Center for Advanced Multimodal Mobility Solutions and Education

USDOT Tier 1 University Transportation Center
Program Progress Performance Report #3

Submitted to:	U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology (OST-R)
Grant Number:	69A3551747133
Project Title:	Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE)
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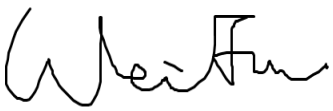
Submission Date:	October 30, 2018
DUNS:	06-630-0096
EIN:	56-0791228
Recipient Organization:	University of North Carolina at Charlotte
Project/Grant Period:	November 30, 2016 - September 30, 2022
Reporting Period Start Date:	April 01, 2018
Reporting Period End Date:	September 30, 2018
Report Term or Frequency:	Semi-annual
Signature of Submitting Official:	

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1. ACCOMPLISHMENTS

1.1. What are the major goals and objectives of the program?

The major goals and objectives of the program as outlined in the proposal include the following categories.

Research

CAMMSE will address the FAST Act research priority area of “Improving Mobility of People and Goods” by conducting multi-disciplinary, multi-modal research, education and workforce development, and technology transfer. CAMMSE is motivated by the recent advances in computing, smartphones and communication technologies, and ubiquitous data to create sustainable, efficient, and growth-enabling multimodal transportation systems. Cutting edge analytical methods and models will enhance the effectiveness, efficiency, and reliability of these systems accordingly. Recent technological advancements enable new perspectives and holistic approaches to address the well-known challenges in multimodal transportation systems planning, design, operations, and maintenance. In particular, the following research topic areas will be established to maximize synergy and adaptability across multiple modes and jurisdictions:

- Increase access to opportunities that promote equity in connecting regions and communities, including urban and rural communities;
- Generate innovations in multi-modal planning and modeling for high-growth regions;
- Develop data modeling and analytical tools to optimize passenger and freight movements;
- Innovations to improve multi-modal connections, system integration and security; and
- Smart Cities.

Leadership

The CAMMSE team is nationally and internationally recognized for its contributions to the field of transportation research, and for its deployment of successful solutions to critical, real-world transportation challenges. In addition, team members are committed advocates and longstanding leaders within the multimodal transportation community and the UTC system itself. Through this UTC grant, the Consortium plans to build on its demonstrated experience to mentor future leaders in the field of transportation. CAMMSE plans to nurture students through skill building and professional development

activities that promote notable research scholarships and successful transportation careers.

Education and Workforce Development

With years of collective education, research, and UTC experience, CAMMSE will provide a transportation education program through its partner universities. The program will promote creative and multidisciplinary problem-solving and exposure to a myriad of educational and workforce development experiences. The program will serve to attract, educate, and train future and existing transportation professionals with the know-how to undertake and implement innovative projects being or to be conducted.

The workforce development program will leverage the existing training skills and delivery resources available within partner universities. On-line webinars will be designed and delivered using available technical resources, which could provide Continuing Education Credits (CEUs) to interested course participants. In addition, UTC funds will be used to support and host the monthly transportation seminar series, particularly while classes are in session. The target audience is current students and the local university community. UTC funds will also enhance our ability to host nationally and internationally recognized speakers. The target audience is local and regional (onsite), and national when recording and posting talks online.

CAMMSE will support career-building activities that facilitate student transition from school to the workplace by offering enhanced student research opportunities, research seminars, guest speakers, professional conference travel and other professional networking opportunities. In addition, outreach programs at the pre-collegiate level (elementary to high school) will be designed to spark interest in transportation issues and to encourage youth to consider transportation academic programs and careers. The outreach initiatives will particularly focus on recruiting underrepresented minorities into transportation and other STEM fields.

Technology Transfer

The technology transfer program at CAMMSE is designed to support the USDOT in its objective of “expanding technology transfer to partners and stakeholders” by sharing research results quickly and to the widest possible audience. CAMMSE has demonstrated ability to disseminate research results, spur implementations, and conduct continuing education programs. The technology transfer program is a direct extension of the Center’s research and education programs; in other words, these activities are designed to increase the scope and effectiveness of research accomplishments and education initiatives. General objectives within the technology transfer area in CAMMSE will be to:

- Increase the national visibility of CAMMSE research and education activities.
- Increase the availability and speed at which CAMMSE research results are disseminated.
- Provide technical assistance based on CAMMSE research and development.

Collaboration

CAMMSE has an extensive history of forming collaborative relationships at a variety of technical, fiscal and administrative levels. Across all its activities, from conducting pooled fund studies to hosting tech transfer events, CAMMSE will seek to work with collaborators from all sectors.

Diversity

In order for the transportation workforce to reflect the diversity of the national workforce pool, CAMMSE will continue to pursue the development of innovative programs to encourage new entrants, particularly those from groups currently underrepresented in the field. CAMMSE will actively participate in a number of committed activities through which the CAMMSE will increase interest in STEM disciplines and raise awareness of transportation-related careers amongst underrepresented groups.

1.2. What was accomplished under these goals?

Research

As initially planned, the CAMMSE Call for Research Proposals for 2019 Year 3 was developed and officially sent out to all CAMMSE Assistant Directors and researchers internally at UNC Charlotte and Associate Directors at all other member universities on June 12, 2018. The submission deadline for all project proposals were Thursday, July 12, 2018 at 4:00 pm. 21 research proposals were received. Rigorous peer-reviews were then conducted. After examining the proposal evaluation comments and review ratings of all proposals, CAMMSE Research Program Leadership Committee discussed and then selected 17 of them for funding. The decision letters were sent to all PIs by Friday, August 17, 2018.

For all research projects that were selected for funding, the CAMMSE Project Information Forms were developed including project title, university, principal investigator, PI contact information, funding source(s) and amounts provided (by each agency or organization), total project cost, agency ID or contract number, start and end dates, brief description of research project, implementation of research outcomes, and impacts/benefits of implementation. The project information is in the processing of being posted on the CAMMSE website as well as on RiP as required by OST-R. The subcontracting process for these research projects is currently ongoing. All funded projects in the third year (i.e., in the year of 2018-2019) are expected to be completed within two years. Final Reports will be submitted within two months after the completion of each project.

The appendix contains the list of the funded projects (in Year 3) with respect to each member university.

CAMMSE was funded by USDOT in November 2016 under the FAST act. Although most of the projects are still ongoing, CAMMSE research results have been published in multiple journals, including *Transportation Research Part A: Policy and Practice, Transportation Research Part B: Methodological*, *Transportation Research Part C: Emerging Technologies, Journal of Advanced Transportation*, *ASCE Journal of Transportation Engineering, Part A: Systems*, *ASCE Journal of Infrastructure Systems, ASCE Journal of Cold Regions Engineering*, *International Journal of Transportation Science and Technology*, *Journal of Transportation Planning and Technology, Journal of Transportation Systems Engineering and Information Technology*, *Accident Analysis and Prevention*, *Transportation Letters: the International Journal of Transportation Research, World Wide Web, IEEE Transactions on Vehicular Technology, IEEE/ACM Transactions on Networking, IEEE Transactions on Mobile Computing, IEEE Internet of Things Journal, Personal and Ubiquitous Computing, Journal of the Chinese Ceramic Society*, *Transportation Research Record: Journal of Transportation Research Board*, and *ACM Transactions on Embedded Computing System, Journal of Transport Geography, IET Intelligent Transport Systems, Journal of Modern Transportation, Journal of Building Materials, Journal of Transportation Safety & Security,* and *International Journal of Transportation Science and Technology.*

CAMMSE research results were also presented at many conferences on different occasions, which include the First Annual National Mobility Summit of US DOT University Transportation Centers, the ASCE International Conference on Transportation & Development (ICTD 2018), the 2018 Autonomous Vehicles Symposium (AVS), 2018 Southern District ITE (SDITE) Annual Meeting, the 2018 World Transport Convention (WTC), the North Carolina Turnpike Authority (NCTA) Automated Vehicle Proving Ground (AVPG) partnership meeting, the 18th COTA International Conference of Transportation Professionals (CICTP 2018), the Chinese Overseas Transportation Association (COTA) 21st Annual Winter Symposium, five different universities in China (Shijiazhuang Tiedao University, Tongji University, Shanghai Maritime University, Wuhan University of Science and Technology, and Dalian University of Technology), the CSCE 2018 Annual Meeting, the 15th IFAC Symposium on Control in Transportation Systems (CTS 2018), and the GeoShanghai 2018 Conference.

During this reporting period, CAMMSE has completed all ten research projects of year 1 (that were numbered 2017 Project from 01 to 10), and seven projects of year 2 (including 2018 Project from 01 to 05 all of which were conducted by UNC Charlotte, 2018 Project 06 by the University of Texas at Austin, i.e., UT-Austin, and 2018 Project 16 by Washington State University, i.e., WSU). All final project reports of year 1 have been posted on the CAMMSE's website for public consumptions and are in the processing of being provided to the Transportation Research Board (Transport Research International Documentation database), the National Transportation Library, the U.S. DOT's Research Hub, the Transportation Library, the Volpe National Transportation Systems Center, FHWA's Research Library, and the U.S. Department of Commerce as required by OST-R. The final project reports of year 2 that have been completed are also in the processing of being posted on the CAMMSE's website and

provided to Transportation Research Board, etc. These projects have resulted in valuable findings and advanced models, which will advance both the state of the art and state of the practice in respective fields.

Leadership

Representing the CAMMSE, Dr. Wei Fan attended the First Annual National Mobility Summit of US DOT University Transportation Centers on April 12, 2018 in Washington, D.C. which was organized by Mobility 21, a National UTC by Carnegie Mellon University. On June 4-6, 2018, Dr. Wei Fan attended the 2018 Council of University Transportation Centers (CUTC) Summer Meeting in Minneapolis, MN. From June 22 to July 4, 2018 Dr. Wei Fan was invited to visit and gave talks at five different universities in China, including the Shijiazhuang Tiedao University, Tongji University, Shanghai Maritime University, Wuhan University of Science and Technology, and Dalian University of Technology. Dr. Wei Fan also attended the 18th COTA International Conference of Transportation Professionals (CICTP 2018) from July 5 to 8, 2018 at Tsinghua University in Beijing, China and was invited to give a presentation in one of the spotlight sessions. Dr. Fan served as an Area Editor of and worked as one of the Academic Committee Members for this conference. He also chaired a technical session entitled "Autonomous and Connected Vehicles" on Saturday, July 7, 2018.

CAMMSE Research Program Leadership Committee has also been in touch via emails on a regular and on an as-needed basis during this period. The First Annual CAMMSE Research Symposium was held at UNC Charlotte in Charlotte, NC, from August 6 to 7. Center Director Dr. Wei Fan and Associate Directors from all other four member universities attended the Symposium, along with the researchers and students from each member university of CAMMSE. Two outstanding keynote lectures ("Transitioning to Connected and Automated Vehicles" by Dr. Chris Hendrickson of Carnegie Mellon University, and a "Do Bicycle Riders Exhibit Different Behavior in Different Riding Environments?" by Dr. Randy Machemehl of the University of Texas at Austin) were given during the symposium. Several sessions were also held during the two-day event, including two technical sessions and a graduate student poster session. This event provided an opportunity to exchange ideas, foster collaborations, and generate new ideas.

CAMMSE Center Director and Associate Directors have been actively serving on many editorial boards (e.g., Associate Editor of the *IEEE Transactions on Intelligent Transportation Systems*, *ASCE Journal of Transportation Engineering, Part A: Systems*, and *International Journal of Transportation Science and Technology*, Journal of *Transportation of the Institute of Transportation Engineers,* Editorial board of the *Institute of Transportation Engineers, Transportation Letters, Transportmetrica A: Transport Science)* and many professional committees (e.g., member of the ASCE Connected & Autonomous Vehicles Impacts Committee, ASCE Advanced Technologies Committee, ASCE Public Transport Committee, ASCE Rail Transportation Committees; member of the TRB Standing Committees (AHB60, AHD60, AP025, ADB10, ABR10, ABJ70, AFN30, ADC20, ADC60, and AFP40), session chair of INFORMS, and at large

member of PENC state board, etc.) as well as proposal, book review committees (e.g., NCHRP, NSF, NDSEG, Cognella, Inc., and Luxembourg National Research Fund), the dissertation award committee of the Hong Kong Society of Transportation Studies, the Chair for Session for Pavement Materials: Recent Advances, GeoShanghai 2018 Conference, and the chair of the Organizing Committee of TRB ADC 60 (Committee on Resource Conservation and Recovery) Summer 2018 Workshop.

Education and Workforce Development

CAMMSE has been working with Institute of Transportation Engineers (ITE) Student Chapter at UNCC in supporting and hosting the bi-weekly transportation seminar series in which guest speakers are invited to UNCC to present their current project activities while classes are in session. The target audience is current students and the local university community. Dr. Fan's transportation research group has also been conducting graduate student seminars on a weekly basis.

CAMMSE Center Staff (Drs. Wei Fan, Miguel Pando, David Weggel, Martin Kane, and Yu Wang) has been meeting on a bi-weekly basis. Topics discussed among these important regular meetings will include, but are not limited to, the annual research symposium in the summer, annual summer camp at UNC Charlotte, research, education and outreach as well as technology transfer activities. In particular, Dr. Miguel Pando, CAMMSE Assistant Director of Education and Outreach, has successfully led several education and outreach activities at UNCC for CAMMSE during this reporting period. Such activities are detailed as follows:

- Coordinated the design of Middle and High school outreach activity on Modes of Transportation, which was also presented to UNCC members of CAMMSE center for feedback and comments.
- Organized, planned, and coordinated the 2018 CAMMSE Summer Transportation Engineering camp held at UNC Charlotte from June 11-15, with input and regular planning meetings with Drs. Wei Fan and David Weggel. Summer camp program also included input from Dr. Martin Kane who led two traffic field trip activities during the camp.
    - Camp consisted of a total of 35 camp hours with an attendance of 15 high school students.
    - Sent out the summer camp review forms and received emails form parents of participants with excellent reviews.
- Conducted outreach to recruit underrepresented minority students for 2018 CAMMSE Transportation Engineering camp.
    - Contacted Communities of Charlotte-Mecklenburg Schools (CMS), UNCC Center for STEM Education, and Cabarrus Schools.
- Led scholarship review committee to select 2 campers for free registration (Gift by Stewart Engineering).
    - Selected 2 students out of 15 applicants.
- Organized, planned, and coordinated a STEM Blasters Educational activity for High School students, which was held at UNC Charlotte in the week of June 18 for 3 hours a day (total 15 hours, with Dr. Martin Kane).

    - Activity for Center of STEM Education at UNC Charlotte (Dr. Shagufta Raja, Director of Pre-College STEM programs).
- Reached out to several Middle and High schools in the CMS and Cabarrus school system for Education, Outreach and Training (EOT) activities in 2018-2019 School Year.

On May 8, 2018, CAMMSE Staff Dr. Martin Kane gave a presentation to Boy Scout meeting about Transportation and the title of the presentation was “What is Transportation?” Dr. Martin Kane also attended the Annual Professional Engineers of North Carolina (PENC) meeting from June 7 to 9, 2018.

Three Ph.D. students of CAMMSE (Zhen Chen, Pengfei Liu and Zijing Lin) served as a volunteer and helped organize the CAMMSE'S Transportation Engineering Summer Camp from June 11-15, 2018 on the UNC Charlotte campus. This summer camp is a partnership between UNC Charlotte's Civil and Environmental Engineering Department and Camps on Campus and is a grant-supported educational activity with the US DOT University Transportation Center CAMMSE. Students also conducted outreach activities for CAMMSE.

At WSU, materials from the CAMMSE project were used in teaching two transportation related courses: Econometrics II (Ph.D. level, 25 students), Econometrics IV (Ph.D. level, 20 students), and Topics in Applied Microeconomics (Ph.D. level, 8 students).
A list of students that were supported by CAMMSE were selected for many awards:

- Sen Du, Richard Perteet Graduate Fellowship, 2018.
- Jialuo He, Richard Perteet Graduate Fellowship, 2018.
- Yan Zhang, Smart & Green Infrastructure Research Scholarship, 2018.

At TSU, graduate students supported by CAMMSE received many awards, including:

- Texas ITE Houston Section Scholarship 2018: Akintola Aremu, Qiao Sun, Lan Lan;
- The International Transportation Management Association 2018: Akintola Aremu, Ibukunoluwa Oyelade;
- The Transportation Club of Houston Scholarship 2018: Tao Tao;
- The International Transportation Management Association 2018: Tao Tao, Akintola Aremu.

The TSU Summer Maritime Academy (SMA) was held from June 11-15, 2018, on the campus of TSU. The day camp was designed to introduce rising high school sophomores through seniors to maritime transportation management and the multimodal connections at US ports and to the Transportation degrees offered at TSU. Twenty-six high school students and one home schooled student attended this summery program this year.

The Summer Internship Program with Elkin High School Engineering Academy is a two-week internship program that offers high school students the opportunity to work with professors and graduate students in TSU’s research labs, enabling them to participate

in various research projects and learn about many of the tools and software programs that were used for transportation research purposes. Students from Elkin High School were selected for working as interns in TSU research lab during this summer. They worked on research projects related to improving transportation mobility and safety.

The Fast Forward Leadership and Skills Development Workshop was held on April 25, 2018, on the campus of TSU. It is a signature event of the Department of Transportation Studies. The event was designed to focus on leadership and soft skills training that the students may not receive in a traditional classroom setting. Workshop topics included: Professional Communication Skills, Leading with Excellence, Conflict Resolution, and Dealing with Change.

In particular, students funded by CAMMSE projects have received notable national and regional awards including: *Roy D. Williams Memorial Scholarship*, *Dwight Eisenhower Fellowship, the excellent paper award in the 2018 World Transport Convention, WTS Diane Woodend Jones Leadership Legacy Scholarship, International Road Federation Fellowship, ITMA Scholarship and Texas ITE Houston Section Scholarship.*

Technology Transfer

A draft Technology Transfer (T2) Plan was completed (an effort led by Dr. David Weggel) and submitted to USDOT for review on July 24, 2018. The T2 Plan was later presented to all CAMMSE PIs (e.g. UNC Charlotte and all consortium university PIs) for their review and comments during the CAMMSE Symposium in August of 2018. The CAMMSE's Technology Transfer (T2) Plan is currently under review by USDOT and will be revised and finalized based on USDOT's guidance/instructions.

At UT Austin, one of the best Technology Transfer tools are the students that work on these CAMMSE research projects. During this reporting period, two master's students from UT-Austin that were sponsored through UTC projects have graduated. These two UT-Austin students were key in the technology development and have both gone to work in the Transportation Engineering industry. They will carry the new technology with them and use it in their new jobs, teach peers how to use the technology, thereby implementing the technology. Most importantly, these new techniques will continue to grow and improve as they are used. The professors at UT-Austin have also used their classes to teach the new techniques developed through the CAMMSE UTC, therefore planting the new technology in students that are not directly supported by the UTC.

CAMMSE faculty, staff, researchers and students have been making presentations at different meetings including First Annual National Mobility Summit of US DOT University Transportation Centers, the ASCE International Conference on Transportation & Development (ICTD 2018), the 2018 Autonomous Vehicles Symposium (AVS), 2018 Southern District ITE (SDITE) Annual Meeting, the 2018 World Transport Convention (WTC), the North Carolina Turnpike Authority (NCTA) Automated Vehicle Proving Ground (AVPG) partnership meeting, 18th COTA International Conference of Transportation Professionals (CICTP 2018), the Chinese Overseas Transportation

Association (COTA) 21st Annual Winter Symposium, five different universities in China (Shijiazhuang Tiedao University, Tongji University, Shanghai Maritime University, Wuhan University of Science and Technology, and Dalian University of Technology), the CSCE Annual Meeting 2018, the 15th IFAC Symposium on Control in Transportation Systems (CTS 2018), and the GeoShanghai 2018 Conference.

Collaboration

CAMMSE created a diverse collaboration network with different state and local government agencies, and educational and professional organizations, as well as community practitioners. CAMMSE also worked to build collaborative relations with international transportation centers and universities.

CAMMSE Center Staff (Drs. Wei Fan, Miguel Pando, David Weggel, Martin Kane, and Yu Wang) has been meeting on a bi-weekly basis. Topics discussed among these important regular meetings will include, but are not limited to, the annual research symposium in the summer, annual summer camp at UNC Charlotte, research, education and outreach as well as technology transfer activities.

CAMMSE Center Director Dr. Wei Fan attended the Workshop on Traffic Signal Timing Practice and Research that was held on May 11-13, 2018 in Reno, Nevada, and met with Dr. Zong Tian and Dr. Hao Xu and discussed the potential for research collaboration in the future. CAMMSE Director Dr. Wei Fan attended the North Carolina Turnpike Authority (NCTA) Automated Vehicle Proving Ground (AVPG) Third Partnership Meeting on July 24, 2018 at UNC Charlotte in Charlotte, NC. Dr. Wei Fan gave an update on CAMMSE's involvement with ASCE Connected & Autonomous Vehicles (CAV) Impacts Committee and also recent progress on two CAV-related research projects conducted by Dr. Fan and his research team within CAMMSE. Dr. Fan was also invited to give presentations at five different universities in China (including Shijiazhuang Tiedao University, Tongji University, Shanghai Maritime University, Wuhan University of Science and Technology, and Dalian University of Technology) and a collaborative relationship is currently being developed between UNC Charlotte and these universities.

UT-Austin collaborated with the City of Austin and Capital Metropolitan Transportation Authority. UT-Austin also partnered with the Women in Transportation Seminar Heart of Texas (WTS-HOT) Student Chapter and the Institute of Transportation Engineers (ITE)/ Intelligent Transportation Systems (ITS) Student Chapter.

At WSU, during this time period, Dr. Jia Yan (WSU) served as a visiting professor at Nankai University and Tianjin Chengjian University. Dr. Xianming Shi (WSU) served as a visiting professor at Wuhan Polytechnic University, China. Dr. Shi also hosted two visiting scholars from Wuhan University of Science & Technology, and Central South University of Forestry & Technology, China, respectively. The Washington State Department of Transportation (WSDOT) provided in-kind support for the CAMMSE 2018 Project 16, by donating salt for the pre-wet deicer project; the Montana State University

was a collaborator as well, as this research utilized the MSU Subzero Sci. & Tech. Facility.

TSU collaborates with Houston-Galveston Area Council (HGAC) to provide internship positions for graduate students. Dr. Yi Qi collaborated with Qilu University of Technology on a CAMMSE research project. Dr. Wenrui Qu and her students provided assistance on field data collection. TSU collaborated with Propeller Club Port of Houston to establish a student auxiliary chapter in TSU, which provides the opportunity for our students to receive the scholarship from the club, and attend the club meetings and events, etc. It will help them in establishing and advancing their careers.

Diversity

Several Ph.D. students from underrepresented groups have been hired to conduct CAMMSE's research during this reporting period. For example, at UNCC, five international graduate students (Mr. Maio Yu, Mr. Zhen Chen, Mr. Yang Li, Ms. Zijing Lin and Mr. Pengfei Liu from China) joined the INES Ph.D. program and they have been working as CAMMSE research assistants. Mr. Bo Qiu, although is currently not financially supported by CAMMSE, has also been an advisee of Dr. Fan. UT-Austin students sponsored by CAMMSE come from all sort of diverse backgrounds, including international students. UT-Austin supported students include three females (Ms. Zenia, Ms. Jennifer, and Ms. Amelia) and five males (Mr.Hao, Mr. Mengyu, Mr. Abdullah, Mr. Cesar, and Mr. Santhosh) through CAMMSE. One female research engineer (Michelle Akin, P.E., WSU) and one female visiting scholar (Dr. Yaqin He, WSU) was actively involved in the CAMMSE 2017 Project 9.

1.3. What opportunities for training and professional development has the program provided?

The bi-weekly seminars are open to the general public, particularly to the local and state transportation agencies, as well as the industry practitioners.

In particular, the Fast Forward Leadership and Skills Development Workshop was held on April 25, 2018, on the campus of TSU. It is a signature event of the Department of Transportation Studies. The event is designed to focus on leadership and soft skills training that the students may not receive in a traditional classroom setting. Workshop topics included: Professional Communication Skills, Leading with Excellence, Conflict Resolution, and Dealing with Change.

1.4. How have the results been disseminated?

News items and information about graduate seminars have been regularly posted on the website at https://cammse.uncc.edu/news.

In particular, as mentioned before, UNC Charlotte has made many presentations both nationally and internationally. UT-Austin has also presented the results internationally at the Canadian Society of Civil Engineers (CSCE) Conference in June 2018 and has published results at the 15th IFAC Symposium on Control in Transportation Systems in June 2018.

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

The following tasks are planned in order to accomplish the goals and objectives of CAMMSE.

(1) All final project reports that have been completed will be provided to the Transportation Research Board (Transport Research International Documentation database), the National Transportation Library, the U.S. DOT's Research Hub, the Transportation Library, the Volpe National Transportation Systems Center, FHWA's Research Library, and the U.S. Department of Commerce as required by OST-R.
(2) For all research projects that were selected for funding in 2019 year 3, the CAMMSE project information forms will be posted and updated on the CAMMSE website as well as on RiP once the subcontracts are officially signed.
(3) Finalize revising the CAMMSE's Technology Transfer (T2) Plan based on USDOT's guidance/instructions.
(4) CAMMSE plans to be featured in the spotlight newsletter for USDOT UTC programs in March 2019.
(5) Attend NC Section Institute of Transportation Engineers (NCSITE) and Southern District ITE (SDITE) Annual Meetings, as well as the 2019 TRB 98th Annual Meeting to present papers based on research.

2. PRODUCTS

2.1. Publications, conference papers, and presentations

Publications

[1] Chen, Z. and Fan, W., A Multinomial Logit Model of Pedestrian-Vehicle Crash Severity in North Carolina, Accepted for publication in *International Journal of Transportation Science and Technology*, October 2018.

[2] Jiang, Z., Gu, J.J., Han, Y.Z., Fan, W. and Chen, J.J., Modeling Actual Dwell Time for Rail Transit Using Data Analytics and Support Vector Regression, *ASCE Journal of Transportation Engineering, Part A: Systems*, Volume 144 Issue 11, 04018071, 2018.

[3] Jiang, Z.B., Gu, J.J., Fan, W., Liu, W. and Zhu, B.Q. Q-Learning Approach to Coordinated Optimization of Passenger Inflow Control with Train Skip-stopping on a Urban Rail Transit Line, Accepted for Publication in *Computers & Industrial Engineering*, https://www.sciencedirect.com/science/article/pii/S0360835218302596, In Press, June, 2018.

[4] Li, Y. and Fan, W., Modelling the Severity of Pedestrian-Injury in Pedestrian-Vehicle Crashes in North Carolina: A Partial Proportional Odds Logit Model Approach, Accepted for Publication in *Journal of Transportation Safety & Security*, https://doi.org/10.1080/19439962.2018.1483989, In Press, October 2018.

[5] Liu, H., Claudel, C. and Machemehl, R.B. A Stochastic Formulation of the Optimal Boundary Control Problem Involving the Lighthill Whitham Richards Model. *IFAC-PapersOnLine*, *51*(9), pp.337-342, 2018.

[6] Liu, K., Zhang, K., Shi, X. Performance Evaluation and Modification Mechanism Analysis of Asphalt Binder Modified by Graphene Oxide. *Construction and Building Materials*, 163, 880-889, 2018.

[7] Yan, Jia, The effect of merger on airline efficiency: evidence from China, forthcoming in the *International Journal of Industrial Organization*, with Xiaowen Fu, Kun Wang and Tae Oum, 2018.

[8] Yan, Jia, Vehicle Size Choice and Automobile Externalities: A Dynamic Analysis, forthcoming in the *Journal of Econometrics*, with Clifford Winston, 2018.

[9] Yu, M. and Fan, W., Accessibility Impact of Future High Speed Rail Corridor on the Piedmont Atlantic Megaregion, *Journal of Transport Geography*, Volume 73, pp. 1-12, 2018.

[10] Yu, M. and Fan, W., Optimal Variable Speed Limit Control at a Lane Drop Bottleneck: Genetic Algorithm Approach, *ASCE Journal of Computing in Civil Engineering*, Volume 32 Issue 6, 04018049, pp. 1-17, 2018.

[11] Yu, M. and Fan, W., Optimal Variable Speed Limit Control in a Connected Autonomous Vehicle Environment for Relieving Freeway Congestion, Accepted

for publication in *ASCE Journal of Transportation Engineering, Part A: Systems*, September 2018.
[12] Zhao, Q., Goodman, T., Azimi, M. and Qi, Y. Roadway-Related Truck Crash Risk Analysis: Case Studies in Texas. *Transportation Research Record*, p.0361198118794055, 2018.

Conference papers

[1] Baumanis, Carolina, Jennifer Hall, and Randy Machemehl. Comparing Cyclist Behavior Among Three Urban Test Beds in Austin, TX, *Proceedings of the CSCE Annual Meeting*, June 2018.

Presentations

[1] Baumanis, Carolina, Jennifer Hall, and Randy Machemehl (2018) "Comparing Cyclist Behavior Among Three Urban Test Beds in Austin, TX, Presentation given at the CSCE Annual Meeting, June 2018.
[2] Fan, W. and Chen, Z., Estimation of Origin-Destination Matrix Using Public Transit Smart Card Transaction Data, Presented at the ASCE International Conference on Transportation & Development (ICTD) 2018, Wyndham Grand Pittsburgh Downtown Hotel, Pittsburgh, PA. Wednesday, July 18, 2018.
[3] Fan, W. and Yu, M., Accessibility Impact of Future High-Speed Rail Corridor on the Piedmont Atlantic Megaregion, 2018 World Transport Convention, China National Convention Center, Beijing, China. Wednesday, June 20, 2018.
[4] Fan, W. and Yu, M., Optimal Variable Speed Limit Control for the Mixed Traffic Flows in a Connected and Autonomous Vehicle Environment, Presented at the ASCE International Conference on Transportation & Development (ICTD) 2018, Wyndham Grand Pittsburgh Downtown Hotel, Pittsburgh, PA. Wednesday, July 18, 2018.
[5] Fan, W. and Yu, M., Optimal Variable Speed Limit Control in a Connected Autonomous Vehicle Environment for Relieving Freeway Congestion, Presented at the Automated Vehicles Symposium 2018, Golden Gate 5, Hilton San Francisco Union Square, Monday, July 9, 2018.
[6] Fan, W. and Yu, M., Optimal Variable Speed Limit Control in a Connected Autonomous Vehicle Environment for Relieving Freeway Congestion, Poster Session at the Automated Vehicles Symposium 2018, Exhibit Hall, Hilton San Francisco Union Square, Monday, July 9, 2018.
[7] Fan, W. and Yu, M., Optimal Variable Speed Limit Control in an Autonomous Vehicle Environment for Relieving Freeway Congestion, Presented at the Automated Vehicles Symposium 2018, Golden Gate 2, Hilton San Francisco Union Square, Wednesday, July 11, 2018.
[8] Fan, W. and Yu, M., Tabu Search Strategies for Variable Speed Limit Control at a Lane Drop Bottleneck, 2018 World Transport Convention, China National Convention Center, Beijing, China. Wednesday, June 20, 2018.
[9] Fan, W. Mobility Research Projects at Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE), University Research Panel, the First

Annual National Mobility Summit of US DOT University Transportation Centers, April 12, 2018, Washington, D.C.
[10] Fan, W., Data Analytics Approach to Identifying and Ranking Freeway Bottlenecks: A Case Study in Charlotte, North Carolina, 2018 World Transport Convention, China National Convention Center, Beijing, China. Wednesday, June 20, 2018.
[11] Fan, W., Developing a Systematic Approach to Identifying and Ranking Freeway Bottlenecks Using Vehicle Probe Data, Spotlight Session 4: “Innovation in Multimodal Transportation System", Meeting Room 6, Xijiao Hotel, Beijing, China. Saturday, July 7, 2018.
[12] Fan, W., Developing a Systematic Approach to Improving Bottleneck Analysis in North Carolina, Presented at the ASCE International Conference on Transportation & Development (ICTD) 2018, Wyndham Grand Pittsburgh Downtown Hotel, Pittsburgh, PA. Monday, July 16, 2018.
[13] He., J., Shi, X. Opportunities and Challenges of the Use of Bio-based Additives to Pavement: A Review. Transportation Research Board ADC 60 (Committee on Resource Conservation and Recovery) Summer 2018 Workshop, July 16, 2018, Spokane, WA.
[14] Mondal, A., & Konduri, K. C. (2018, August). Synthesizing Household and Person-level Attributes using Hidden Markov Model. Poster session presented at the Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE) Symposium 2018, Charlotte, NC.
[15] Nazari, M.H., Shi, X. New Green Deicers Prepared from Local Fruit Wastes Using an Innovative Method. Transportation Research Board ADC 60 (Committee on Resource Conservation and Recovery) Summer 2018 Workshop, July 16, 2018, Spokane, WA.
[16] Shi, X. Mechanical Performance of Asphalt Binder Modified with Graphene Oxide and Warm Mix Additives. Transportation Research Board ADC 60 (Committee on Resource Conservation and Recovery) Summer 2018 Workshop, July 16, 2018, Spokane, WA.
[17] Shi, X., Akin, M., He, Y. The Potential Impacts of Connected Vehicle Technology in Improving Multimodal Winter Travel. 2018 CAMMSE Research Symposium, August 6, 2018, Charlotte, NC.
[18] Shi, X., Liu, K. Mechanical performance and modification mechanism of asphalt modified with graphene oxide and warm mix additives. Presentation invited by the GeoShanghai 2018 Conference, May 30, 2018, Shanghai, China.
[19] Shi, X., Nazari, M.H. Best Practices in Preventing & Mitigating the Corrosion Risk of Roadway Deicers to Winter Maintenance Equipment. April 5, 2018, Presentation invited by the Corrosion Protection Technology (CPT) for Winter Maintenance: A Peer Exchange Workshop, by the University of California, Davis, and California Department of Transportation. Davis, CA.
[20] Zhang, Yan, Lathan Card, Michelle Akin, Xianming Shi (2018) “Optimal Prewet Deicer Performance Determined from Laboratory Tests” Poster Presentation at First Annual CAMMSE Research Symposium, Charlotte, NC, August 6–7, 2018.

2.2. Website(s) or other internet site(s)

The CAMMSE website is located at http://cammse.uncc.edu/. This website has been used to disseminate any information related to the program.

On Friday, April 27, 2018, CAMMSE Director Dr. Wei Fan was interviewed by WSOCTV's Blaine Tolison about I-485 interchange designs and wrong-way driving and a full story can be viewed via this link "Get the Full Story".

2.3. Technologies or techniques

Nothing to report.

2.4. Inventions, patent applications, and/or licenses

Nothing to report.

2.5. Other products

CAMMSE Graduate Seminar Series @ UNCC, Sponsored by CAMMSE

[1] "Left-turn Crossover Distance for Displaced Left Turn Intersection Design", presented by Qiao Sun (CAMMSE graduate research assistant), April 18, 2018, EPIC CEE Conference Room 3344.
[2] "Exploring Users' Activities and the Impact of Attributes on Bike Share Demand at the Station Level: A Case Study in Houston, Texas", presented by Akintola Aremu (CAMMSE graduate research assistant), April 18, 2018, EPIC CEE Conference Room 3344.
[3] "Safety Performance of Displaced Left Turn Intersections: Case Studies in San Marcos, Texas", presented by Dr. Yi Qi.
[4] "Determining the Accuracy of Vessels' Estimated Time of Arrival in a Multimodal System", presented by Dr. Mehdi Azimi.
[5] "Impact of Connected and Automated Vehicles on Freeway Capacity - Design Simulation Scenarios", Presented by Mr. Pengfei Liu (CAMMSE INES Ph.D. research assistant), 10-11am, April 26, 2018, EPIC CEE Conference Room 3344.
[6] "Modeling Cycling Route Choice with Expanded Path Size Logit Model", Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 10-11am, May 09, 2018, EPIC CEE Conference Room 3344.
[7] "USING GTFS TO ASSESS TRANSIT EQUITY - Data Assembling and Methodology Explanations", Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 9-10am, August 22, 2018, EPIC CEE Conference Room 3344.

[8] "Optimal Variable Speed Limit in a CAV Environment", Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 9-10am, August 29, 2018, EPIC CEE Conference Room 3344.
[9] "Long-term Travel Time Reliability Analysis", Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 9-10am, September 5, 2018, EPIC CEE Conference Room 3344.
[10] "Impact of Connected and Automated Vehicles on Freeway Capacity - Numerical Results", Presented by Mr. Pengfei Liu (CAMMSE INES Ph.D. research assistant), 9-10am, September 12, 2018, EPIC CEE Conference Room 3344.
[11] "Modeling Bicycle Volume with Strava Data: Data Processing and Result Analysis", Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 9-10am, September 19, 2018, EPIC CEE Conference Room 3344.
[12] "Using GTFS to Assess Transit Equity - Case Study and Numerical Results", Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 9-10am, September 26, 2018, EPIC CEE Conference Room 3344.
[13] "Integrated Connected Autonomous Vehicles Platooning and Optimal Variable Speed Limit Control on Freeways", Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 9-10am, October 03, 2018, EPIC CEE Conference Room 3344.
[14] "Travel Time Reliability Prediction", Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 9-10am, October 10, 2018, EPIC CEE Conference Room 3344.
[15] "Impact of Connected and Automated Vehicles on Freeway Capacity — Calibration", Presented by Mr. Pengfei Liu (CAMMSE INES Ph.D. research assistant) made a presentation, 9-10am, October 17, 2018 at EPIC CEE Conference Room 3344.

ITE Seminar Series @ UNCC, Co-organized and sponsored by UNCC ITE Student Chapter and CAMMSE

[1] "Resume Building" by Mr. Patrick Madsen from UNCC Career Center. Location: EPIC 3226, October 10, 2018.
[2] The Young Member Committee from NCSITE came to UNCC for networking and the meeting was co-hosted by UNCC ITE Student Chapter and CAMMSE. Location: EPIC 3226, October 24.

Other Seminars

[1] "Fast Forward Leadership and Skills Development Workshop", TSU, April 25, 2018.

Technical Reports

[1] Akin, M., He, Y. and Shi, X., *The Use of Connected Vehicle Technology to Facilitate Multimodal Winter Travel*, Technical Report for CAMMSE Research Project. September 2018.

[2] Fan, W. and Chen, Z, *Estimation of Origin-Destination Matrix and Identification of User Activities Using Public Transit Smart Card Data*, Technical Report for CAMMSE Research Project. September 2018.

[3] Fan, W. and Yu, M, *Improving the Movements of People and Freight: A Case Study of the Piedmont Atlantic Megaregion*, Technical Report for CAMMSE Research Project. September 2018.

[4] Fu, Mengyu, *Characterization of cyclist behavior across built environments. M.S. Thesis. The University Texas at Austin*, UT Electronic Theses and Dissertations, 2018. (http://hdl.handle.net/2152/68176)

[5] Liu, H. and Machemehl, R., *Corridor Level Adaptive Signal Control*, Interim Technical Report for CAMMSE Research Project. September 2018.

[6] Lownes, N., *Robust Routing, Assignment, and Simulation of Transit Systems*, Technical Report for CAMMSE Research Project. September 2018.

[7] Kilgore, S. and Machemehl, R., *Forecasting Ridership for Commuter Rail in Austin*, Technical Report for CAMMSE Research Project. September 2018.

[8] Konduri, K. and Mondal, A. *Stochastic Multimodal Network Modeling: Hidden Markov Model Based Synthetic Population Generation for Use in Microsimulation Models Of Transit Systems*, Technical Report for CAMMSE Research Project. September 2018.

[9] Mehdi Azimi *et al., Predicting The Vessel Arrival Times to The Port of Houston Container Terminals: A Machine Learning Approach in Lieu of The Vessels' Operator Input Estimated Time of Arrival*, Technical Report for CAMMSE Research Project. September 2018.

[10] Qi, Y. *et al., Use of Innovative Intersection Designs for Roadway Traffic Congestion Mitigation*, Technical Report for CAMMSE Research Project. September 2018.

[11] Yahia, Cesar, *Unmanned Aerial Vehicle Path Planning for Traffic Estimation and Detection of Non-Recurrent Congestion*. M.S. Thesis. The University Texas at Austin, UT Electronic Theses and Dissertations, 2018.

[12] Yan, J., *The Effect of Competition of Transport Modes on Mobility*, Technical Report for CAMMSE Research Project. September 2018.

Software Products

CAMMSE research will result in enhancements to existing open-source software projects including:

[1] PopGen: see https://github.com/foss-transportationmodeling/popgen/releases, and

[2] DaySim: see https://github.com/RSGInc/DaySim/releases.

3. PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS

3.1. Who has worked on the program?

The members of CAMMSE UTC include the University of North Carolina at Charlotte (UNCC); the University of Texas at Austin (UT Austin); the University of Connecticut (UConn); Washington State University – Pullman (WSU); and Texas Southern University (TSU). Table 1 lists the leadership team members who have worked on the program during this reporting period.

Table 1. CAMMSE Staff Working on the Program

Name	Wei Fan	Randy Machemehl	Nicholas Lownes	Xianming Shi	Yi Qi
Program/Project Role	Center Director	Associate Director at UT Austin	Associate Director at UConn	Associate Director at WSU	Associate Director at TSU
Contribution to Program/Project	Oversees overall operations of the program. Responsible for coordinating with stakeholders and developing and implementing the CAMMSE strategic plan	Serves as liaison between CAMMSE and UT Austin	Serves as liaison between CAMMSE and UConn	Serves as liaison between CAMMSE and WSU	Serves as liaison between CAMMSE and TSU
Funding Support	UNCC	UT Austin	UConn	WSU	TSU
Collaborated with Individual(s) in Foreign Country(ies)	Yes	No	Yes	Yes	Yes
Country(ies) of Foreign Collaborator(s)	P.R.China	No	Australia	P.R.China	P.R.China
Traveled to Foreign Country(ies)	N/A	N/A	N/A	N/A	N/A
If traveled to foreign country(ies), duration of stay	N/A	N/A	N/A	N/A	N/A

3.2. What organizations have been involved as partners?

Table 2 provides a list of the organizations that have partnerships with CAMMSE.

Table 2. A List of Organizations Creating Partnerships with CAMMSE

Organization Name	Type / Location	Partners Contribution to Project				
		Financial Support	In-kind Support	Facilities	Collaborative Research	Personal Exchanges
Capital Metro – Austin Public Transit	Government /TX		X	X		
Centralina Council of Governments	MPO/NC		X			
Charlotte Area Transit System	Government /NC		X			
City of Austin	Government /TX		X	X		
City of Charlotte	Government /NC		X			
Connecticut Department of Transportation	Government /CT				X	
CTTransit	Transit Operator				X	X
Houston Bike Share	Non-profit/ TX				X	
Houston-Galveston Area Council					X	
North Carolina Department of Transportation	Government /NC		X			
North Carolina Turnpike Authority Automated Vehicle Proving Ground (NCTA-AVPG)	Government /NC				X	
Northeast Forestry University	University /China				X	
Propeller Club Port of Houston					X	
Qilu University of Technology					X	X
Texas Department of Transportation	Government /TX		X	X		
Texas Southern University	University /TX	X	X	X		
Tongji University	University /China				X	
University of Arizona	University /AZ				X	
University of Houston	University /TX				X	
University of Connecticut	University /CT	X	X	X		
University of North Carolina at Charlotte	University /NC	X	X	X		
University of Texas at Austin	University /TX	X	X	X		
Washington Department of Transportation	Government /WA				X	
Washington State University	University /WA	X	X	X		

Our CAMMSE UTC has successfully established an external advisory board which will contain members from a variety of universities and government agencies. The detailed information about all five advisory board members is provided below:

- Dr. Michael Accorsi, Professor and Senior Associate Dean, School of Engineering, University of Connecticut.
  Email: michael.accorsi@uconn.edu
- Dr. Amit Bhasin, Director, Center for Transportation Research, Associate Professor, Transportation Engineering, The University of Texas at Austin.
  Email: a-bhasin@mail.utexas.edu
- Elizabeth Robbins, Planning Policy & Partnerships Manager, Multimodal Planning Division, Washington State Department of Transportation.
  Email: robbins@wsdot.wa.gov
- Neil Mastin, Research and Development Manager, North Carolina Department of Transportation.
  Email: jmastin@ncdot.gov
- Wade Odell, Research Engineer, Texas Department of Transportation.
  Email: Wade.Odell@txdot

3.3. Have other collaborators or contacts been involved?

Dr. Wei Fan, CAMMSE Director, has been making presentations, working, co-writing and publishing papers with faculty and researchers from the Key Laboratory of Road and Traffic Engineering, Ministry of Education and College of Transportation Engineering at Tongji University in Shanghai, P.R.China. A collaborative relationship has been successfully developed between two universities. Dr. Fan was also invited to give presentations at four other universities in China (Shijiazhuang Tiedao University, Shanghai Maritime University, Wuhan University of Science and Technology, and Dalian University of Technology) is currently building a collaborative relationship with these universities.

TSU established a collaboration with Houston Bike Share, a 501(c)(3) non-profit organization the bike share program (Houston BCycle) in Houston. Dr. Mehdi Azimi talked to a member of the board of directors and also the Executive Director. Houston Bike Share shared the ridership data including trip start time and date, trip end time and date, trip duration, start station, end station, number of docks per station, bicycle id, etc. to be used in CAMMSE's research project.

4. IMPACT

The CAMMSE is currently conducting a variety of research, education and outreach, technology transfer, and diversity activities and as such, the impact of this program cannot be measured during this reporting period.

4.1. What is the impact on the development of the principal discipline(s) of the program?

Results from UT-Austin's 2018 Project 06, Characterization of Bicycle Rider Behavior among Various Street Environments may provide a basis for changes in traffic control device application to bicycle traffic. The study used field observations of bicycle riders to measure their responses to control devices across a variety of situations ranging from control device rich environments to those with no bicycle control devices. Rider compliance varied inversely with the richness of the control device environment indicating, at least in some cases, more control devices may not be better.

4.2. What is the impact on other disciplines?

The results from UT-Austin's 2018 Project 06 Characterization of Bicycle Rider Behavior among Various Street Environments can be applied to Human Behavioral/Social Science and Urban Planning disciplines.

4.3. What is the impact on the development of transportation workforce development?

During this reporting period, two master's students from UT-Austin that were sponsored through UTC projects have graduated. These two UT-Austin students were key in the technology development and have both gone to work in the Transportation Engineering industry.

4.4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?

Information developed through UT-Austin's research is being shared with the City of Austin as the City functions as a partner in the research efforts. UT Austin students are invited to spend time in the City Traffic Control Center representing a valuable learning environment, but the learning is really two-way as the City engineers and students learn from each other.

4.5. What is the impact on technology transfer?

The CAMMSE-supported students that have graduated during this reporting period will carry the new technology that they have helped develop with them for the rest of their careers. This new technology will be used their new jobs, and they will teach peers how to use the technology, thereby implementing the technology. Most importantly, these new techniques will continue to grow and improve as they are used.

4.6. What is the impact on society beyond science and technology?

Through events like “UNCC STEM Blasters for High School Students”, “The TSU Summer Maritime Academy (SMA)” and “CAMMSE'S Transportation Engineering Summer Camp”, CAMMSE has provided a medium for sponsored students to develop important soft skills. All these events required that students interact with the local community and think of creative ways to portray complicated concepts in a simple and easy to understand way. Students also had to use creativity to think of an interesting way to capture young children’s attention and keep them engaged. The CAMMSE has had impacted both the local community and the sponsored students by encouraging creativity and fostering human-to-human connections.

In particular, the direct impact of UT-Austin’s projects is a better understanding of how to improve multi-modal mobility (i.e., vehicles, cyclists) and safety (i.e., the interaction between cyclists and motorists).

5. CHANGES/PROBLEMS

5.1. Changes in approach and reasons for change

Nothing to report.

5.2. Actual or anticipated problems or delays and actions or plans to resolve them

Due to some reasons, a few CAMMSE Year 2 research projects have been experiencing some delays. For example, due to the award timing and the contracting issues and primarily due to the lack of time to recruit students for the projects, the three Year 2 research projects at the University of Connecticut (UCONN) were not able to get off the ground. As such, a no-cost extension for these projects was needed through September 30, 2019, which would give researchers at UCONN more time to complete all research projects and submit final reports and participate in the Annual CAMMSE Research Symposium in November 2019. To resolve them, Dr. Nicholas Lownes, the Associate Director of CAMMSE at UCONN has been actively working with his grant management staff so that when Year 3 funds come in, if 75% of their total grant has not be expended, the new projects can get off the ground right away.

Other consortium members, including UT Austin, Texas Southern University and Washington State University, also experienced similar situations due to the award timing and the contracting issues and primarily due to the lack of time to recruit students for the projects. As such, a no-cost extension for most of their Year 2 research projects was also needed through September 30, 2019. Currently, all partner institutions have been working extremely hard to address these issues in order to accomplish the project objectives.

5.3. Changes that have a significant impact on expenditures

Nothing to report.

5.4. Significant change in use or care of animals, human subjects, and/or biohazards

Nothing to report.

5.5. Changes of primary performance site location from that originally proposed

Nothing to report.

5.6. Additional information regarding products and impacts

Nothing to report.

6. SPECIAL REPORTING REQUIREMENTS

(1) **External Advisory Board:** Available on the program website: https://cammse.uncc.edu/directory/external-advisory-board

(2) **Financial and Annual Recipient Share Reports:** The SF 425 requirements will be met by separate reports.

APPENDIX

CAMMSE @ UNC Charlotte Funded Projects, 2016-2018 (Year 1)

University	Principle Investigator	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Estimation of Origin-Destination Matrix and Identification of User Activities Using Public Transit Smart Card Data
	Wei Fan	Applied Research	Improving the Movements of People and Freight: A Case Study of the Piedmont Atlantic Megaregion
University of Texas at Austin	Randy Machemehl	Applied Research	Forecasting Ridership for Commuter Rail in Austin
	Randy Machemehl	Advanced Research	Corridor Level Adaptive Signal Control
University of Connecticut	Nicholas Lownes	Basic Research	Stochastic Multimodal Network Modeling
	Nicholas Lownes	Basic Research	Robust Routing, Assignment, and Simulation of Transit Systems
Washington State University	Xianming Shi	Applied Research	The Use of Connected Vehicle Technology to Facilitate Multimodal Winter Travel
	Jia Yan	Applied Research	The Effect of Competition of Transport Modes on Mobility
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Use of Vessel Automatic Information System Data to Improve Multi-modal Transportation in and around the Ports
	Yi Qi	Applied Research	Use of Innovative Intersection Designs for Improving Mobility and Reducing Roadway Traffic Congestion

CAMMSE @ UNC Charlotte Funded Projects, 2017-2019 (Year 2)

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Use of Multisensor Data in Modeling Freeway Travel Time Reliability
	Wei Fan Martin Kane	Applied Research	Using General Transit Feed Specification (GTFS) Data as a Basis for Evaluating and Improving Public Transit Equity
	Wei Fan Yu Wang	Applied Research	Evaluating the Potential Use of Crowdsourced Bicycle Data in North Carolina
	Wei Fan	Advanced Research	Impact of Connected and Automated Vehicles (CAVs) on Freeway Capacity
	Wei Fan	Advanced Research	Optimal Variable Speed Limit Control for the Mixed Traffic Flows in a Connected and Autonomous Vehicle Environment
University of Texas at Austin	Randy Machemehl	Applied Research	Characterization of Bicycle Rider Behavior among Various Street Environments
	Randy Machemehl	Applied Research	Evolution of Advanced Transit Signal Priority with Gap-Based Signal Recovery Strategy
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic
University of Connecticut	Nicholas Lownes Charles Patton Kelly Bertolaccini	Applied Research	Investigating the Linkage between Transit Access to Services and Affordable Housing Availability
	Karthik Charan Konduri	Advanced Research	Development of Continuous Time, Temporally Constrained and Behaviorally Consistent Tour Pattern Generation System for Modeling the Impacts of Autonomous Vehicle Future
	Norman Garrick Carol Atkinson - Palombo	Applied Research	What Do We Want from Autonomous Vehicles (AVs)? Using Participatory Planning and Scenario Analysis of Alternative Futures to Identify Stakeholders' Desired Outcomes from the Strategic Deployment of Emerging Transportation Technology
Washington State University	Xianming Shi	Applied Research	Developing Friction Data to Support the Optimal Use of Pre-wet Deicing Salt for Enhanced Winter Mobility
	Xianming Shi	Applied Research	Modeling the Macroscopic Effects of Winter Maintenance Operations on Traffic Mobility on Washington Highways
Texas Southern University	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Determination of Freeway Acceleration Lane Length for Smooth ad Safe Truck Merging
	Yi Qi Mehdi Azimi	Applied Research	Innovative Countermeasures for Reducing the Truck Waiting Time at

	Qun Zhao		Marine Terminals
	Mehdi Azimi Yi Qi Qun Zhao	Applied Research	Investigating the Impact of Different Attributes on Bicycling Mode Share as A Multimodal Connectivity Strategy in Large Cities: A Case Study in Houston

CAMMSE @ UNC Charlotte Funded Projects, 2018-2020 (Year 3)

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Applied Research	Estimating Travel Time Reliability on a Freeway Corridor: Spatial Correlation Approach
	Wei Fan Martin Kane	Applied Research	Optimizing Transit Equity and Accessibility by Integrating Relevant GTFS Data Performance Metrics
	Wei Fan Yu Wang	Applied Research	Analyzing Cycling Behavior during Different Time Periods Using Crowdsourced Bicycle Data
	Wei Fan	Applied Research	Impact of Connected and Autonomous Vehicles (CAVs) on Intersection Capacity
University of Texas at Austin	Randy Machemehl	Applied Research	Corridor Level Adaptive Signal Control (Phase II)
	Randy Machemehl	Applied Research	Quantification of Societal Bicycle Impacts
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles (Phase II)
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic (Phase II)
University of Connecticut	Jeffrey Cohen Nicholas Lownes	Applied Research	Highways and Wealth Distribution: A Geospatial Analysis
	Karthik Konduri Nalini Ravishanker	Applied Research	Are Transportation Network Companies Synergistic with Other Shared Ride Mode Offerings? An Exploratory Analysis of Demand Data from NYC Utilizing High Resolution Spatiotemporal Models
	Norman Garrick Carol Atkinson - Palombo	Applied Research	EQUITY, EXTERNALITIES & PUBLIC POLICY: Understanding the Surprising and Oversized Use of Ridesourcing Services in Poorer Neighborhoods in NYC
Washington State University	Ali Hajbabaie	Applied Research	Dynamic Speed Harmonization in Connected Urban Street Networks: Improving Mobility
	Xianming Shi	Applied Research	Effects of Incorporating Connected Vehicle Technologies into No-Notice Emergency Evacuation during Winter Weather (Phase I)
	Michelle Akin Xianming Shi	Educational Research	Multimodal Transportation Engineering Curriculum for Middle and High School Students
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Impacts of Bicycling Corridor Improvements on Users' Behaviors in Large Cities
	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Development of Guidelines for Implementation of Contraflow Left-Turn Lanes at Signalized Intersections
	Yi Qi Qun Zhao	Applied Research	Signal Timing Strategy for Displaced Left Turn Intersections

	Mehdi Azimi		

Center for Advanced Multimodal Mobility Solutions and Education