



UTC Semi-Annual Progress Report

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Center Director Name, Title, and Contact Information

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North Carolina Agricultural and Technical State University
1601 E. Market Street, Greensboro, NC 27411

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Signature of Submitting Official:

Dr. Maranda McBride, Director, Center for Advanced Transportation Mobility



1. ACCOMPLISHMENTS:

What are the major goals of the program?

The Center for Advanced Transportation Mobility (CATM) will employ multidisciplinary approaches and processes to design, develop, and implement innovative solutions to the transportation needs of vulnerable populations. CATM will utilize the knowledge, skills, and expertise of its affiliates and partners to identify the needs of individuals who are often underrepresented in the design process due to specific physical and/or mental conditions or their socio/economic status. These collaborations will be leveraged to develop and implement comprehensive research, education, workforce development, and technology transfer programs that improve access to transportation for vulnerable users.

CATM endeavors to enhance the transportation industry by achieving the following goals:

- 1) Develop innovative assistive technologies to enable safe and efficient mobility for individuals with special needs (Research).
- 2) Develop forward-looking optimization tools to effectively manage transportation system disruptions (Research).
- 3) Promote equity by increasing access to transportation educational and workforce development opportunities for underserved populations (Education, Outreach, and Workforce Development).
- 4) Disseminate knowledge about the transportation industry to a broad range of stakeholders using multiple technology transfer methods (Technology Transfer).

The overall goal of the center is to develop and implement research, education, outreach, workforce development, and technology transfer programs to address the need for improved mobility across multiple modes of transportation – primarily highway, rail, and air. In an effort to accomplish this goal, several activities took place during this reporting period. Table 1 provides a list of these activities and their statuses as of September 30, 2018.

Table 1: Progress of period 3 activities

Research	Status	% Complete
Conduct year 3 research proposal solicitation, review, and award process	On schedule	60%
Continue making progress on year 1 projects	On schedule	45%
Conduct annual visit to member institutions to obtain research status reports	On schedule	50%
Education, Outreach, and Workforce Development Activities		
Develop and conduct Spring 2018 student-to-student K-12 initiative workshops	Complete	100%
Recruit and select participants for 2018 Summer High School Transportation Institute (STI)	Complete	100%
Distribute applications for 2018 CATM Transportation Scholarship program	Complete	100%
Identify students for 2018 CATM Summer Transportation Research Internship	Complete	100%
Develop research project for 2018 research interns	Complete	100%
Hold 26 th Summer High School Transportation Institute	Complete	100%
Select 2018-19 Transportation Scholarship program awardees	Complete	100%
Conduct 2018 Eisenhower Fellowship recruitment process	On schedule	90%
Take students to 2018 Southeastern Region UTC conference	On schedule	80%
Take students to 2019 TRB conference	Forthcoming	0%
Implement NC A&T Transportation Shark Tank Competition	Behind schedule	0%
Develop transportation case for Fall case competition	Behind schedule	25%
Develop and hold transportation awareness day	Behind schedule	0%

Develop teacher/counselor transportation workshops	Behind schedule	0%
Technology Transfer Activities		
Hold the 2 nd Annual CATM Symposium	On schedule	80%
Establish the CATM Facebook page	Complete	100%
Establish the STI Facebook page	Complete	100%
Create and distribute 2017-18 CATM newsletter	Complete	100%
Create and distribute Fall 2018 newsletter	On schedule	80%
Assist with the 2018 Southeastern Region UTC Conference planning	On schedule	95%
US DOT Reporting Activities		
Complete and submit PPPR#2	Complete	100%
Create and submit Technology Transfer Plan	Complete	100%
Complete and submit 2018 performance indicator report	On schedule	90%
Complete and submit SF425 for Q6 and Q7	Complete	100%
Complete and submit recipient share report #2	On schedule	80%
Review year 1 final research reports for completed projects	Complete	100%
Upload year 1 final research reports to TRID database	Complete	100%
Complete and submit PPPR#3	On schedule	80%

What was accomplished under these goals?

Several research, education, outreach, workforce development, and technology transfer activities took place within the CATM consortium during the reporting period. Below is a summary of these activities and associated accomplishments.

Research

Table 2 provides a running list of the year 1 and 2 projects along with their current statuses, the primary research priority areas that are addressed by each project, and the link to the project abstracts. This is followed by a summary of the key accomplishments associated with each of the projects.

Table 2: Funded projects

Project Title	Status/Award Year	Research Priority Area(s)	Project Link
Public Dialysis Transport Efficiency using Digital Media	Completed/Y1	IM, TS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/2-paratransitabstract.pdf
Automated Last Mile Connectivity for Vulnerable Road Users	Continuing/Y1	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/1-last-mile-abstract.pdf
Development, Design, and Calibration of the Vulnerable Road User Mobility Assistance Platform (VRU-MAP)	Continuing/Y1	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/3-vrumap-abstract.pdf
Multi-scale Models for Transportation Systems under Emergency Conditions	Continuing/Y1	IM, RC, TS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/4_2-emergencyabstract.pdf
Analysis of the Non-Driving Mobility Needs of People with Disabilities	Continuing/Y2	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/6-mobilityneedsabstract.pdf
Asymmetric Information Sharing in Dialysis Paratransit Using an Agency Approach	Continuing/Y2	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/5-paratransit2abstract.pdf

Assessing Pedestrians' Perceptions and Willingness to Interact with Autonomous Vehicles	Continuing/Y2	IM	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/8-pedestrianperceptionsabstract.pdf
Travelers' Rationality in Anticipatory Online Emergency Response	Continuing/Y2	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/7-travelersrationalityabstract.pdf
Particle Dynamics Model for Hurricane Evacuation and Fuel Shortage: Model Based Policy Analysis	Continuing/Y2	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/9-particledynamicsabstract.pdf

IM = Improving mobility of people and goods; RC = Reducing congestion; PS = Promoting safety; ID = Improving durability and extending the life of transportation infrastructure; PE = Preserving the environment; TS = Preserving the existing transportation system

Public Dialysis Transport Efficiency using Digital Media (Paratransit)

This project was completed in January and the final report was posted on the CATM website. The link to the report was submitted to the TRID database.

Automated Last Mile Connectivity for Vulnerable Road Users (Last Mile)

A request for bids to industry to acquire a suitable low-speed automated shuttle that could be used for project testing was submitted. This request was based on the specifications developed in the previous quarter. The bidding was closed, a supplier selected, and negotiations completed with an industry supplier for the acquisition of a low-speed automated electric vehicle (LSAV) for testing. Work with Virginia Tech and the supplier is currently in progress to complete the acquisition process. Research methods are being developed using the literature review and will be finalized once the test vehicle(s), locations, and populations have been established. Work to integrate the Last Mile project with the VRU-MAP project has commenced to provide a more complete user experience for participants during testing. Discussions have been initiated with Blacksburg Transit (BT) to integrate testing with their infrastructure to make the user experience more realistic. FTA's 'Connection Protection' testing is planned for the LSAV link to the BT fixed-route transit system.

Development, Design, and Calibration of the Vulnerable Road User Mobility Assistance Platform (VRU-MAP)

During this reporting period, considerable progress was made on the core interface and functionality of the VRU-MAP application, including routing, crowd-source development, turn-by-turn directions, and porting to iOS. A sidewalk tracking system has been developed to track sidewalks with a departure warning system. This sidewalk tracking system can provide the user with essential information that can minimize the risk of an accident. This system can identify and track the sidewalks present. It can detect and display the recommended travel path in the case of shadows, unstable movements, and other defects in the road surface. Any unintended departure towards the edge of sidewalks is detected and the user is notified. In addition, potential extensions of this work to brain-computer interface are being explored since the topic is related to vulnerable road users. Some results from preliminary studies have been obtained to investigate the possibility of controlling wheelchairs using brain signals.

Multi-scale Models for Transportation Systems under Emergency Conditions (Emergency)

An optimization model for the simple airline recovery problem during a severe weather disruption was developed during this reporting period. Work is currently being conducted on the extension of the model for use with other real-world conditions. Network optimization models for

road restoration problems after a hurricane have also been developed. Work on the test of the models and the extension of the models for road restoration preparation before a hurricane is in progress. A search for Hurricane Irma data and its effects on Florida highways was completed and a cluster analysis of Annual Average Daily Traffic (AADT) data was performed to identify critical routes and highways in North Carolina. In addition, the simulation study on the effects of the gender and age of passengers on evacuation efficiency was completed and a review of the smart airport technology and application was initiated.

Analysis of the Non-Driving Mobility Needs of People with Disabilities (Non-Driving Mobility Needs)

Development and IRB approval of the data collection instrument along with initial data collection for this project were completed during the reporting period. Development of a follow-up interview protocol was also completed.

Asymmetric Information Sharing in Dialysis Paratransit Using an Agency Approach (Dialysis)

During this reporting period, a demonstration at the North Carolina Public Transit Association Meeting in Wilmington, NC was given in April. Calls and visits were made to paratransit agencies and dialysis clinics in 13 North Carolina counties. During this time, call center information was obtained to gather statistics on call center activity with dialysis clinics, Social Services, and the Councils on Aging. Also, demographics and travel data were obtained on the paratransit agencies. These statistics informed the Bayesian asymmetric analysis of this information exchange. Additionally, work with the Institute of Transportation Research was performed to better understand the secondary transit data collected on these counties.

Assessing Pedestrians' Perceptions and Willingness to Interact with Autonomous Vehicles (Pedestrian Willingness)

This project consists of 4 studies that are in various stages of completion. In study 1, participants were provided with the hypothetical scenario of interacting with an autonomous vehicle or human controlled vehicle and their willingness to cross the street assessed. Study 2 had the same design as study 1 but it added in a mediation analysis to attempt to explain if affect mediates the relationship for participants. For studies 3 and 4 hypothetical modifications to the autonomous vehicles were created where the type of equipment on-board to provide feedback to the pedestrian would be manipulated. Studies 1 and 2 have been completed and the data analysis for study 3 has commenced. The images to be used in study 4 are in the process of being drafted and study 4 is expected to be completed during the fall term.

Travelers' Rationality in Anticipatory Online Emergency Response (Travelers' Rationality)

Initial models for both travelers' choice with emergency and online dispatching have been completed for this project. The basic framework on real world transportation network simulation with emergency scenarios has been built. Preliminary results for the the travelers' choice model and online dispatching model applied on the transportation network simulation have been obtained. Even though the work is not complete, papers have been submitted to the TRB Annual Meeting to obtain feedback.

Particle Dynamics Model for Hurricane Evacuation and Fuel Shortage: Model Based Policy Analysis (Hurricane Evacuation)

During the reporting period, a computational model for particle dynamics fuel shortage estimation was developed along with a new method for parameter estimation based on an Unscented Kalman filter. In addition, traffic data for Hurricane Irma was obtained and analyzed and data for Hurricane Florence was collected. Work is currently ongoing for the particle dynamics model for evacuation.

There was a total of 33 students working as research assistants on projects within CATM during the reporting period. Table 3 provides a breakdown of these students by classification and gender.

Table 3: Demographics of student research assistants

Classification	Male	Female	Total
Undergraduate	4	6	10
Master's	4	3	7
Doctoral	11	5	16
Total	19	14	33

In addition to the four research projects currently being funded through the UTC grant, other research projects were also active within CATM during the reporting period. Table 4 provides a list of these projects and the agencies that fund them. Table 3 includes the students working on these projects as well.

Table 4: Additional transportation research project

Project Title	Funding Agency
Improving Customer Service at North Carolina License Plate Agency Offices	NC DOT
Can you hear it now? A study of personal listening devices and pedestrian safety	Southeastern Transportation Center
Antecedents of Distracted Driving: Role of Cognitive Factors	None

Education

During the reporting period, N.C. A&T students participated in experiential learning activities which included the 2018 CATM Summer Transportation Research Internship Program, the TRB and Dwight D. Eisenhower Transportation Fellowship Programs, and the GM/SAE Autodrive Challenge.

Three undergraduate students participated in the CATM Summer Transportation Research Internship Program from June 2018 through July 2018. Two of the students were senior Industrial and Systems Engineering majors and the other was a rising sophomore Accounting major. This 8-week program started off with a research workshop to prepare them for the research experience and consisted of two faculty-led research activities and transportation-related field trips. Two of the students initiated a project on the bike sharing program on N.C. A&T's campus and the other student worked on a project investigating transportation issues associated with food bank pickups. At the end of the internship, each student was required to present their research activities to the Summer Transportation High School students as well as other faculty and staff members at N.C. A&T (Figure 1).

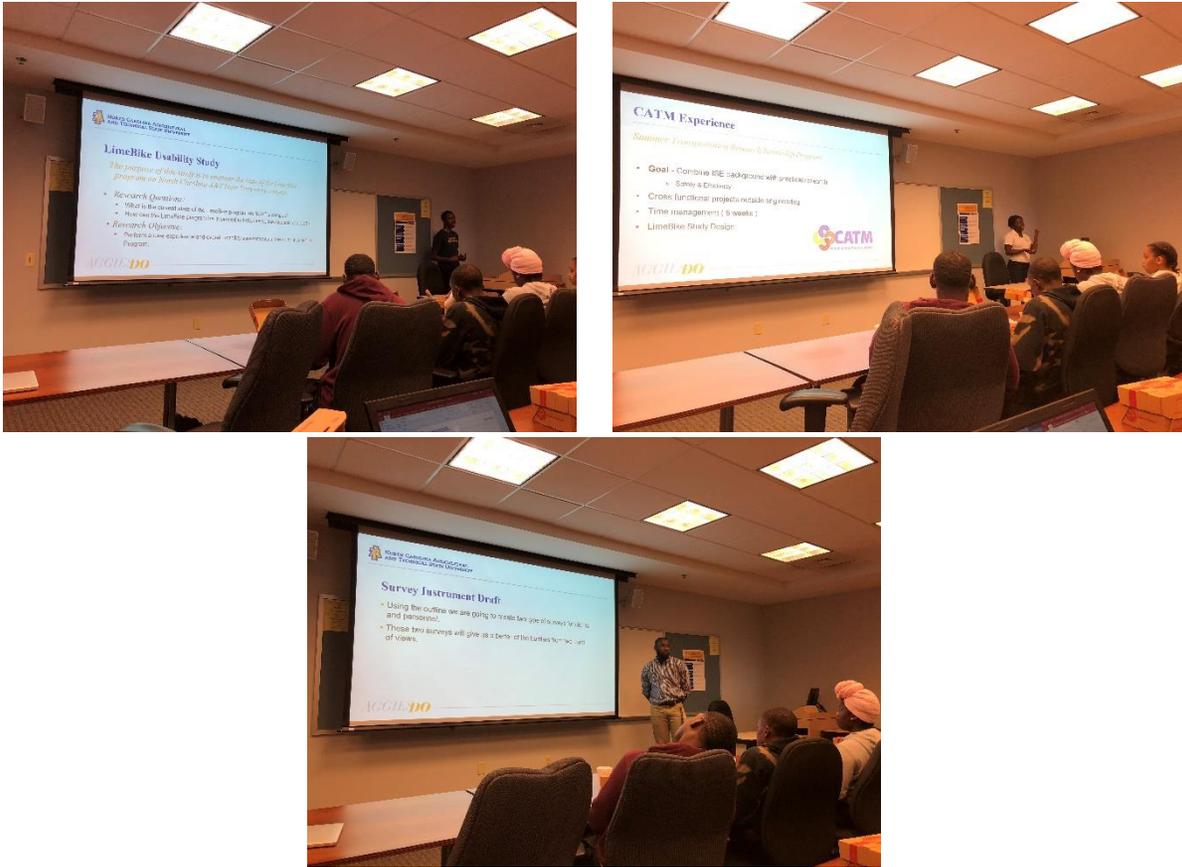


Figure 1: CATM summer interns presenting research activities to 2018 Summer High School Transportation Institute participants, faculty, and staff (from top left: Joseph Brown, freshman Accounting student; Patti Kamara, senior Industrial Engineering student; and Nnamdi Okoro, senior Industrial Engineering student).

During the reporting period, Rueben Ortega (N.C. A&T’s 2017-18 Transportation Research Board Minority Student Research Fellow) and Malik Norwood (N.C. A&T’s 2017-18 Dwight David Eisenhower Transportation Fellow) completed and submitted their transportation research papers to their respective programs. Rueben was a civil engineering major and the title of his paper was “Application of a biomodifier as a fog sealant to delay asphalt ultraviolet aging.” Malik was a supply chain management major and the title of his paper was “The relationship between traffic congestion and income in North Carolina”. Both worked under the guidance of a faculty mentor.

The application process for the 2018-19 Dwight David Eisenhower Transportation Fellowship Program also took place during the reporting period. Applications were distributed, received, and reviewed by a panel resulting in a 1st, 2nd, and 3rd place ranking of three applicants. The awardees for this program have not yet been announced by the program officials.

CATM continues to support students participating in the AutoDrive Challenge (Figure 2). Two graduate students and 1 undergraduate student are being supported by the UTC grant during year 2 of the competition. Additional information about the Aggies Autonomous Auto (A3) team can be found on their Facebook page (<https://aggiesautonomousauto.github.io>).



Figure 2: Aggies Autonomous Auto (A³) team members.

In addition to these programs, CATM presented three freshmen Incentive Awards for the 2018-19 academic year. The Incentive Award is given to incoming freshmen who are alumni of the N.C. A&T Summer High School Transportation Institute and have declared transportation/supply chain management as an undergraduate major. In addition to the Incentive Awards, CATM Transportation scholarships were awarded to 11 supply chain management undergraduate students. These students are required to maintain a specified GPA and participate in transportation-related experiential learning and extracurricular activities affiliated with CATM throughout the academic year.

Workforce Development and Outreach

The selection process for the 2018 Summer High School Transportation Institute (STI) began in May 2018. Sixteen high school juniors and seniors were selected to participate in the 2018 STI program from June 27th through August 3rd. Stipends for eight of these students were funded through the CATM grant, the other eight students were funded by the Southeastern Transportation Center UTC grant. A team of university faculty as well as private and public sector professionals from diverse disciplines and areas of transportation utilized a variety of educational activities, including lectures and presentations, group projects, and field trips to meet program objectives (see examples in Figure 3). Each participant was enrolled in and successfully completed a freshman college-level English course. Successful completion earned the students college credit for an English 100 course that can be transferred to the college of their choice. Other components of the program include SAT Preparation, Library/Research Instruction, and a Financial Planning Workshop.

Evaluations were administered after each scheduled session, guest presenter, and site visit. Pre/posttests were also administered. Student projects were presented at the closing ceremony on August 3rd. Projects were well researched and delivered and included topics associated with rail safety, bridge safety, air safety, and NC Ports. The students' newly acquired knowledge of the field of transportation was made visually evident with creatively designed PowerPoint presentations. Each participant received a certificate of completion at the end of the program.



Figure 3: 2018 STI high school students engaging in various activities. Clockwise from top left: 2018 STI Cohort; students at the Visualization Lab at the Turner-Fairbanks Highway Research Center, students working on their bridge building project, students at the Charlotte Light Rail Headquarters.

CATM's Student-to-Student Initiative was implemented during the reporting period (Figure 4). A PowerPoint presentation on "What is Supply Chain" was developed and undergraduate supply chain students volunteered to go to the designated high schools to present the material. The undergraduates talked about internship experiences, scholarship opportunities, study abroad opportunities, the STI experience, transportation research opportunities, and lucrative careers in supply chain and transportation. This information was presented at three high schools in Greensboro, NC.

Faculty members at ERAU reached out to the Gaetz Aerospace Institute for collaboration on high school students' education and training. The Gaetz Aerospace Institute is a premier cooperative partnership linking ERAU with secondary schools. Through this partnership, high schools can offer students the opportunity to enroll in ERAU courses for university credit. This concurrent enrollment follows the high school schedule so students do not have to leave campus to attend ERAU courses. Presentations on research opportunities were made by CATM researchers at the Gaetz Institute Meeting. Several high school students approached them afterward inquiring about the availability of research internships. Two master's degree students have made progress towards their theses based on this work.



Figure 4: N.C. A&T supply chain management students teaching high school students about transportation and supply chain management.

Technology Transfer

Planning for the 2nd Annual CATM Symposium took place during the reporting period. The symposium will be held at VTTI on November 5, 2018 (Figure 5). The keynote speaker for the symposium will be Mohammed Yousef, program manager for the Accessible Transportation Technologies Research Initiative (ATTRI) within the Federal Highway Administration’s Office of Operations and R&D. The progress that has been made for each CATM funded research project will be presented along with the education and workforce development initiatives that have taken place over the last year.



Figure 5: 2nd Annual CATM Symposium Flyer.

A CATM Facebook page, Instagram page, and STI Facebook page were created during the reporting period. In addition, the CATM website was updated to include more information about the new projects, completed project final reports, and other activities. Other technology transfer activities such as publications and presentations can be found in the Outputs section of this report.

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

During this reporting period, the CATM summer interns participated in a 4-day training workshop where they learned how to conduct a literature review, formulate hypotheses, and follow the scientific method for collecting and analyzing data. They also learned how to develop poster presentations and the undergraduate students presented their research to the STI students at the end of their 8-week internship (Figure 1). Other students working on CATM funded projects also learned about research design and had the opportunity to practice their skills by conducting research under the direction of a faculty advisor. Most of these students are expected to present the results of their research at the UTC Conference for the Southeastern Region in October and/or CATM Annual Symposium in November.

Researchers at VTTI conducted multiple training sessions to educate and train people how to use the electroencephalography equipment to capture brain signals for research. One of the researchers from ERAU was invited to give a talk to local high school counselors on the applications of simulation and modeling.

Have the results been disseminated?

In addition to the conference papers and presentations provided in the Outputs section of this report, the following is a list of dissemination activities that took place for individual research projects during the reporting period.

- Researchers from each of the year 2 project presented their studies to the CATM External Advisory Committee members in April.
- VRU project updates were included in a talk at AVS 2018. Preliminary findings and the concepts were presented multiple times in Industrial & Systems Engineering undergraduate courses at N.C. A&T. Also, the material developed for the project was used for an undergraduate research project as a part of an NSF REU program during the summer of 2018 at N.C. A&T.
- The paratransit project researchers demonstrated the purpose of the paratransit study to the North Carolina Public Transportation Association and discussed how members could participate in the research on scheduling information for paratransit.
- The final report for the year 1 paratransit study was posted to the CATM website and the link sent to the TRID database.

Brochures and applications for the 2018 Summer High School Transportation Institute (STI) were disseminated through the guidance counselor's office at all of the schools within the targeted counties around Greensboro, NC. The application and brochure were also available for anyone to download from the Transportation Institute website. Hardcopies were available in the Transportation Institute office. Postings on the Transportation Institute and STI Facebook pages as well as the CATM web pages were used to help disseminate the STI activities taking place during the program. Newsletter articles were also written about these activities and will be distributed electronically during the Fall 2018 semester and posted on the CATM website. Other center activities were also disseminated through the CATM website and social media outlets.

The CATM and Eisenhower scholarship opportunities were emailed to N.C. A&T supply chain management students in March. Announcements were placed on the N.C. A&T communications network throughout the College of Business and Economics' building and hard copies were made available in the Transportation Institute office.

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

Below is a list of the primary tasks for the next reporting period.

- Continue research project specific activities.
- Collect and review quarterly research progress reports to gauge the need for mitigation or contingency plans.
- Review year 3 research projects proposals and make awards.
- Review and post final reports for completed projects.
- Participate in the 2018 UTC Conference for the Southeastern Region.
- Hold the 2nd Annual CATM Symposium.
- Participate in the 2019 TRB Annual meeting.
- Distribute the Fall 2018 newsletter.
- Conduct transportation industry and research laboratory visits for students.
- Hold the third CATM Executive Advisory Committee Meeting.
- Continuously update the CATM website and social media outlets with newsworthy information.
- Conduct brown bag seminars as one means of disseminating the results of research activities.
- Conduct the Spring 2019 Student-to-Student Initiative sessions.
- Plan and hold a Transportation Awareness Day.
- Finalize case for Transportation Case Competition.
- Plan N.C. A&T Transportation Shark Tank Competition.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS:

Organizations that have been involved as partners

Not including the center staff at N.C. A&T and the various students involved in CATM activities, Table 5 provides a list of the individuals who have been involved in the center activities as partners during the reporting period and their associated organizations.

Table 5: List of partners

Organization Name	Organization Location	*Partner's Contribution to the Project	Name (First and Last)	Partner University
Dept. of Economics	Greensboro, NC	Collaborative Research	Ryoichi Sakano, Ph.D.	N.C. A&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Shengbin Wang, Ph.D.	N.C. A&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Laquanda Leaven, Ph.D.	N.C. A&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Omar Woodham, Ph.D.	N.C. A&T
Dept. of Management	Greensboro, NC	Collaborative Research	Mary Lind, Ph.D. & Rhonda Hensley, Ph.D.	N.C. A&T
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Xiuli Qu, Ph.D.; Lauren Davis, Ph.D.; & Younho Seong, Ph.D.	N.C. A&T

Dept. of Computational Science and Engineering	Greensboro, NC	Collaborative Research	Hyoshin (John) Park, Ph.D.	N.C. A&T
Dept. of Electrical and Computer Engineering	Greensboro, NC	Collaborative Research	Ali Karimoddini, Ph.D. & Abdollah Homaifar, Ph.D.	N.C. A&T
Dept. of Mechanical Engineering	Greensboro, NC	Collaborative Research	Sun Yi, Ph.D.	N.C. A&T
Virginia Tech Transportation Institute	Blacksburg, VA	Facilities	Jon Antin, Ph.D.	Virginia Tech
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Andrew Alden, Ph.D.; Kevin Grove, Ph.D.; Justin Owens, Ph.D.; Andrew Miller, Ph.D.; & Erin Mabry, Ph.D.	Virginia Tech
Dept. of Computer Science	Blacksburg, VA	Collaborative Research	Daniel Kavanaugh	Virginia Tech
Safe-D National UTC	Blacksburg, VA	Collaborative Support	Zac Doerzaph	Virginia Tech
Institute for Transportation Research and Education (ITRE)	Raleigh, NC	Financial Support, Collaborative Research	James Martin, P.E. & Brittany Gaustad	NC State University
Savannah State University	Savannah, GA	Collaborative Research	Suman Niranjana, Ph.D.	Savannah State University
Dept. of Psychology	Birmingham, AL	Collaborative Research	David Schwebel, Ph.D. & Despina Stavrinou, Ph.D.	UAB - Birmingham
Dept. of Graduate Studies, College of Aviation	Daytona Beach, FL	Collaborative Research	Dahai Liu, Ph.D.; Jennifer Thropp, Ph.D.; & Scott Winter, Ph.D.	ERAU
Dept. of Aerospace Engineering	Daytona Beach, FL	Collaborative Research	Namilae Sirish, Ph.D.	ERAU
Civil Engineering	Daytona Beach, FL	Collaborative Research	Scott Parr	ERAU
Gaetz Institute at ERAU	Daytona Beach, FL	Collaborative Support	Sam Harris	ERAU
UNC Highway Safety Research Center	Chapel Hill, NC	Collaborative Support	Caroline Mozingo	University of North Carolina – Chapel Hill
Humans and Autonomy Lab	Durham, NC	Collaborative Support	Missy Cummings	Duke University
Center for Connected Multimodal Mobility	Clemson, SC	Collaborative Support	Charlotte Ryggs	Clemson University

NC Department of Transportation	Raleigh, NC	In-kind Support-Presentations, Financial Support	JoAna McCoy, Director of Education Initiatives	
NC FHWA Division	Raleigh, NC	In-kind Support, Collaborative Support	Lynise DeVance, Program Manager, Civil Rights Office	
NC Department of Transportation	Raleigh, NC	Collaborative Research	John Kirby, P.E.	
Smith High School	Greensboro, NC	Collaborative Support	Gwendolyn Atkinson	
Dudley High School	Greensboro, NC	Collaborative Support	Kiyah McDermid	
STEM Early College	Greensboro, NC	Collaborative Support	Sequilla McLean	
Florida Department of Transportation	Miami, FL	Collaborative support	Suraj Pamulapati	
EasyMile	Toulouse, France	Collaborative Research	Lauren Isaac	

Other collaborators or contacts involved

Dr. Ahren Johnston and Dr. Mehour Parast served as the Dwight D. Eisenhower Transportation Fellowship faculty research mentor and TRB Minority Fellowship faculty research mentor, for the N.C. A&T Eisenhower and TRB Fellows, respectively.

The VRU-MAP team has contacted several disability advocacy organizations for assistance in recruiting participants, including Autism Speaks, the National Organization for Disability, Virginia Board for People with Disabilities, National Empowerment Center, National Down Syndrome Society, National Aging and Disability Transportation Center, American Federation for the Blind, National Association of the Deaf, American Association of People with Disabilities, and Paralyzed Veterans of America.

The Dialysis project team has contacted and is collaborating with individuals at more than 30 of the county transit offices and dialysis clinics in North Carolina. In addition, another CATM researcher has engaged in initial discussions with the Urban Mobility & Equity Center led by Morgan State University on paratransit dynamic scheduling and routing in preparation for a year 4 project proposal. Depending on the peer review and agreement between the centers’ directors, the two UTCs may work together on a paratransit project.

VTTI researchers routinely collaborate with stakeholders from the National Surface Transportation Safety Center for Excellence. Stakeholders represent the following organizations: Federal Motor Carrier Safety Administration, General Motors, National Safety Council, Travelers Insurance, and VDoT. VTTI also has an ongoing collaboration on a naturalistic driving study with researchers from the University of Alabama – Birmingham and have an ongoing naturalistic driving study collaboration with a consortium of researchers in Australia including the University of New South Wales Transport and Road Safety Research Group (TARS), Monash University Monash University Accident Research Centre(MUARC), and other governmental and private entities in Australia.

Additionally, CATM’s director has reached out to and had conversations with various individuals with longstanding associations with the UTC program to obtain advice and guidance on center

operations. These individuals include Greg Winfrey and Melissa Tooley from Texas A&M University.

3. OUTPUTS:

The major outputs that are expected to result from the activities within CATM include the development of an assistive technology for VRUs, the development of an optimization model to support emergency related decision-making processes, and design recommendations to improve human safety when interacting with automated vehicles. While the major studies that contribute to these outputs have not yet been completed, the research activities summarized in the Accomplishments section illustrate the progress that has been made. In addition, the following subsections provide references to documented evidence of this progress.

Publications, conference papers, and presentations

The following is a list of products associated with the CATM activities.

JOURNALS

- Cheng, Y., Liu, D., Namilae, et al., A systematic review of factors affecting emergency evacuation. To be submitted to Ergonomics.
- Derjany, P., Namilae, S., Liu, D., and Srinivasan, A. Pedestrian dynamics and contagion in winding queues. To be submitted to Physica A, Nov 2018.
- Islam, S., Namilae, S., Liu, D. A multiscale epidemic model for hurricane fuel shortages. To be submitted to PLOS ONE, October 2018.
- Odelade, M., Seong, Y., Yi, S. Comparison between p300 responses evoked speller matrix and a novel control matrix. Submitted to Brain-Computer Interfaces.
- Park, H., Haghani, A., Gao, S., Knodler, M.A., Samuel, S. Anticipatory dynamic traffic sensor location problems with connected vehicle technologies, Transportation Science. In Press.
- Park, H., Pugh, N. Generalized Estimating Equation Model based Recursive Partitioning: Applied to Distracted Driving. Journal of Advanced Transportation. Published May 2018.
- Park, H., Waddell, D., Haghani, A. Online emergency vehicle dispatching with look-ahead on a transportation network. Transportation Research Part C: Emerging Technologies. Minor Revisions Requested.
- Yu, X., Gao, S., Hu, X., Park, H. A Markov decision process approach to vacant taxi routing with e-hailing. Transportation Research Part B: Methodological. Minor Revisions Requested.

CONFERENCE PAPERS AND PRESENTATIONS

- Chen, J., Liu, D., Cheng, Y., Namilae, S., Thropp, J., Seong, Y. Effects of exits and number of passengers on airport evacuation efficiency using simulation, Proc. of 2018 IISE (Institute of Industrial and Systems Engineers) Annual Research Conference.
- Cheng, Y., Liu, D., Chen, J., Namilae, S., Thropp, J., Seong, Y. Human behavior under emergency and its simulation Modeling: a review, Proc. of 9th AHFE International Conference.
- Chilukuri, D., Yi, S., Seong, Y. Development of mobile application for VRU's using computer vision. Presented at IEEE SoutheastCon 2018 and published in the proceedings (<https://ieeexplore.ieee.org/document/8479138>).
- Hensley, R. and Lind, M.L. A preliminary examination of public dialysis transportation efficiency using available technologies, 2018 Southeast Decision Sciences Institute. Acknowledged the USDOT UTC support.
- Horton, J. Pedestrian Safety with Personal Listening Devices. Abstract presented at the 2018 Institute of Industrial and Systems Engineering (IISE) Conference. Acknowledged the USDOT UTC support.

- Islam, S., Namilae, S., Liu, D. Is Hurricane Fuel Shortage an Epidemic? Analysis of Data from Hurricane Irma and Hurricane Florence. 6th Annual UTC Conference for the Southeastern Region. Accepted.
- Lind, M.L., Hensley, R. Asymmetric Information Sharing in Dialysis Paratransit Using an Agency Approach, 2018 Decision Science Institute.
- Mhatre, S., Richmond, D., Qu, X. Davis, L. Vulnerability Assessment of the Southeast North Carolina Highway Transportation System to a Hurricane. Proceedings of the 2018 IISE (Institute of Industrial and Systems Engineers) Annual Research Conference. Acknowledged the USDOT UTC support.
- Namilae, S., Derjany, P., Liu, D., Mubayi, A., Srinivasan, A. Multiscale pedestrian dynamics and infection spread model for policy analysis, 9th International Conference on Pedestrian and Evacuation Dynamics.
- Namilae, S., Islam, S., Liu, D. Particle Dynamics Model for Hurricane Evacuation and Fuel Shortage: Model Based Policy Analysis, UTC CATM Symposium. Accepted.
- Oh, S., Seong, Y., Yi, S. Neural Investigation of Human Operator's Social Construct on the Use of Automation using EEG. Research abstract presented at 2018 IISE Annual Conference & Expo.
- Park, H. Sensor Deployment for Reduction of Arterial Traffic Congestion. The 98th Annual Meeting of TRB2019, #19-04832. Accepted.
- Park, H. Simulation-based Optimization for Reconfiguration of Mobile Wireless Sensor Network. In Proceeding of the IEEE Wireless Telecommunications Symposium 2018 (WTS 2018).
- Park, H. Rationality based server dispatching. 2018 INFORMS Annual Meeting.
- Park, H., Haghani, A. Stochastic Dynamic Sensor Location Problem with Efficient Solutions. The 98th Annual Meeting of TRB2019, #19-04783. Accepted.
- Park, H. Pugh, N. Portable Traffic Sensors to Enhance Arterial Mobility. IEEE SoutheastCon 2018.
- Park, H., Pugh, N., Schonfeld, P., Haghani, A. Effect of Demand Shifting on Security Checkpoint Operation Paper # 287. The 22nd Air Transport Research Society (ATRS) World Conference.
- Pugh, N., Park, H. Generalized Estimating Equation Models Based on Recursive Partitioning in Distracted Driving. In proceeding of the International Conference on Applied Human Factors and Ergonomics (AHFE 2018).
- Pugh, N., Park, H. Prediction of Red-Light Running using an Artificial Neural Network. IEEE SoutheastCon 2018
- Waddell, D., Pugh, N., Park, H. Visualization-based Dynamic Dispatching of First Responders. The 98th Annual Meeting of TRB2019, #19-05569. Accepted.
- Waddell, D., Pugh, N. Shirzad, K., Park, H. Simulation-Based Optimization of Emergency Response Considering Rationality of Travelers. The 98th Annual Meeting of TRB2019, #19-05975. Accepted.
- Yi, S., Dekkata, C., Yu, P., Chilukuri, D. Autonomous Navigation of Connected UGVs for Mapping, NDT and VRUs. Poster presented at the Automated Vehicles Symposium 2018 and published in the proceedings (http://auvsilink.org/AVS2018/Posters/Sun%20Yi_Autonomous%20Navigation%20of%20Connected%20UGVs%20for%20Mapping%20C%20NDT%20VRUs..pdf).
- Yu, X., Gao, S., Hu, X., Park, H. Multi-Cycle Optimal Taxi Routing with E-hailing. In proceeding of the 18th COTA International Conference of Transportation Professionals (CICTP 2018), No. 664.

BOOKS AND NON-PERIODICAL, ONE-TIME PUBLICATIONS

Websites or other internet material

- Dr. Hyoshin (John) Park maintains a list of his research activities on the following website: <https://johnpark.club>.
- CATM Website: <https://www.ncat.edu/cobe/transportation-institute/catm/index.php>
- CATM Facebook Page: <https://www.facebook.com/NCATCATM/>

- STI Facebook Page: <https://www.facebook.com/groups/627756624232070/>
- Webpages where STI program information is provided:
<https://www.ncat.edu/cobe/transportation-institute/files/pdfs/stibrochure2020ada.pdf>
<https://www.ncat.edu/cobe/transportation-institute/summer-high-school-transportation-institute.php>

Technologies or techniques

- Particle dynamics traffic and fuel shortage model and associated codes.

Inventions, patent applications, and/or licenses

- Park, H., Predictive Emergency Management considering Human Decisions (U.S. Patent Provisional Application, in preparation of an invention disclosure).
- Park, H., Explicit Duration Hidden Markov for Vehicle Automation with Distraction. U.S. Patent Provisional Application USSN 62/615,795. (working with patent agents for a normal application).
- Park, H., Anticipator Dynamic Traffic Sensor Location Problems with Connected Vehicle Technologies. U.S. Patent Provisional Application USSN 62/620,232. (working with patent agents for a normal application).

Other products

Data

- Flight data at 3 airports during the month of Hurricane Matthew.

Software

- Computer code for Particle dynamics evacuation study.
- Computer code for stochastic fuel shortage model.
- Arena discrete event model for Volusia county fuel shortage study.

4. OUTCOMES:

The anticipated outcomes of CATM research include the adoption of new technology to help VRUs, enhanced decision-making techniques for emergency evacuation processes, and automated vehicle design guidelines based on pedestrian perceptions of and interactions with automated vehicles. So far these outcomes have not yet been realized; however, meaningful progress is being made in each area.

Several students completed their research projects and associated degrees during this reporting period and went on to start their careers. For instance, Mr. Deion Waddell successfully defended his master's thesis based on the Travelers' Rationality project and is now working as an engineer with Northrup Grumman. Ms. Janelle Horton completed her thesis on pedestrian safety while participating in a summer internship program at Fiat Chrysler Automotive company. She is awaiting an offer for a permanent position with them or another automotive company. In addition, 12 African-American undergraduate students who received scholarships from CATM and participate in CATM activities graduated during this reporting period and joined the workforce.

5. IMPACTS:

What is the impact on the effectiveness of the transportation system?

The VRU-MAP project will be a significant benefit for people navigating by foot and/or multimodal transit through urban environments, particularly those with disabilities. While the short-term focus of the project is on providing guidance for people with physical disabilities, it is expected that the flexibility of this platform will enable future iterations to provide assistance for people with a wide range of disabilities, as well as for neurotypical pedestrians who wish for a more customizable, personalized routing option than is currently available.

Recent hurricanes in Florida and the southeastern United States have led to mass evacuations. The ability to accurately estimate where and when many evacuees are likely to need fuel could, in the future reduce localized fuel shortages and driver anxiety while increasing overall preparedness. A predictive model of fuel shortages resulting from the Hurricane Evacuation project will be an effective tool for providing policy suggestions for both evacuations and back-up fuel storage locations. Furthermore, with the advancement of real-time traffic data collection and crowd sourced fuel supply data, predictive models can be updated during future evacuations and initial estimates enhanced, as storm events unfold.

The optimization models developed for airline recovery and road restoration resulting from the Emergency project will improve the effectiveness and efficiency of response activities in local and regional transportation systems during and after a hurricane. Deploying effective response activities in response to a hurricane can improve the mobility of people and disaster relief efforts both during and after a hurricane.

What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

The Dialysis project is laying the foundation for better scheduling and routing for ADA and seniors in rural counties of North Carolina. The ultimate impact is a better quality of life for individuals requiring dialysis treatment as well as their loved ones since more efficient and reliable scheduling can make the entire treatment process more comfortable. The advanced operations research models used in the Travelers' Rationality project have been applied to other research domains including sensor location problems designed to improve the mobility of travelers while the Hurricane Evacuation team has borrowed computational tools from particle dynamics and epidemic modeling thereby broadening their usage as well. The VRU-MAP project's focus on artificial intelligence, machine vision, and other cutting-edge engineering technologies will pave new ways to accelerate research on human-machine interactions with applications to mobile app development. In particular, machine vision and augmented reality will spawn variation in the ways people interact with and learn about the world around them. In addition, the final study for the Pedestrian Willingness project will compare different communication platforms such as lights and sounds deployed via the autonomous vehicle to determine how this will affect pedestrians' willingness to cross the street. The findings from this final study are expected to contribute to guidelines that will be used by manufacturers and engineers in the development of autonomous vehicles.

What is the impact on the body of scientific knowledge?

The VRU-MAP project incorporates aspects of human factors, psychology, and information science. Both the process and implementation of the product will impact all of these domains by utilizing smart phone and GPS technology to create an application that will be tailored towards individuals with special mobility needs. A strong focus on human factors psychology is required to provide better and more usable information to the disability population and the large amount of information required to support this app will lead to new advancements in information science. This design elements that have been incorporated into the app this reporting period

will make it easier for individuals to navigate the built environment more safely and efficiently. In addition, the results of the Non-Driving Mobility Needs project will increase knowledge and awareness of the barriers facing people with disabilities in the transportation domain.

The experiment and survey results associated with the Last Mile project will reveal the current perception of potential last-mile users of autonomous vehicles and changes in perception after experiment. The analysis of the survey results will increase awareness of the human and environmental factors preventing and enhancing the use of autonomous vehicle.

The model developed as a part of the Emergency project will provide a theoretical and empirical foundation on pedestrian evacuation process under emergency. Related human factors such as age, gender, handicap, and group travel percentage are being investigated and the panic factors were considered under the emergency situations. Although the experiments were conducted in a specific airport platform, the manipulation of these factors are general; thus, the results can be easily extended and generalized. Currently, study in this area is very limited, due to the complex nature of emergency situations. This empirical approach provides valuable insights for determining the effects of various factors under emergency in a systematic way. Moreover, environmental factors such as obstacles and pedestrian density is being addressed using social forces model based on particle dynamics.

The preliminary findings of the Pedestrian Willingness study indicate the willingness to cross (WTC) was affected by the type of driver, gender of the participant, and nationality of the participant. However, the interactions in the data present an interesting, and somewhat unexpected, story. In general, Indians were more WTC compared to their American counterparts and were in fact not affected by the type of driver or gender. Only American males reported similar WTC ratings compared to all Indians. American females, on the other hand, produced lower WTC ratings across the board and were particularly unwilling to cross in front of a driverless vehicle. The relationship between type of driver and WTC ratings was at least partially explained by the presence of emotional factors. This type of information has not been captured by previous studies in this domain and thus will contribute to several of the principal disciplines of CATM.

What is the impact on transportation workforce development?

A significant number of minority undergraduate and graduate students are being trained in a variety of disciplines including industrial engineering, human factors, computer science, decision sciences, and simulation. The goal of this training is to provide them with research experience that will enable them to work with and improve transportation issues. Working on the research projects equips them with a better understanding of the importance of transportation systems and the impact of a wide range of human factors and natural disasters on the effectiveness and availability of transportation systems. These students have not only learned general research methodology techniques but have developed more advanced critical thinking skills and presentation skills. These skills will benefit them regardless of their discipline of study. Many of these students are working within an interdisciplinary team; thus, the interdisciplinary research and training in which they are involved will make broad impacts in the transportation industry in terms of workforce as well as the research outcomes by facilitating the development of new research directions.

The research from the Hurricane Evacuation project was presented to high school teachers and students through Gaetz Aerospace Institute and several high school students expressed interest in internships opportunities following the presentation. All of the research related to this project will be presented to FDOT colleagues to generate interest on fuel shortage modeling among practitioners.

The STI program introduced several high school students to the various disciplines of transportation. Students engaged in various active learning activities that allowed them to see how transportation is interwoven into every aspect of life. While only a couple of the students coming into the program expressed an interest in a career in transportation, by the end of the program, 8 of the 16 high school participants indicated through an outgoing survey that they intend to study transportation in the future and 6 out of 10 indicated they plan to pursue a career in the transportation industry.

6. CHANGES/PROBLEMS:

Due to the departure of the director of the Transportation Academy at the University of the District of Columbia Community College, there was no longer anyone qualified to work on the transportation-related tasks assigned to the institution. As a result, the UDC subcontract was terminated. Funding originally allocated to UDC in year 1 will be added to the funding available for the year 3 research awards.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report for this period.