

Semiannual Program Progress Performance Report for
Southeastern Transportation Center (STC)
US DOT Regional University Transportation Center



**Submitted to: US Department of Transportation
Office of the Secretary of Transportation**

Grant period: 1 October 2013—30 September 2017

Reporting period: 1 October 2016—30 March 2017

Submitted: 28 April 2017

Submitted to Robin Kline
University Programs Grant Manager
US Department of Transportation
202.366.2732
robin.kline@dot.gov

Submitted by Stephen H. Richards, PhD



STC Principal Investigator and Director

Grant: DTRT13-G-UTC34
DUNS: 00-338-7891
EIN: 62-6001636

865.974.5255 • stever@utk.edu
University of Tennessee, Knoxville
309 Conference Center Building
Knoxville TN 37996-4133



STC Program Progress Performance Report #7

1. Accomplishments

1.a. What are the major goals of the program?

This document summarizes the activities that the Southeastern Transportation Center (STC) has initiated, continued, or completed during the past six months. STC is USDOT's Regional UTC representing the eight southeastern states, and is led by the University of Tennessee, Knoxville (UT). We are a strong consortium of exceptional universities striving to fulfill the mission of the University Transportation Center Program in Region 4, with a special emphasis on our programmatic theme, **comprehensive transportation safety**. As STC winds down its projects from this grant, we have maintained the activities for and reaped the results from our four program areas: research, education, work force development, and technology transfer.

1.b. What was accomplished under these goals? What opportunities for training and professional development have the program provided?

Major Research Initiatives (MRI)

STC has four active MRIs, all of which are multi-year, multi-university major research projects. Each MRI is led by a Coordinator or Co-coordinators, with assigned Principal Investigators overseeing the work performed by each university partner.

MRI 1: Crash Modification Factors and the Highway Safety Manual

HSRC

HSRC's primary contribution to MRI 1 is to compare the performance of cross-sectional regression models that make use of propensity scores with the results from before-after studies. During the current reporting period, work continued on assigned project tasks and progressed satisfactorily.

UK

UK successfully completed the following MRI 1 work activities during the reporting period:

- Assessed data sources for socio-economic variables and cultural factors to be considered in the development of non-engineering and roadway SPFs.
- Applied, refined, and documented the HSM-based benefit-cost analyses used for evaluation of HSIP safety improvements implemented in KY.
- Two case studies were undertaken to apply HSM methodologies to highway design projects for the KY Transportation Cabinet (KYTC). One was completed and delivered as a draft report.

MRI 2. Integrated Simulation and Safety

UCF

During the current reporting period, UCF continued building the pedestrian-vehicle conflict scenarios at both midblock crossings and intersections in the driving simulator. The data were extracted and analyzed. Based on the data analysis, we found that at midblock crossings time of day is an important factor that affects drivers' behaviors. According to the results, nighttime driving increases the maximum deceleration, but also decreases the maximum deceleration location, the PET, and the minimum TTC compared to daytime driving. In addition, the marked crosswalk is also associated with the pedestrian safety. Although the marked crosswalk has nothing to do with the maximum deceleration, the minimum distance and the PET, it increases the maximum deceleration location and the minimum TTC.

The UCF also initiated a literature search related to the consolidation of historic crashes and microsimulation-based conflicts. We summarized driver's avoidance behavior patterns during the pedestrian-vehicle conflict. From these data, we extracted four key variables: deceleration adjustment time, maximum deceleration rate, maximum deceleration time, and brake release time. Then, we associated driver characteristics variables (age and gender) and potential risk factors (time of day, marking, roadway type, and dressing color) with the four key variables using the ANOVA.

Results indicate that age, gender, roadway type, and clothing color are the significant factors that affect the deceleration adjustment time. Time of day and marking have no effects on deceleration adjustment time. In addition, age, gender, time of day, marking, and clothing color impact the maximum deceleration time. Among those under 40 years old, male drivers, daylight driving, crosswalk with marking, and brightly colored clothes increase maximum deceleration time.

On the other hand, for drivers under 40 years old, male drivers, daylight driving, crosswalk with marking, and brightly colored clothes decreased the maximum deceleration rate. However, the roadway type only affects the maximum deceleration rate, and does not influence maximum deceleration time. One lane roads with a parking lane have a higher deceleration rate than two lane roads. Last, age and clothing color are found to be significantly associated with the release brake time.

UK

Related to MRI 1, the UK research team developed prediction models for crashes, and completed 80% of simulations required for the development of relationships between crashes and simulation-based conflicts.

MRI 3. Exploring Socio-Demographic Characteristics and Culture Factors in Differential Safety Performance across Geography

USF

During the current reporting period, the USF team's final report for this project was submitted. The team's goal, which was to gain a better understanding of why the fatality rate (i.e., fatalities per unit of exposure) is historically higher in the Southeastern (SE) region than in non-Southeastern (NSE) regions of the United States, was accomplished. This study explored how

the exposure measured could affect the relative safety performance between the SE and NSE regions. More importantly, it explored sources and the degree of the differential safety performance in the overall fatality rate. Further, it explored how SE and NSE differ in the components of the fatality rate, i.e., the risk of involvement and the risk of death once being involved. Finally, it carried out linear regression analysis of general fatality rates and the risk of death for pedestrians.

Results showed that SE and NSE differences in the overall fatality rate did not vary much across several socio-demographic groups and time of day and day of week periods, but it did vary significantly across functional classes. In fact, rural non-freeway facilities accounted for almost 80% of the difference in the overall fatality rate. From the analysis of the components of the fatality rate, it was found that the higher fatality rate in SE was largely attributable to its higher risk of death. For pedestrians during 2009, for example, the fatality rate was 78% higher in SE than in NSE and the much higher fatality rate primarily resulted from its 85% higher risk of death. The linear regression analysis of general fatality rates indicates that SE and NSE differences largely disappear once differences in socio-demographic factors or in risk-taking behaviors were controlled for. The linear regression analysis of the pedestrian risk of death indicates that a 10% drop in statewide average speed of vehicle travel could reduce of the risk of pedestrian death by 3.1 percentage points, which is significant relative to the average risk of pedestrian death at 7.99% in the SE region.

MRI 4 Big Data for Safety Monitoring, Assessment, and Improvement

Along with the potential benefits of big data come issues related to large data volumes, high data velocities, varied data types and formats, and the veracity of the data's accuracy and reliability, thus making big data and the proactive applications that rely upon it vulnerable to interruption, overload, and misuse. As part of MRI 4, the STC is exploring many of these issues.

UT

The UT MRI 4 research team continued work on multiple tasks including the following: assessing and investigating data sources and scenarios for how different data types can contribute to improving safety; macroscopic safety analysis and real-time crash risk analysis (including pedestrians); analyzing real-time travel time data quality collected from license plate readers, Bluetooth readers, probe vehicles, INRIX database, NAVTEQ, Remote Traffic Microwave Sensors (RTMS).

UK

During the current reporting period, a preliminary simulation model was built to test the application of BSM data on intersection safety analysis.

Opportunity and Exploratory (O&E) Grants

O&E Grants are typically awarded to a single university, are one year long, and have one PI. Oftentimes, graduate students receive some support for participation in the research.

2017 O&E Projects

In March 2017, STC awarded 7 new O&E Grants, focusing on multiple safety topics.

Project Title	University	PI
Connected and Automated Vehicles: What are the implications of partial adoption?	UT	Asad Khattak
Technology based risk mitigation strategies to improve older driver safety	Kentucky	Adam Kirk
Electric bikes in bikeshare systems and big data: opportunities to assess widespread safety and health	Tennessee	Chris Cherry
Development of a connected vehicle test bed on UT campus	Tennessee	Lee Han
Can you hear it now? A study of personal listening devices and pedestrian safety	North Carolina A&T	Maranda McBride
Disaster analytics: Disaster preparedness and management through online social media	Central Florida	Samiul Hasan
A scalable augmented reality testbed for automated and human-driven vehicle coordination experiments	Tennessee	Subhadeep Chakraborty

2016 O&E Projects

The 2016 O&E Projects are all wrapping up; final reports are being submitted by the PIs.

UT

Chris Cherry, New technologies and bicycle safety (final report submitted).

The main object of the research was to assess travel behavior of bicycle users: travel speeds, use of bicycle route, wrong-way riding, and route choice preferences. This project characterized routes chosen by cyclists as determined by speed limit, traffic volume, and type of bicycle facilities. These inputs were used to assess user safety. Additionally, the research project provided a huge array of data from the users about their travel characteristics.

Asad Khattak: CAV - What are the implications of partial adoption?

Substantial progress was made in developing an ad-hoc, behaviorally-based vehicle simulator in Matlab. However, this task has implicit limitations to simulate and visualize high density traffic for extended periods of time. After a deep search for alternatives, the SUMO simulator was selected for its flexibility in changing the car-following models and to account for vehicle crashes. The work focuses on adapting the SUMO car-following models to represent vehicles with different levels of automation. This is a work in progress with two graduate Civil Engineering students and an ORNL researcher contributing to the project.

UCF

The UCF research team submitted a progress report to FHWA per the main sponsor matching contract. We secured IRB approval on right way driver notification survey, and conducted the survey with a random sample of 900 toll road customers in Central Florida. UCF continues to collect data from devices installed on CFX system and evaluate the efficacy of the new technology installed to combat WWD. A paper was presented and accepted for publication at

TRB 2017 conference and accepted for publication in TRR. We made two progress presentations to CFX in November 2016 and February 2017. Our PhD student, Adrian Sandt, won the Student of the Year award and represented STC in the CUTC award ceremony at the TRB 2017 meeting. His paper won the best student paper award this year (2017) of TRB freeway operations committee and was nominated for a second award (a new one called Cunard Award) given to the best paper lead by a young author under 35. It will compete with all committees under the operations section of TRB.

Education & Workforce Development

NCAT

Education

STC supported seven undergraduates and one graduate student for the Fall 2016 semester. It also supported six freshmen Incentive Award students for the 2016-17 academic year. These recipients will receive research mentoring, internships, and experiential learning activities. Three students were selected as Dwight David Eisenhower Transportation Fellows. These students participated in the Eisenhower Showcase and Poster Sessions at TRB.

Workforce Development/Outreach:

The application process for the 2017 Summer High School Transportation Institute is underway. Students take a for-credit English course, participate in lectures and interactive presentations that support academic and career choices in transportation, SAT preparation, and personal development sessions; and field trips to support classroom experience. Additionally, they study a different mode of transportation each week along with career choices in each mode. This year the STI will celebrate its 25th anniversary of the program. A special closing ceremony is planned for this celebration.

Dr. Laquanda Leaven continues to work with the Knox County School System in Knoxville, TN and the University of Tennessee-Knoxville to develop a transportation clearinghouse. This is the third year of the project funded by the Garrett A. Morgan Technology and Transportation Program (GAMTTEP). During this reporting period, Dr. Leaven added to the clearinghouse by developing monthly transportation blogs. These “Did you know” blogs communicate the importance of transportation in ways relatable to K-12 students and teachers. The monthly blogs have not yet been posted to the website but are being collected by the GAMTTEP project leaders for later use once the majority of the website content has been developed.

HSRC

During this reporting period, HSRC launched two rounds of its Road Safety 101 course. These two courses reached a total of 46 students from a variety of backgrounds, including planning, engineering, public health and law enforcement. HSRC offered the first course from October to November 2016. The class size was limited to 16 students to facilitate involvement between students and instructors. This was the first time instructors used the GoToTraining platform instead of Blackboard Collaborate, and found it to be a more user-friendly method for delivering live classes. Student feedback was positive, and we identified places to improve course materials.

The next course began in March 2017. This course will not end until the next reporting period (April 2017). We increased the overall class size to see if it was possible and did not negatively affect interaction with students. So far, the course has worked quite well with the larger size, though we will not get our student evaluations back until after the course has concluded in April. During this time period, HSRC also opened applications for its next offering of Road Safety 101, which is scheduled to take place from May-June 2017.

UK

Methods used for application of the Highway Safety Manual to evaluate design projects were documented and demonstrated to KYTC representatives. We launched the Calibrator. EDC4 Webinar Series. FHWA – Yanira Rivera, 11/2/2016.

http://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/ddsa_resources/#webinars

1.c. Have the results been disseminated? If so, in what way(s)?

UT

UT hosts “Engineering Day” each year to give university students and faculty time with high school students interested in pursuing engineering degrees. The 2016 Engineers day saw almost 1,500 students from 54 different high schools (including some home schoolers). During the 2016 Engineer’s day event, we engaged participants in several transportation engineering research projects. The participants visited our new traffic management center, rode electric bicycles, and used our driving simulator.

Collaborating with the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Network (CURENT), a national Engineering Research Center sponsored by NSF, we allowed high school students to work and share results from one of our research projects. The research topic was “Analysis of Electric Vehicle Charging Analysis of Electric Vehicle Charging Stations along US I-40.” At the end of the program, the students made PowerPoint and poster presentations at a fair hosted by CURENT.

We participated in the Fall 2016 Freshmen Engineering Fair. Professor Asad Khattak and several graduate students were at the event to share latest technology in autonomous and connected vehicle and show how their adoption will impact transportation systems and the environment.

NCAT

Results from the Teen Texting While Driving O/E project were presented at Savannah State University in October as part of their Interdisciplinary Transportation Studies lecture series funded by their National Science Foundation HBCU-UP Targeted Infusion Project grant.

UCF

UCF made two presentations to CFX in November 2016 and in February 2017. A media interview with Channel 9 was conducted on December 14, 2016.

UK

Results from the case study application of HSM methods to design projects were documented in draft report form and delivered to KYTC representatives. Three related webinars were presented as noted above. A paper was prepared for TRB and presented as a poster; another paper is under review for the Road Safety and Simulation 2017 conference in Delft, Netherlands. A Master's thesis based on MRI4 first year work has been produced. Results of the O/E Grant study have been documented in a Final Report.

1.d. What do you plan to do during the next reporting period to accomplish the goals and objectives?

UT

Research: The transportation faculty will continue to work on STC research that relates to the Highway Safety Manual, safety simulations, big data and connected & automated vehicle applications in safety, new technologies, pedestrian and bicycle issues and the role of socio-demographics in safety.

Education: We have successfully recruited nine students with strong interests in safety to the UTK program; we will mentor these students in the coming months and work with them to present research results at TRB and other conferences. Transportation faculty will continue the transportation seminar series, with speaker presentations available online. A graduate course related to Intelligent Transportation Systems will be offered in Fall 2017.

Outreach: We will continue to work on 1) safety aspects of connected and automated vehicles, and 2) pedestrian and bicycle transportation issues, focusing on technical aspects of their safety. International links will be strengthened with universities in Asia, Europe and Australia. STC will further strengthen the Journal of Transportation Safety & Security. JTSS is now listed in the Web of Science Citation Index, and will increase both the page budget and number of issues to six per volume in 2018 to keep up with the burgeoning backlog.

HSRC

Research: We plan to complete our research study on the comparisons of before-after and cross-sectional models.

Education: We will offer the Road Safety 101 at least one more time, and that will happen in May-June 2017.

NCAT

Research: Dr. McBride submitted a research abstract to the Applied Human Factors and Ergonomics Conference and is scheduled to give a presentation titled "Exploring Adolescent Texting While Driving Behaviors using the Theory of Planned Behavior and Psychosocial Factors" in Los Angeles, CA in July. She and her coauthors will submit a journal article on their Texting and Driving Study to Transportation Research: Part F. Dr. McBride is currently working on an extension of this project with Dr. Suman Niranjana, the Director of the Interdisciplinary Transportation Program at Savannah State University.

Education: During the next reporting period students will be selected to participate in the 2017 Summer High School Transportation Institute. Scheduling the five and one-half week program

will begin. Other activities planned involve developing partnerships and planning for the 25th anniversary celebration. Students participating in the TRB Minority Student and Eisenhower Fellows programs will be selected along with faculty mentors for the TRB program.

Workforce Development and Outreach: Dr. Leaven submitted a research abstract to the WTS (Women in Transportation) Conference scheduled to be held in Brooklyn, NY. The abstract for her posted titled “Increasing the Pipeline for Future Women in Transportation Management and Transportation Engineering through Synergizing STEM/Transportation Topics into High School Courses” was accepted and will be presented in May.

UCF

We finalized the TRB paper and submitted it for publication. The plan is to submit more papers to TRB 2018 in summer 2018. Also, the plan is to continue collecting data about the WWD countermeasures and analyzing it. As for MRI #2, the plan is to finish the Task 2 and Task 3 of the third year STC.

UK

- **MRI1:** Results from the case study application of HSM methods to design projects were documented in draft report form and delivered to KYTC representatives. Three related webinars were presented as noted above.
- **MRI2:** A paper was prepared for TRB and presented as a poster; another paper is under for review for the Road Safety and Simulation 2017 conference in Delft, Netherlands
- **MRI4:** Master’s thesis based on first year work has been produced.

USF

Further reports will stem from this research and submitted for publication, conference presentations, and educational support.

2. Products: What has your STC work produced?

2.a. Journal publications:

UT

Kamrani, M., Wali, B., & Khattak, A. J. Can Data Generated by Connected Vehicles Enhance Safety? Proactive Approach to Intersection Safety Management. Transportation Research Record: Journal of the Transportation Research Board, 2017 (Accepted). STC/Federal support acknowledged.

Li, X., Khattak, A. J., & Wali, B. Large-Scale Traffic Incident Duration Analysis: The Role of Multi-agency Response and On-Scene Times. Transportation Research Record: Journal of the Transportation Research Board (2017) (Accepted). STC/Federal support acknowledged.

Wali, B., Khattak, A. J., Liu, J. Heterogeneity Assessment of Incidents Durations: Estimation of Random Parameter and Quantile Regressions. (Invited for Publication in International Journal of Intelligent Transportation Systems Research, 2017). STC/Federal support acknowledged.

UCF

Sandt*, A., AL-DEEK+, H., and Rogers*, J., “Identifying Wrong-Way Driving Hotspots by Modeling Crash Risk and Assessing Durations of Wrong-Way Driving Events,” Journal of the Transportation Research Board, February 2017.

Rogers*, J., Sandt*, A., AL-DEEK+, H., Alomari*, A., Gordin, E., and Carrick, G. “Modeling the Risk of Wrong-Way Driving on Freeways and Toll Roads,” Journal of the Transportation Research Board, No. 2554, pp. 166-176, DOI: 10.3141/2554-18, November 2016.

UK

Amiridis, K., Stamatiadis, N., and Kirk, A. “Safety Based Signalized Intersection Left-Turn Phasing Decisions,” Journal of the Transportation Research Board, 2619, 2016 (accepted)

USF

2.b. Books or other non-periodical, one-time publications:

Nothing to report.

2.c. Other publications, conference papers and presentations:

UT

Wali, B., Khattak, A. J., Liu, J. Heterogeneity Assessment of Incidents Durations: Estimation of Random Parameter and Quantile Regressions. Presented and Awarded with the “Distinguished Scientific Paper – Americas Award” by the 23rd ITS World Congress, Melbourne, Australia (2016). STC/Federal support acknowledged.

Khattak, A. J., Wali, B. Dynamics of Driving Regimes Extracted from Basic Safety Messages Transmitted Between Connected Vehicles. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA. (2017). TRB PAPER # 17-00234. STC/Federal support acknowledged.

Khattak, A. J., Wali, B. Exploring Non-Linear Dependencies in Correlates of Rural Two-Way Two-Lane Roadway Crashes. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00239. STC/Federal support acknowledged.

Greene, D. L., Khattak, A. J., & Wali, B. (2017). Planning Tools for Deployment of Alternative Energy Refueling Infrastructure. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA. TRB PAPER # 17-03416.

Kamrani, M., Wali, B., & Khattak, A. J. Can Data Generated by Connected Vehicles Enhance Safety? Proactive Approach to Intersection Safety Management. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00238. STC/Federal support acknowledged.

Wali, B., Khattak, A. J., Liu, J. Heterogeneity Assessment of Incidents Durations: Estimation of Random Parameter and Quantile Regressions. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00236. STC/Federal support acknowledged.

Liu, J., Khattak, A. J., & Wali, B. Do Safety Performance Functions Vary Across Space? Application of Geographically Weighted Regressions. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00237. STC/Federal support acknowledged.

Xu, J., Khattak, A. J., & Wali, B. Injury Severity Analysis of Passenger Vehicle-Truck Collisions and Contributory Unsafe Pre-Crash Behaviors. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00241. STC/Federal support acknowledged.

Li, X., Khattak, A. J., & Wali, B. Large-Scale Traffic Incident Duration Analysis: The Role of Multi-agency Response and On-Scene Times. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-01049. STC/Federal support acknowledged.

Boakye K., A. Khattak, J. Liu. How Do Smartphone and Non-Smartphone Users Access and Use Travel Information? Evidence from 2014 Puget Sound Regional Household Travel Survey. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-00698

Boakye, K., S. Nambisan, and M. Shelley. The Impacts of Click It-Or-Ticket Campaign and Saturation Patrol Interventions on Nighttime Seat Belt Usage. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-04622

Boakye, K., S. Nambisan, and M. Shelley. Influence of Passenger Presence on Driver's Seatbelt Use at Nighttime. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-04622

Boakye, K., S. Nambisan, and M. Shelley. Nighttime Seatbelt Use of Front-Seat Passengers Based on Their Corresponding Drivers' Seatbelt Use. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-04802

Lee, H., and Y. Zhang. Enhancing Relative Positioning Accuracy in V2V Safety Applications Using Multivehicle Kinematics and Nonlinear Filtering. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-03709

Lee, H., and Y. Zhang. Dijkstra-DBSCAN: A Network Based Clustering Algorithm to Support Incident Hotspots Detection and Management in Connected Managed Lane Networks. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-05918

Lee, H., Y. Liu, and Y. Zhang. Real-Time Piecewise Regression and Its Application in Effective and Economical GPS Trajectory Data Collection. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-03680

Lee, H., Lim, H., S. Chin, and H. Hwang. A Gravity Model Using Spatial Correlation of Time Series Data For Freight Distribution Estimation: A Case Study of the County-Level Coal Distribution Estimation in the United States. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-06189

Lee, H., Lim, H., S. Chin, and H. Hwang. Incorporating Information Complexity into Regression-Based Freight Generation Model Selection. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-06162

Bae, B., B. Whetsel, and L. Han. A Gray Zone in Isolated Intersection Control Type Selection. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-02609

Cherry, C., H. Yang, and X. Lu. Application of Geographically Weighted Regression to Predicting Bicycle and Pedestrian Volume at Intersections. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-02391

Nambisan, S., Z. Ling, N. Franceschetti, C. Cherry, and A. Boggs. Truck Parking Facilities and Ramp Parking: Role of Supply, Demand, and Ramp Characteristics. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-06604

Weinert, J., J. Macarthur, Z. Ling, and C. Cherry. Differences Between Cycling Experiences and Perceptions Between E-bike and Bicycle Users in the United States. Presented at the 96th Annual Meeting of the Transportation Research Board, Washington DC, USA (2017). TRB PAPER # 17-06462

UCF

Sandt*, A., AL-DEEK+, H., and Rogers*, J., "Identifying Wrong-Way Driving Hotspots by Modeling Crash Risk and Assessing Durations of Wrong-Way Driving Events," published in the *Transportation Research Board 96th Annual Meeting Compendium of Papers CD-ROM*, Washington D.C., January 8-12, 2017.

Wu, J., Radwan, E. and Abou-Senna, H. Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings: A driving simulator study Transportation Research Board 96th Annual Meeting.

Radwan, E., Darius, B., Wu, J., & Abou-Senna, H. (2016, November). Simulation of pedestrian safety surrogate measures. In ARRB Conference, 27th, 2016, Melbourne, Victoria, Australia.

UK

E.R. Green, C. Blackden, M.A. Fields. "Spatial Database For Intersections", 95th Annual TRB, Washington, DC; Transportation Research Board: Washington, DC, 2016. Published in conference proceedings.

E.R. Green, N. Stamatiadis, R. R. Souleyrette. "Segment Length and Highway Safety Analysis: Does It Matter?", 96th Annual TRB, Washington, DC; Transportation Research Board: Washington, DC, 2017. Published in conference proceedings.

E.R. Green, K.R. Agent, E. Lammers. "Development of an Improved Method for Determining Advisory Speeds on Horizontal Curves", 96th Annual TRB, Washington, DC; Transportation Research Board: Washington, DC, 2017. Published in conference proceedings.

Kazi, O., A Data Driven Approach to Quantify the Impact of Crashes, 2016, Thesis, University of Kentucky, published.

Zhang, X. and M. Chen. Quantifying Effects from Weather on Travel Time and Reliability, Presented at the 96th Annual Meeting of the Transportation Research Board, Washington, DC, 2017.

Agarwal, N. and A. Kirk. Application of VISSIM Basic Tools to Simulate Emergency Preemption. Road Safety & Simulation International Conference Paper.

UK

“Safety Based Signalized Intersection Left-Turn Phasing Decisions,” 96th Annual Meeting of the Transportation Research Board, Washington, DC, January 8-12, 2017 (Amiridis, A.).

Agarwal, N. and A. Kirk. Application of VISSIM Basic Tools to Simulate Emergency Preemption. Road Safety & Simulation International Conference Paper.

2.d. Website(s) or other Internet site(s):

UT

The STC website (stc.utk.edu) is the primary source of information related to the regional UTC.

2.e. Technologies or techniques:

UT

“I Bike KNX” smart phone app for iOS and Android has been developed by Dr. Cherry and several other researchers. It uses smart phone’s GPS to record routes and allows users to report problems along their route such as potholes. It contributes to safety improvement and route choice optimization for cyclists.

2.f. Inventions, patent applications and/or licenses:

UT

Patent application under review: “Device for level bicycle at-grade crossing of rail tracks.”

2.g. Other products:

UT

Faculty purchased from ARADA Technologies in-vehicle, mobile, and roadside units for field testing in Connected and Automated Vehicles. Traffic and incident data from INRIX and TDOT are being obtained. The CAV units were successfully tested. UTK faculty started a seminar series devoted to the creation of Southeastern Smart Mobility Consortium with potential for TDOT and USDOT support. UTK faculty purchased equipment to display traffic data in real-time and create a well-functioning transportation laboratory. The Lab has modeling and simulation capabilities that include display and archiving of incoming operations feeds from TDOT, and its software includes accident reconstruction software ARAS, TransCAD, and TransModeler.

UK

MRI1: SPF-R is a script developed for R Studio that helps develop and compare Safety Performance Functions (SPF). SPF-R requires an input file containing crash and volume data for intersections or segments. Within SPF-R, you can filter the input file for specific roadway

geometries or you can create SPFs for a set of roadway types or crash severities. The program produces a CURE plot as well as several metrics describing the model's goodness-of-fit.

3. Participants and Other Collaborating Organizations

3.a. Table of Collaborating Organizations

Organization Name	Location of the Organization	*Partner's Contribution to the Project	Name (First and Last)	University
National Cooperative Highway Research Program	Washington, D.C.	Collaborative match using funds from NCHRP Project 17-63: Guidance for the Development and Application of Crash Modification Factors	Raghavan Srinivasan	HSRC
Conference of Minority Transportation Officials (COMTO)	Washington, DC	Collaborative Support-Garett Morgan Youth Symposium and financial support - NCA&T Scholarship	Brad Mims, Interim President/CEO of COMTO	NCAT
NC Department of Transportation	Raleigh, NC	In-kind support-presentations, financial support-internship program	JoAna McCoy, Director of Education Initiatives	NCAT
NC FHWA Division	Raleigh, NC	In-kind support-presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	NCAT
Knox County School System	Knoxville, TN	Collaborative Support	Brianna Fisher	NCAT
The University of Tennessee-Knoxville	Knoxville, TN	Collaborative Support	Jerry Everett	NCAT
Institute for Transportation Research and Education (ITRE)	Raleigh, NC	Financial support, collaborative support – research collaboration	James Martin, Associate Director	NCAT
Savannah State University	Savannah, GA	Collaborative Support	Suman Niranjana	NCAT
University of Alabama - Birmingham	Birmingham, AL	Collaborative Support	David Schwebel Despina Stavrinou	NCAT
Parsons-Brinkerhoff	Raleigh, NC	Collaborative Support	Timothy Brock	NCAT
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Support Facilities	Jon Antin	NCAT
Embry-Riddle Aeronautical University	Daytona Beach, FL	Collaborative Support	Dahai Liu	NCAT
Central Florida Expressway Authority (CFX)	4974 ORL Tower Road Orlando, FL 32807	Provided direct match for this project	Corey Quinn, P.E.	UCF
Enforcement Engineering, Inc.	Jacksonville, Florida	Has provided privileged wrong way data for analysis	Grady Carrick, Ph.D.	UCF
Vanasse Hangen Brustlin, Inc (VHB)	Weedsport, New York	Collaborative Support	Frank Gross	UK
North Carolina Highway Safety Research Center	Chapel Hill, NC	Collaborative Support	Raghavan Srinivasan	UK

University of Tennessee	Knoxville, TN	Collaborative Support	Airton Kohls	UK
Center for Advanced Public Safety (at Univ. of Alabama)	Tuscaloosa, AL	Collaborative Support	Dr. Randy Smith	UA
Alabama Center for Insurance Information and Research	Tuscaloosa, AL	Collaborative Support	Dr. Lars Powell	UA
Department of Information Systems, Statistics, Management Science	Tuscaloosa, AL	Collaborative Support	Dr. Mike Porter	UA
National Science Foundation	Washington DC	Sponsor of projects	N/A	UT
Tennessee DOT	Nashville TN	Matching request & data	N/A	UT
ORNL	Oak Ridge TN	Collaborative support		UT
INRIX	Kirkland WA	Collaborative support	N/A	UT
US Dept. of Energy	Washington DC	Sponsor of projects	N/A	UT
Knoxville Regional Trans Planning Org	Knoxville TN	Collaborative support & personnel time	N/A	UT
Social Bicycles (SoBi)	New York	Collaborative support & data match	N/A	UT
Georgia Tech	Atlanta	Collaborative support	N/A	UT
NURail-----UIUC	Champaign Urbana IL	Collaborative Support	Chris Barkan	UT
Various Jiaotong Universities in China	Beijing, Nanjing, Guangzhou, Shenzhen, Changsha, China	Collaborative support & personnel exchanges	Dr. Xuedong Yang	UT
Social Bicycles	New York	Data match, personnel time, and collaboration	Ryan Rzepeki	UT
Community Action Committee	Knoxville TN	In---Kind Support, collaborative support	Karen Estes	UT
East Tennessee Human Resource Agency	Knoxville TN	personnel exchanges	Aaron Bradley	UT
Knoxville Area Transit e---HM consortium – see info below	Knoxville TN Label Master, Blue Dot Solutions, etc.	personnel exchanges Support of initiative	Melissa Roberson	UT
National Science Foundation	Washington DC	Support of Big Data from CAVs	N/A	UT
CURRENT (an NSF Engineering Research Center)	College of Engineering, UTK	In---Kind Support, collaborative support and nominal stipend for a graduate student to mentor two high school students in the Young Scholars Program	Dr. Chie---Fei Chen	UT
MKT 466: Capstone Design course	Haslam College of Business, UTK	In---Kind Support for 42 students to develop a marketing campaign to increase seat belt usage during nighttime hours	Cindy Raines	UT

3.b. Additional collaborators:

UT

Noteworthy new projects obtained by UTK faculty include:

- Khattak, A., S. Chakraborty & S. Nambisan, Study of Driving Volatility in Connected and Cooperative Vehicle Systems, US National Science Foundation, University of Tennessee at Knoxville, \$399,793, Sept. 1, 2015-Aug 31, 2018.
- Khattak A., S. Richards & D. Chimba, Highway Safety Manual, Safety Performance Functions (SPF) and Roadway Calibration Factors, Tennessee Department of Transportation, University of Tennessee at Knoxville, \$249,996, Oct. 1, 2015-Sept 30, 2017.

A UTK team including faculty from Civil & Environmental Engineering, UTK Industrial and Systems Engineering, UTK Mechanical Aerospace and Biomedical Engineering, Electrical Engineering and Computer Science was selected in an internal competition to develop and submit a proposal to the National Science Foundation. This is to develop a Research Experiences for Teachers Site that is focused on Transportation Systems.

International collaborations in safety during the reporting period include Beijing Jiaotong University, Southeast University, Tongji University, Southwest Jiaotong University, Kunming University of Science and Technology, Tsinghua University, Shenzheng University, and Changsha University of Science and Technology; and COTA-Chinese Overseas Transportation Association. Utrecht University, Monash University, TU Delft, and University of Novi Sad.

HSRC

As part of the MRI1 research area, we have collaborated with the NCHRP Project 17-63 team that includes:

- Dr. Bhagwant Persaud, Ryerson University
- Dr. James Bonneson, Kittelson and Associates
- Dr. Ezra Hauer, University of Toronto, Retired
- Dr. Fan Li, Duke University, Department of Statistics
- Dr. Eric Donnell, Pennsylvania State University

NCAT

Education – Interdepartmental and interdisciplinary Collaboration:

Dr. Elli Fini in Civil Engineering was instrumental in our participation in the TRB Minority Student Transportation Research Fellowship program. She was a faculty research mentor for civil engineering students who wrote papers for presentation at 2017 TRB. Drs. Laquanda Leaven and Kofi Obeng served as the Dwight D. Eisenhower Transportation Fellowship faculty research mentors for our Eisenhower Fellows. They mentored student during the writing process of the research papers presented at 2017 TRB.

UA

UA is working with Cambridge Systematics on writing the Strategic Highway Safety Program for the State of Alabama. This project is funded by the Alabama DOT.

4. Impact

4.a. What impact has your STC work had on the principal disciplines of the program?

UT

The work undertaken at UT is improving safety through research on Highway Safety Manual, safety simulations, big data applications, and the role of socio-demographics in safety. The multi-disciplinary research activity underway with diverse consortium partners is creating the knowledge-base and foundation needed for innovations in safety countermeasures and making methodological advances in safety modeling, simulation, and visualization. The impact of safety research will be felt in multiple modes of transportation and by multiple stakeholders.

As an example, findings from the STC Big Data major research initiative are creating new metrics of driving volatility. These can be used in real-time to support instantaneous driving decisions. This work is providing new analytics (driving volatility) using big data coming in from sensors to enhance safety. The information on driving volatility can be used, for example, in high-schools to reward students who show “calm” driving patterns rather than volatile driving patterns. The idea of driving volatility appealed to the National Science Foundation, awarding a 3-year research grant titled “Study of Driving Volatility in Connected and Cooperative Vehicle Systems,” for \$399,793.

HSRC

Most of the crash modification factors in the Highway Safety Manual, the CMF Clearinghouse, and other sources are just single factors implying that the safety effect of a treatment does not depend on the characteristics of a site. The MRI¹ effort from HSRC will develop crash modification functions that will provide insight into how the safety effect of a treatment may vary depending on the characteristics of a site.

NCAT

The data from the texting while driving (TWD) surveys provide evidence of individual differences that affect teenager TWD behavior. The study results are being used to identify the most salient factors associated with teenage drivers’ decisions to TWD. These individual differences and decision factors are the basis for customized driver training protocols that will be developed.

The data from the pedestrian study is expected to identify potential hazards that might be eliminated by using a different type of listening device. Since people will continue to use listening devices while walking or bicycling, encouraging the use of a device that increases situation awareness should increase safety by reducing the likelihood of traffic-related accidents caused by missed traffic cues.

UCF

MRI 2 research provides an added dimension for using driving simulator to analyze pedestrian safety from the driver's point of view. The lack of pedestrian safety data has been a major hurdle for researchers to better quantify pedestrian crash rates. This research will assist with this goal.

UK

New methods have been developed for identification and prioritization of locations on KY highways with the greatest potential for crash reductions. State DOT has expressed interest in the application of the concept and method developed in this study. The expected result would include better practice in highway work zone scheduling and more efficient highway incident management. New methods for emergency vehicle preemption and signal cycle transitions have been identified to assist Kentucky agencies as they move towards advanced traffic controllers.

4.b. What impact has your STC work had on other disciplines?

UT

UT's safety work underway is relevant to social sciences; e.g., findings from the study of socio-demographics may create new social science-based knowledge. Analysis of spatial/geographical aspects of safety has the potential to impact the field of geography. Another example is the application of modeling, simulation, and visualization techniques to safety. These can improve transportation operations (e.g., incident/accident management), transportation planning and sustainability (e.g., by considering the costs of injuries and death and potential improvements in facility design) and link with epidemiology and health. Engineering faculty at UT are collaborating with the Haslam College of Business faculty on educational efforts.

NCAT

Both the TWD and pedestrian study are multidisciplinary projects, incorporating concepts from psychology, information technology, transportation, and decision sciences. Even though these studies focus on transportation safety, the methods employed in the studies can be applied to research investigating industrial safety concerns, general risk taking behaviors, and communication devices. The protocols that will be developed based on the findings of the TWD study also have the potential to impact policy as it pertains to driver education.

4.c. What impact has your STC work had on the development of transportation workforce development?

UT

The transportation engineering and science program at UT has 24 students working toward their graduate degrees during the reporting period. There are also 287 undergraduate students in Civil & Environmental Engineering that will be exposed to transportation safety through their required undergraduate transportation course. The Civil & Environmental Engineering faculty offered these transportation courses during Fall 2016 and Spring 2017:

- CE 550 - Transportation Seminar
- CE 551 - Traffic Engineering: Characteristics
- CE 552 - Traffic Engineering: Operations
- CE 553 – Geometric Characteristics (DE section included)

- CE 558 – Transportation Planning
- CE 652 – Analysis Techniques for Transportation Systems II
- CE 595 – Transportation Safety (DE section included)

HSRC

We expect that the Road Safety 101 course will provide basic skills to practitioners in the traffic safety area, and encourage them to make better holistic decisions.

NCAT

The blogs created for the Knox County Garrett Morgan project provide opportunities for K-12 students and teachers to learn more about transportation through stories and information that is relatable to these target groups. Young people learn about the importance of transportation in all areas of life, which will help develop future transportation professionals.

4.d. What impact has your STC work had on physical, institutional and information resources at your university or partner institutions?

UT

The University Transportation Centers grant has allowed the STC to acquire new laboratories, equipment, and space.

UA

STC work has been the basis of new relationships between the Department of Civil, Construction, and Environmental Engineering and UA's Department of Information Systems, Statistics, Management Science and the Alabama Center for Insurance Information and Research.

4.e. What impact has your STC work had on technology transfer?

NCAT

The TWD study is likely to have an impact on the current driver training practices. Now that the data analyses have been completed, psychosocial profiles of young drivers are being identified based on their TWD behaviors, and customized training protocols will be developed. These protocols are expected to be more effective at deterring young drivers from texting while driving. The training protocols will be used to develop training modules that can be implemented in driver training classes. The pedestrian study may result in the development of a different type of communication device that will enable persons to communicate and/or enjoy listening to their personal media devices without sacrificing their safety. The results of the Garret Morgan project will provide K-12 teachers with the educational resources they need to incorporate transportation concepts into their classes. This should give rise to curriculum material designed specifically to teach transportation concepts.

UA

Work related to MRI 3 (socio-economic factors affecting crashes) has been applied to the development of the Alabama Strategic Highway Safety Plan for the State of Alabama. This project is funded by the Alabama DOT.

UCF

MRI #2 has produced one doctoral student to date.

4.f. What impact has your STC work had on society beyond science and technology?

UT

Socio-demographic, attitudinal, and behavioral research on safety are improving public knowledge and providing a fundamental understanding of how to improve safety from broad social, economic, spatial, and behavioral perspectives. Highway Safety Manual improvements is leading to knowledge about reductions in hazards and application of new countermeasures that can save lives.

The Big Data applications in safety inspires innovation and new ways of approaching safety by combining information from diverse databases, which are increasingly generated by Connected and Automated Vehicles. Safety simulations are leading to a better understanding of vehicles' interactions, why collisions occur, how to better respond to them, and their consequences. The simulations advance the knowledge and skills of people who work in the safety field, and facilitate the study of human factors. Modeling, simulation, and visualization helps formulate regulatory policies that lead to safety improvements.

UCF

Wrong way driving is a serious and deadly problem. This research supported by the O&E Grant will save lives.

5. Changes/Problems

Nothing to report in these categories.

6. Additional information regarding Products and Impacts

6.a. Outputs:

UT

Wali, B., Khattak, A.J., Xu, J. Contributory Fault and Level of Personal Injury to Drivers Involved in Head-on Collisions: Application of copula-based bivariate ordinal models. Accident Analysis and Prevention, 2017. (Under second stage review). STC/Federal support acknowledged.

Khattak, A. J., Wali, B. Dynamics of Driving Regimes Extracted from Basic Safety Messages Transmitted Between Connected Vehicles. Transportation Research Part C – Emerging Technologies, 2017 (Under second stage review). STC/Federal support acknowledged.

Greene, D. L., Khattak, A. J., & Wali, B. Planning Tools for Deployment of Alternative Energy Refueling Infrastructure. Transport Reviews, 2017 (under-review).

Khattak, A. J., Wali, B. Exploring Non-Linear Dependencies in Correlates of Rural Two-Way Two-Lane Roadway Crashes. *Journal of Transportation Safety and Security*, 2017. (Ready for submission) STC/Federal support acknowledged.

Liu, J., Khattak, A. J., & Wali, B. Do Safety Performance Functions Vary Across Space? Application of Geographically Weighted Regressions, *Accident Analysis and Prevention*, 2017. (Ready for submission). STC/Federal support acknowledged.

Wali, B., Khattak, A. J., Xu, J. A Simultaneous Drivers Injury Severity Analysis of Passenger Vehicle-Truck Collisions and Contributory Unsafe Pre-Crash Behaviors. *Accident Analysis and Prevention*, 2017. (Ready for submission). STC/Federal support acknowledged.

Wali, B., Khattak, A. J., Bozdogan, H. A Methodology For Analysis of Location-Based Volatility and Crashes in Connected Vehicle Environment: A Full Bayesian Random Parameter Count Data Approach. *Transportation Research, Part C: Emerging Technologies*, 2017. (To be submitted). STC/Federal support acknowledged.

UCF

Wu, J., Radwan, E., and Abou-Senna, H. Pedestrian-vehicle conflict analysis at signalized intersections using micro-simulation. *Journal of Transportation Safety and Security*. (Submitted).

Wu, J., Radwan, E., and Abou-Senna, H. Assess pedestrian-vehicle conflicts at signalized intersection with a concurrent pedestrian phasing – A driving simulator study. *Journal of Transportation Research Part F: Psychology and Behavior*. (Submitted).

Wu, J., Radwan, E., and Abou-Senna, H. Assessment of pedestrian-vehicle conflicts with different potential risk factors at midblock crossings based on driving simulator experiment. *Advances in Transportation Studies*. (Submitted).

UK

Amiririds, K. *, Stamatiadis, N., and Kirk, A. 2017 “Safety-Based Decisions for Left-Turn Phasing,” *Proceedings of the Road Safety and Simulation 2017 Conference*, Deft, Netherlands, October 2017 (under review).

6.b. Outcomes:

All outcomes reported above.

6.c. Impacts:

All impacts reported above.