and co-organized lectures around the One Health/Planetary Health approach to public health prevention and problem solving. Students build their related competency via investigating a breadth of public health issues including both chronic and infectious disease, and the impact of our environment and climate on disease spread, acquisition, and impact.	Cornell	16
NS2600 Introduction to Global Health	Alexander Travis' Introduction to Global Health analyzes contemporary issues, problems, and controversies from a multi-disciplinary perspective.	Cornell	113
SYSEN 5300 Systems Engineering and Six	H. Oliver Gao and advised six sigma student teams to work on projects to reduce carbon emissions from transportation in the	Cornell	30

Sigma for the Design and Operation of Reliable Systems	Cornell community.		
CE4375 Global Sustainable Engineering & Practice	Entire course is about sustainability.	UTEP & University of Piura (Peru)	30
ECI 251 Travel Demand Analysis	Updated curricula to include findings from the empirical work.	UCD	18
ECI 289H Transportation Planning	Included case studies and preliminary results from the research.	UCD	10
COSMOS	This is a new course designed to teach high-school students on the topic of sustainable transportation systems. It will include the topics and findings from the research.	UCD	30
ECI 161 Transportation Systems Operations	Updated curricula to include CTECH research outcomes in transportation planning.	UCD	125
Transportation Engineering II	Incorporated CTECH research outcomes into the course content and enhanced materials on sustainable transportation and the correlation between transportation and community health.	USF	75
Sustainable Transportation	Incorporated CTECH research outcomes into the course content and enhanced materials on sustainable transportation.	USF	34

In addition, Professor Gao also helped Professor Yiye Zhang from Weill Cornell Medical in advising a student team project on Data-driven Optimization of Order Sets Within an Electronic Health Record System.

How have the results been disseminated?
Completed research activities (Table 12) have been summarized in final reports submitted to TRID. Engagement activities listed above provided a platform to disseminate research from consortium members. Also, news items are posted regularly on the website at http://ctech.cee.cornell.edu/news/.

What do you plan to do during the next reporting period to accomplish the goals?
We plan to continue to move the Center forward during the next reporting period as summarized below.

Administrative:

1) Facilitate an internal call for the year 3 NRIF project proposals and make award decisions. The solicitation will aim to stimulate innovative, impactful, interdisciplinary research at consortium universities, encouraging cross-university and/or external partner collaborations.
2) Internal call for Ph.D. Dissertation Awards, a competitive process with one possible for each of the four partner institutions.
3) Facilitate the Annual Meeting and Poster Session to be held October 7, 2018 in Davis, California, a day of presentations followed by a poster session where researchers can showcase their work.
4) Annual Meeting of the Executive and Technical Advisory Boards to take place on October 8, 2018, after members have attended the Annual Meeting and Poster Session.
5) The Executive Committee will work with the members to nominate a graduate student in transportation for the CUTC Student-of-the-Year Award.
6) Develop a survey that can be used to gauge satisfaction of program participants.
7) Create a competitive process by which participants in the CURIE Academy can apply for the following year's CTECH REU opportunity.

Research:
Researchers at each of the consortium universities will continue work on active projects and publications (see Tables 1 and 2). Research projects will involve graduate students, providing them with hands-on opportunities to engage in interdisciplinary and cutting-edge research. The Executive Committee members will monitor ongoing projects at each of their respective institutions to ensure they are progressing on schedule with products and results delivered. We expect most of these projects will yield results that can be disseminated via regular journal publications, meeting presentations, and other channels during future reporting periods.

Engagement:
One student from the 2017 CATALYST Academy was invited back to be the 2018 CTECH Research Experience for Undergraduate Program. She will spend ten weeks this summer working on a transportation related project culminating with a written report and presentation, while also participating in a Cornell campus wide program for hundreds of high school students here to gain exposure to various research topics, learn how to carry out a research project from start to finish, develop professionally, and hopefully benefit from the experience of being on a college campus. The goals are to help acclimate the soon-to-be undergraduate to a college environment, expose the research side of academia, provide tools for future academic success, and to spark an interest in research and the pursuit of and advanced degree.

From July 15-21, 2018, we will host the 2018 CURIE Academy, a one-week, residential program for approximately 50 rising junior and senior high school females. Participants will listen to lectures, participate in team activities, and engage in experiments and computer simulations on topics related to Smart and Healthy Cities. They will learn how urban infrastructure provides critical services for the health, economic well-being, and security of modern communities, and represents one of the defining characteristics of the modern world. Also, that sacrificing environmental quality and public health for urban infrastructure is simply not feasible. The convergence of several trends and technologies, ranging from internet of things (IoT), new mobility services enabled by advances in information technology and the cloud, to connected and automated electric vehicles, to millennials' attitudinal changes towards auto travel (solo driving in particular) will expose them to new openings for innovations that address the livability challenges of people without further degrading the environment and public health. These students will learn that Smart and Healthy Cities are emerging on the horizon with urban innovation, technology advancement, and new demographic trends.

In Summer 2018, UTEP faculty and students will participate in the EXCITE program. This is an outreach effort organized by the College of Engineering to introduce engineering to 150-300 high school students in El Paso, Texas. These students will be invited to tour laboratories and to participate in hands-on experiments. CTECH faculty and researchers will be part of the program to introduce the field of transportation engineering and how it relates to the environment and community health.

Table 8: Upcoming Presentations

Date	Title	Speaker(s)	Event/Organization	Type	Location
4/11/18	From Transportation to Air Pollution and Public Health – Are we doing the right thing, and doing it right?	H. Oliver Gao, Cornell	OST-R Transportation Innovation Speaker Series (Webinar)	Federal (Academic, Government, Industry)	Washington, DC
4/25/18	System Challenges and Innovation in Urban Infrastructure for Healthy Living in Smart Cities	H. Oliver Gao, Cornell	Panel discussion: "Challenges & Opportunities in American Infrastructure:	Academic, Government, Industry	New York City, NY

			Technology, Resilience, Funding & Finance"		
4/27/18	Improving urban mobility with transit centric on-demand services	Samitha Samaranayake, Cornell	MIT Transit Group	Academic	Cambridge, MA
6/11-15/18	Improving urban mobility with transit centric on-demand services	Samitha Samaranayake, Cornell	NSF Institute for Pure and Applied Mathematics (UCLA)	Academic	Lake Arrowhead, CA
6/18/18	Public-private partnership in infrastructure finance towards sustainable transportation	H. Oliver Gao, Cornell	2018 World Transport Convention	International	Beijing, China
6/27-29/18	Ventilation Control in Complex Tunnels with Distributed Vents	Zhen Tan, Cornell	2018 American Control Conference	Academic	Milwaukee, MN
7/1/18	Imprudent Infrastructure Policy as Grounds for Concern for Public Health	H. Oliver Gao, Cornell	12th IACP Conference	International	Xi'an, China
7/6/18	Modeling PPP with optimal mechanism design in multi-leader-multi-follower (MLMF) Stackelberg game	H. Oliver Gao, Cornell	18th COTA International Conference of Transportation Professionals	International	Beijing, China
7/20/18	Dan McFadden's Impact on Transport Research	Ricardo Daziano, Cornell	Workshop in honor of Daniel McFadden, UC Santa Barbara	Academic	Santa Barbara, CA

Table 9: Upcoming Events/Activities

Date	Event Name	Description	Organizer	Location
4/13/18	Round Table Discussion: Elise Miller-Hooks	How to Write CAREER and other NSF proposals?	USF	Tampa, FL
4/13/18	USF Transportation Research Seminar: Elise Miller-Hooks	Multi-Hazard Resilience Quantification in Transportation Systems and the Societal Functions they Support	USF	Tampa, FL
4/19/18	CTECH Seminar	Optimus Technologies founder and CEO, Colin Huwyler	Cornell	Ithaca, NY
4/19/18	CUTR Transportation Research Seminar	Lesley Ross, Associate Professor, Pennsylvania State University, Maintaining Safe Driving Mobility for Older Adults	USF	Tampa, FL
4/20/18	Florida Airport Council	FAC USF Student Chapter Lunching Ceremony	USF	Tampa, FL
4/20/18	USF Transportation Seminar: Lisa Waters	Florida Airports Status and Trends	USF	Tampa, FL
June 2018	Study Abroad Global & Sustainable Engineering	UTEP will host undergraduates from Piura, Peru for 10 days (field trips and team project), then the participating UTEP students will travel to Piura for a similar experience.	UTEP	El Paso, TX and Piura, Peru

7/15/18-7/20/18	The CURIE Academy – Smart and Healthy Cities	A one-week, summer residential program for approximately 50 rising high school juniors and senior females.	Cornell	Ithaca, NY
10/7/18	CTECH Annual Meeting	First Annual CTECH stakeholder meeting to share research accomplishments and strengthen the community among members from four partner institutions	CTECH	Davis, CA
10/7/18	CTECH Annual Meeting Poster Session	Poster session to showcase research efforts during CTECH Annual Meeting	CTECH	Davis, CA

Table 10: Upcoming Meetings

Date	Purpose and Description	Location
4/2/18	FDOT Systems Implementation Office Discussion (Teleconference)	Tampa, FL
5/7-11/18	International Society for Gerontechnology's 11th World Conference of Gerontechnology to establish network with community partners for research project	St. Petersburg, FL
5/29/18	Uber Intelligent Dispatch Group potential collaboration	San Francisco, CA
6/4-6/18	CUTC Conference	Minneapolis, MN
Summer 2018	Tampa Bay Next Project Drainage Consultant potential collaboration	Tampa, FL
Summer 2018	Stormwater Management Municipal Officials to discuss data availability	Tampa, FL
10/8/18	CTECH Advisory Board Meetings	Davis, CA

Table 11: Planned Media and Online Engagement Activities

Media and Online Engagement	
Web Page	We will continue to keep the CTECH website current and include content submitted by all four partner institutions.
Videos	CTECH plans to continue to develop short project videos for engagement with our community and the general public.
Webinar	CTECH is working on starting a CTECH webinar series.
Online Engagement	Cornell will continue to manage and track CTECH's three social media accounts.

In addition to presentations described above, CTECH Cornell will co-organize CEE seminars and systems engineering seminars. CTECH USF will co-organize Transportation Research Seminars at USF.

Education:

CTECH faculty will work on influencing course curriculum to strengthen the educational programs of consortium universities for preparing next-generation transportation professionals, while inspiring, advising and supporting students in pursuing transportation engineering or related careers. In addition, they will continue and expand workforce development efforts geared to practice professionals, educating current practitioners to be responsive to rapid changes in the transportation field with respect to environment and community health.

The newly developed Student Council group is made up of post docs, graduate and undergraduate students engaged in, or interested in, the Center's research projects, outreach, and dissemination of impacts. Objectives of the group include:

- Institutional and cross institutional networking;
- Finding similar and/or related interests and potential research collaborations;

- Career/professional development;
- Development and delivery of materials for outreach and impact dissemination;
- Poster symposium and annual meeting participation; and
- Seminar/webinar series participation (currently in the planning stage).

Each of the four partner universities has elected a representative to serve as their institution's lead. They will work together to plan, develop, and coordinate activities under the advisement of Professor Yu Zhang, USF. She encourages council members to actively participate in center activities, to be innovative and engaged not only in research, but in leadership and educational outreach.

Co-curricular activities such as industry mentorship programs and seminar series in conjunction with active student chapters of professional organizations provide students with a well-rounded educational experience. Consortium universities currently offer various transportation research seminars covering a wide spectrum of research topics in transportation, environment/energy, and health systems. For instance, Cornell hosts the Ezra Systems Seminar Series, which includes transportation, environment, and health topics research. Transportation-related student chapters at consortium institutes include American Society of Civil Engineer (ASCE), Institute of Transportation Engineers (ITE), Women Transportation Seminar (WTS) and Texas PE, International Council on Systems Engineering (INCOSE), and Engineers for a Sustainable World (ESW). We will continue in co-curricular efforts for education and engagement. The grant will continue to support student chapters of professional organizations and industry mentorship programs to facilitate the connections between students and transportation industry professionals. In these activities, we will make outreach efforts to help attract new entrants and minorities into the transportation field, sustain minorities such as Latinos and females in such programs, and encourage students to pursue transportation as their future career.

In addition to outreach/engagement, the summer CURIE Academy also serves as an interdisciplinary pre-college program. Activities will include classroom discussion and field explorations led by faculty and professionals sharing content on specific topics related to Smart and Healthy Cities.

USF will continue with its industry mentorship program and we continue to invite industry partners to the other three institutions to mentor graduate student research by offering comments and suggestions from a practitioner's point of view, and by providing data or other information. Students benefit from working closely with both a major advisor and a transportation industry mentor. Volunteers from local transportation industry companies and government agencies are encouraged to engage in this joint educational opportunity.

In June 2018, UTEP will host 15 undergraduate students from University of Piura, Peru for 10 days for the study abroad program Global & Sustainable Engineering. They will attend class with 15 UTEP students, go on field trips (e.g., transit company) and do a team project with UTEP students. Then, UTEP students will travel to Peru for similar activities on Piura's campus.

2. PRODUCTS

Products from CTECH members during the reporting period are listed below.

Table 12: Research projects.

University	Completed Projects	Status
USF	A Life Cycle Assessment for Pavement Maintenance and Rehabilitation Technologies	Completed
USF	Analysis of Free-Floating Bike Sharing and Insights on System Operations	Completed
USF	Electric Vehicle Sharing Planning and Operations	Completed
USF	Impacts of Transit-Oriented Compact-Growth on Air Pollutant Concentrations and Exposures in the Tampa Region	Completed

Cornell	Optimal Ventilation Control in Complex Urban Tunnels with Multi-Point Pollutant Discharge	Completed
UTEP	Development of a Comprehensive Metric to Evaluate the Impacts of Transportation-Environment on Community Health	Completed
USF	Regulating Hazardous-materials Transportation with Behavioral Modeling of Drivers	Completed
USF	Spatial Sustainability Assessment of Green Stormwater Infrastructure for Surface Transportation Planning, Phase I	Completed

- Journal publications
  1. Beheshtiana, A., K.P. Donaghy, R. Geddes, H.O. Gao (2018). Climate-adaptive planning for the long-term resilience of transportation energy infrastructure, Transportation Research Part E, Volume 113, Pages 99-122, https://doi.org/10.1016/j.tre.2018.02.009.
  2. Xie, Y., Zhao. L., Xue, J., Gao, H.O., Li, H., Jiang, R., Qiu, X., Zhang, S. (2018). Methods for defining the scopes and priorities for joint prevention and control of air pollution regions based on datamining technologies, Journal of Cleaner Production, https://doi.org/10.1016/j.jclepro.2018.03.101.
  3. Heo, J., P. J. Adams, H.O. Gao, (2017). Public health costs accounting of inorganic $PM_{2.5}$ pollution in metropolitan areas of the United States using a risk-based source-receptor model, Environment International 106 119–126, https://doi.org/10.1016/j.envint.2017.06.006.
  4. Amirgholy, M., H.O. Gao (2017). Modeling dynamics of congestion in urban networks using macroscopic fundamental diagram: user equilibrium, system optimum, and pricing strategies, Transportation Research Part B: Methodology, Volume 104, October 2017, 215-237, https://doi.org/10.1016/j.trb.2017.07.006.
  5. Tan, Z., H.O. Gao (2017). Optimizing Vents Layout and Configuration of Complex Urban Tunnels for Air Quality Control, IEEE Transactions on Control Systems Technology, Volume: 26 Issue: 1, 368-376, https://doi.org/10.1109/TCST.2016.2646326.
  6. Amirgholy, M., M. Shahabi, H.O. Gao (2017). Optimal design of sustainable transit systems in congested urban networks: A macroscopic approach, Transportation Research Part E: Logistics and Transportation Review 103 261–285, https://doi.org/10.1016/j.tre.2017.03.006.
  7. Zhao, L., J. Wang, H.O. Gao, Y. Xie, R. Jiang, Q. Hu, Y. Sun (2017). Evaluation of particulate matter concentration in Shanghai's metro system and strategy for improvement, Transportation Research Part D: Transport and Environment, 53 (2017) 115–127, https://doi.org/10.1016/j.trd.2017.04.010.
  8. Shao, Zeng-Zhen, Zu-Jun Ma, Jiuh-Biing Sheu, H.O. Gao (2017). Evaluation of large-scale transnational high-speed railway construction priority in the belt and road region, Transportation Research Part E: Logistics and Transportation Review, https://doi.org/10.1016/j.tre.2017.07.007.
  9. David, N. and H.O. Gao (2017). The potential of existing cellular networks for detecting the precursors of fog, Journal of Geophysical Research: Atmospheres, 123, https://doi.org/10.1002/2017JD027360.
  10. Amirgholy, M.P., M. Shahabi, H.O. Gao (2017). An Advanced Traveler Navigation System Adapted to Route Choice Preferences of the Individual Users, International Journal of Transportation Science and Technology, Volume 6, Issue 4, 240-254, https://doi.org/10.1016/j.ijtst.2017.10.001.
  11. Sayarshad, H.P, H. O. Gao (2017). A non-myopic dynamic inventory routing and pricing problem, Transportation Research Part E: Logistics and Transportation Review, Volume 109, 83-98, https://doi.org/10.1016/j.tre.2017.11.005.
  12. Beheshtiana, A., K.P. Donaghy, H.O. Gao, S. Safaied, and R. Geddes (2017). Impacts and implications of climatic extremes for resilience planning of transportation energy: A case study of New York City, Journal of Cleaner Production, Available online 10 November 2017, https://doi.org/10.1016/j.jclepro.2017.11.039.
- Books or other non-periodical, one-time publications
  1. Tan, Z., H.O. Gao (2018). Ventilation Control in Complex Tunnels with Distributed Vents. Proceedings of 2018 American Control Conference
  2. David, N. and H.O. Gao (2017). Atmospheric monitoring using commercial microwave networks (A review paper). Proceedings of the 15th International Conference on Environmental Science and Technology (CEST). Rhodes, Greece, August 31-September 2, 2017.
- Website(s) or other Internet site(s)
  1. CTECH archives at https://ecommons.cornell.edu/handle/1813/56097.
- Other Products

1. S. Gurram. Understanding the linkages between urban transportation design and population exposure to traffic-related air pollution: application of an integrated transportation and air pollution modeling framework to Tampa, FL. Ph.D. dissertation, University of South Florida. December 2017.

3. PARTICIPANTS & COLLABORATING ORGANIZATIONS

There are a variety of ways for external entities to engage with CTECH to advance the development and deployment of research and technologies and they are posted on our website at http://ctech.cee.cornell.edu/consortium-opportunities/. To-date we have affiliations with the organizations listed in Table 13.

Table 13: Partner and Collaborating Organizations.

Organization	Location	Contribution to CTECH
AAA Foundation for Traffic Safety	Washington, DC	Advisory Board Member
California Air Resources Board (CARB)	Sacramento, CA	Collaborative research
Caltrans	Sacramento, CA	Advisory Board Member and matching financial support
Center for Connected and Automated Transportation	West Lafayette, IN	Advisory Board Member
Center for Teaching Old Models New Tricks	Phoenix, AZ	Collaborative research
Center for Urban Transportation Research	Tampa, FL	Director, Robert Bertini, is also a CTECH faculty researcher
Cornell Institute for China Economic Research	Ithaca, NY	Collaborative research
Cyclehop	Tampa, FL	Collaborative research
El Paso Metropolitan Planning Organization	El Paso, TX	Provide planning data for research
Florida Department of Transportation	Tampa, FL	Advisory Board Member
Freight Mobility Research Institute (FMRI)	Boca Raton, FL	Collaborative research
KPF	New York, NY	Collaborative research and matching financial support
National Center for Sustainable Transportation	Davis, CA	Director, Susan Handy, is also a CTECH faculty researcher
Nspiregreen, LLC	Washington, DC	Advisory Board Member
Sonoma Technology Institute	Petaluma, CA	Advisory Board Member
Sun Metro	El Paso, TX	Provide transit data for research
Texas DOT	El Paso, TX	Provide data, advice on professional practice
Tompkins Consolidated Area Transit (TCAT)	Ithaca, NY	Collaborative research
Traffic Management Center of City of Tampa	Tampa, FL	Collaborative research
Uber	San Francisco, CA	Provide data for research
University of Florida Transportation Institute	Gainesville, FL	Advisory Board Member
Weill Cornell Medical	New York, NY	Collaborative research and financial support

We continue to seek opportunities for meetings, visits, web conferences, etc. to develop relationships with external collaborators, including partnerships with public and private organizations including State DOTs, metropolitan planning organizations (MPOs), other public-sector organizations at all levels of government, non-profit institutions, technical and practitioner organizations, and industry partners.

4. IMPACT

Transportation that sacrifices environmental quality and public health is simply untenable. 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. Focused on FAST Act's priority area of Preserving the Environment, CTECH will use its fundamental research activities as the driving force to create downstream innovations, practices, and to spur an education program for workforce development. Even in its initial stage, CTECH is already showing its impact on the development of the principal discipline(s) as a unique platform for synergistic and multidisciplinary research and education in the nexus of Transportation, Environment, and Community Health, defining and advancing clear broad impacts to meet global challenges.

What is the impact on the development of the principal discipline(s) of the program?
CTECH is an interdisciplinary consortium involving faculty from engineering, urban planning, environmental science, and social science. Our research program, as organized by interlocking thrusts through interactive structures, promotes cross-fertilizations of ideas inside and outside of the transportation research discipline.

What is the impact on other disciplines?
Research and education thrust one on "Behavior, Active Transportation, the Built Environment, and Health" links travel behavior, active transportation and the built environment to community health. Primary goals are to: (a) identify the multiple factors that motivate travelers to choose transportation modes that promote healthy lifestyles; and (b) characterize the benefits of active transportation toward good health. One current project investigates the factors that explain demand for active transportation, including non-instrumental attributes and non-standard observed attributes, and extended decision rules. Data and methods developed in such studies are expected to also have significant implication for economic choice models, city and regional planning, cognitive science, and social psychology.

Research and education thrust two on "New Transportation Technologies and Business Models" links Mobility-on-Demand (MoD) transportation, environment to community health. MoD systems refer to transportation modes that provide service to customers as requested, such as car sharing, bike sharing, and dynamic ridesharing (e.g., Uber and Lyft). The business is created by the demand for personal mobility, and the supply is enabled by a host of vehicle and infrastructure technologies such as Big Data Analytics, smartphones and social media. In this thrust, researchers will: (a) first conduct research on optimizing the operation of selected MoD systems. To achieve this goal, researchers will use Big Data Analytics to improve business plans, applying vehicle routing, facility location and network design models to maximize service to customers; (b) and then evaluate the systems operations on key performance indicators for environmental sustainability and relate them to known public health improvements. To take this a step further, researchers will later incorporate public health externalities in the optimization of MoD system operations. Insights into how MoD systems can improve environmental sustainability and public health will enable urban policy makers to make informed decisions on what business incentives to provide to MoD operators. Outcomes from this thrust are expected to contribute to disciplines such as environmental science, operations research, computational optimization, and the emerging data science, as are outcomes from thrust five, "Data-Driven Transportation-Health Informatics".

What is the impact on the development of transportation workforce development?
CTECH's mission is to pursue research and innovation to support sustainable mobility of people and goods while preserving the environment and improving community health. While traditional training and development of the transportation workforce helps prepare professionals well to cope with traditional transportation problems, the exposure and training of the transportation workforce on the aspects of environment and community health has been lacking. Through the research, education, and engagement activities reported, we are enabling 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.

Our education and workforce building effort trains students and professionals on the findings and insights of the research, as well as the tools used, lessons learned, and best practices. CTECH encourages, inspires and supports students to pursue transportation engineering or related careers through a comprehensive education program. For example, Ankur Mather, a recent Cornell M.S. graduate from Transportation Systems Engineering advised by H. Oliver Gao, finished his M.S. thesis on Sustainability and Resilience of Transportation Networks and joined Cintra in Austin, Texas in November 2017.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?
The Center has drawn increased awareness of, and has created physical, institutional, and information resources/opportunities for, a transportation, environment, and community health systems approach to add value across different levels to all partner institutions and collaborators. At Cornell, for instance, we are becoming a major force driving research, education, and engagement for sustainable means of campus transportation to improve campus environment, lessen environmental degradation, and keep the campus free of exhaust fumes, congestion, and energy waste.

What is the impact on technology transfer?
None to report.

What is the impact on society beyond science and technology?
The integrative research and education of CTECH, as evidenced by outcomes reported, is expected to create a continuous stream of knowledge and information to support systems-wide decisions in transportation-environment-health management. For example, new air quality regulations are expected to cost over $6.5 billion per year and potentially save $120 billion in health-related expenses. Ultimately, CTECH work will contribute to improved community health and sustainable transportation through the development of more scientifically sound and operationally feasible/cost-effective strategies, and through the education of qualified professionals that can become leaders in creating innovative solutions for harmonized built and natural environments. Given that transportation and environmental problems are tenacious and pervasive across the world, CTECH's study framework and methodologies could be applied to other countries via international collaborations.

5. CHANGES/PROBLEMS

Initially, we proposed designing and developing summer and online courses. We have since learned that we can have broader and greater impacts if we create content for existing courses that influence and strengthen existing educational programs at each of the consortium universities. This will provide more opportunity to engage and prepare next-generation transportation professionals, and educate current practitioners to be responsive to rapid changes in the transportation field with respect to environment and community health.

6. SPECIAL REPORTING REQUIREMENTS

Data Management Plan: http://ctech.cee.cornell.edu/data-management-and-sharing-plan/
Website: http://ctech.cee.cornell.edu/
Directory of Key Personnel: http://ctech.cee.cornell.edu/people/
Financial and Annual Share Reports: The SF425 requirements will be met by separate report.
Research Project Descriptions: http://ctech.cee.cornell.edu/projects/
CTECH Specific Metrics: In attached addendum.

CTECH Addendum

Reporting Period End Date: March 31, 2018

CTECH specific performance indicators, not included in the standardized PPPR (UTC-wide), are provided in this addendum.

1) 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. A summary of progress on these initiatives during the reporting period is below.

The title of one of the first year projects (UTEP) was Development of a Comprehensive Metric for Transportation, Environment, and Community Health. The goal of the research was to find out the existing and known relationships between transportation, environment, and community health and to develop a comprehensive metric for engineers, planners and any other decision makers to evaluate the environment and community health impacts of a proposed transportation project. For example, vehicles produce emissions, which causes air pollution. Consequently, it has negative effects on human health. Also, traffic congestion creates stress and fatigue for travelers, which make problems for the well-being of the community. To develop such a metric, we needed to answer questions such as:

- What is transportation? What is environment? What is community health?
- What are the criteria of transportation, environment and community health?
- What are the indicators of each of the criteria?
- What are the relationships between criteria?

After we answered the questions above, we used a concept map, which is a graphical presentation to visualize the criteria, indicators and the relationships. Then we had interviews with different stakeholders like Texas Department of Transportation, El Paso district, MPO and City of El Paso to get their feedback and opinions about the metric and then we revised the metric based on the feedback. We have also interviewed staff at the Paso del Norte Health Foundation to seek their inputs. At the end of the project, we applied the revised metric and concept map for two case studies to show how it works, for different types of transportation projects, one on adding lanes to an existing highway and the second one implementing a new bus rapid transit line.

Another first year project (USF) as an example of mobility models promoting sustainability and health was to analyze the mobility patterns of free-floating bike sharing and provide insights on bike sharing system operation. Bike sharing is a non-motorized sustainable mode. It helps solve the first-mile-last-mile problem of public transit. It attracts people from driving in very short distance travel, e.g. trips from one building to another on campus. USF launched a bike sharing program in 2015, under the lead of Dr. Yu Zhang, CTECH PI at USF, collaborating with Social Bicycles. This is different from other programs in that the university campus recreational center, the department of parking and transportation, and the IT office are all heavily involved. The operation and management of the bike sharing is taken care of internally instead of being outsourced to bike sharing management consulting company. Such a program provides opportunities for students to get familiar with bike sharing systems and provide data and a test bed for their research. The research project was to apply data analytical techniques to analyze historical data to understand how different factors influence the borrow, return, and imbalance of the bike sharing system, e.g. weather, holidays, month of year, day of week, and time of day, etc. The project also proposes a predicative model for forecasting bike sharing demand. The outcomes provide inputs for bike sharing operational management, e.g. where to locate hubs to encourage users to return the bikes to? How to handle the rebalancing of the bikes to improve the level of service of the program? After obtaining the

outcomes, we met with Cyclehop, the bike sharing consulting company that manages the Tampa Bay Coast bike sharing program, and shared the findings with them. Cyclehop agreed on sharing the data so we can apply the same research methodology to help them improve larger scale bike sharing programs.

In addition, separately, a (Cornell) CTECH Ph.D. student, Juan Carlos Martinez Mori, has been developing a model for solving the dynamic bus station allocation problem for on-demand transit services. From a theoretical perspective, this leads to a problem that can be classified as an "online set cover problem with batch processing." Carlos has developed a new primal dual solution approach to this problem that improves on using the standard techniques from the computer science literature. A paper on the theoretical aspects of this work is currently being written and will be submitted during the summer. Carlos is also working on a more practical evaluation of these methods via simulations using real world data. A second publication is planned that will be based on the practical assessment of these methods. The goal of this work is to enable efficient high-capacity sharing systems that will reduce the vehicle miles travelled, and therefore the resulting negative externalities such as emissions, from more standard ridesharing systems like UberX and Lyft.

2) General indicators of progress:

Table 1: Members serving on boards, as editors, on national committees during the reporting period.

Commitment Date Range	Role	CTECH Member	Organization
1/2017-12/2017	Co Editor-in-Chief, Transportation Research Part D	H. Oliver Gao, Cornell	Elsevier
11/2017-11/2018	Cluster Chair for National Meeting 2018 in Phoenix, Arizona	Samitha Samarayanake, Cornell	INFORMS TSL
1/2016-12/2018	Editor-in-Chief	R. (Kelvin) Cheu, UTEP	International Journal of Transportation Science & Technology
2/2107 – 1/2020	Member	R. (Kelvin) Cheu, UTEP	TRB Committee on Artificial Intelligence and Advanced Computing Applications
2/2018-1/2021	Member	R. (Kelvin) Cheu, UTEP	TRB Committee on International Co-operations
2006-present	Member, Editorial Advisory Board	R. (Kelvin) Cheu, UTEP	Journal of Intelligent Transportation Systems
2018-2021	Member	Ricardo Daziano, Cornell	TRB ADB40 Committee (Transportation Demand Forecasting)
2018-2021	Elected Regular Board Member	Ricardo Daziano, Cornell	International Association for Travel Behaviour Research (IATBR)
2018-2021	Member, North American Chapter	Ricardo Daziano, Cornell	International Steering Committee for Travel Survey Conferences (ISCTSC)
2017-2018	Guest Editor	Ricardo Daziano, Cornell	Journal of Choice Modeling for a special issue on estimation of complex models
1998-present	Member	Michael Zhang, UCD	TRB AHB45 Committee (Traffic Flow Theory and Characteristics)

2015-present	Member	Michael Zhang, UCD	International Advisory Committee International Symposium of Transportation and Traffic Theory
2003-present	Associate Editor	Michael Zhang, UCD	Transportation Research, Part B
2000-present	Area Editor	Michael Zhang, UCD	Networks and Spatial Economics (NETS)
2013-present	Associate Editor	Michael Zhang, UCD	Transportmetrica A: Transport Science
2016-present	Associate Editor	Michael Zhang, UCD	Transportation Science
2017-2020	Member	Miguel Jaller, UCD	TRB ABJ40 Committee (Travel Survey Methods)
2017-2019	Chair	Miguel Jaller, UCD	TRB ABJ40(2) Subcommittee (Freight Surveys)
2014-present	Member	Miguel Jaller, UCD	TRB AT025 Committee (Urban Freight Transportation)
2011-2017	Chair	Caroline Rodier, UCD	TRB Emerging and Innovative Public Transport and Technologies
2017-2018	Executive Member	Yueyue Fan, UCD	TRB Network Modeling Committee
4/2018-4/2021	Chair	Yu Zhang, USF	Transportation Research Board Standing Committee on Airfield and Airspace Capacity (AV060)
3/2018-present	Editorial Board	Yu Zhang, USF	International Journal of Sustainable Transportation
7/2014-present	Editorial Board	Yu Zhang, USF	Transportation Research Part C: Emerging Technologies
10/2016-present	Editorial Board	Yu Zhang, USF	International Journal of Transportation Science & Technology
1/2017-1/2018	President	Yu Zhang, USF	Chinese Overseas Transportation Association (COTA)
1/2018-1/2020	Immediate Past President	Yu Zhang, USF	Chinese Overseas Transportation Association (COTA)
10/2017-9/2019	Vice-Chair	Changhyun Kwon, USF	Urban Transportation Planning and Modeling SIG of the INFORMS Transportation Science and Logistics Society
4/2015-4/2021	Member	Changhyun Kwon, USF	Transportation Research Board Standing Committee Transportation Network Modeling Committee (ADB30)
6/2013-present	Member	Amy Stuart, USF	Lectures Committee, Association of Environmental Engineering and Science Professors
2/2018-present	Task Force Member	Qiong Zhang, USF	American Academy of Environmental Engineers and Scientists (AAEES)
2/2018-present	Task Force Member	Qiong Zhang, USF	Association of Environmental Engineering and Science Professors (AEESP)
10/2016-present	Member	Qing Lu, USF	EMI Mechanics of Pavements Committee, American Society of Civil Engineers (ASCE)
1/2017-present	Editorial Board	Qing Lu, USF	Transportation Research Part D
4/2015-present	Member	Qing Lu, USF	Transportation Research Board Standing Committee on Pavement Surface Properties and Vehicle Interaction (AFD90)

4/2014-present	Member	Xiaopeng Li, USF	Transportation Research Board Standing Committee on Transportation Network Modeling Committee (ADB30)
4/2014-present	Member	Xiaopeng Li, USF	Transportation Research Board Standing Committee on Traffic Flow Theory and Characteristics (AHB45)
4/2016-4/2019	Chair	Robert Bertini, USF	Transportation Research Board (TRB) Operations Section (AHB00)
1/2017-12/2019	Member	Robert Bertini, USF	Board of Governors of the IEEE Intelligent Transportation Systems Society
2013-present	Founding Editor and Editor-in-Chief	Fred Mannering, USF	Analytic Methods in Accident Research
2013-present	Editorial Advisory Board	Fred Mannering, USF	Accident Analysis and Prevention
2013-present	Editorial Advisory Board	Fred Mannering, USF	Transportation Research Part C: Emerging Technologies

Table 2: Supported students that have been hired into their first, post-undergraduate or graduate, employment positions during the reporting period.

Student Name	Degree Conferred	First Post-degree Employer
Nothing to report.		

Table 3: Supported students that attended conferences.

Student Name	Conference	Location	Institution
Mayra Chavez	2018 TRB Annual Meeting	Washington, DC	UTEP
Matthew Vechione	ITE Texas District Spring 2017 Meeting	Frisco, TX	UTEP
Zhen Tan	2018 TRB Annual Meeting	Washington, DC	Cornell
Juan Carlos Martinez Mori	2018 TRB Annual Meeting	Washington, DC	Cornell
Juan Carlos Martinez Mori	2018 Shared Mobility Summit	Chicago, IL	Cornell
Natalia Barbour	2018 TRB Annual Meeting	Washington, DC	USF
Yuan Wang	2018 TRB Annual Meeting	Washington DC	USF
Hualong Tang	2018 TRB Annual Meeting	Washington DC	USF
Zhiqiang Wu	2018 TRB Annual Meeting	Washington DC	USF
Aritra Pal	INFORMS 2017	Huston TX	USF
Chunfu Xin	2018 TRB Annual Meeting	Washington DC	USF
Dongfang Zhao	2018 TRB Annual Meeting	Washington DC	USF