Program Progress Performance Report for
University Transportation Centers

Federal Agency and Organization Element to Which Report is Submitted:

United States Department of Transportation (USDOT)

Office of the Assistant Secretary of Transportation for Research and Technology (OST-R)

Federal Grant or Other Identifying Number Assigned by Agency: 69A3551747125

Project Title: Center for Advanced Transportation Mobility

Center Director Name, Title, and Contact Information

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Submission Date: April 30, 2018

DUNS and EIN Numbers:

DUNS: 071576482 and EIN: 566000007

Recipient Organization:

North Carolina Agricultural and Technical State University

1601 E. Market Street, Greensboro, NC 27411

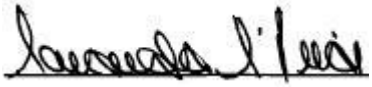
Recipient Identifying Number or Account Number: 270128

Project/Grant Period: November 30, 2016 – September 30, 2022

Reporting Period End Date: March 31, 2018

Report Term or Frequency: Semi-annual

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 March 31, 2018.

Table 1: Progress of period 2 activities

Research	**Status**	**% Complete**
Establish research project subcontracts	Complete	100%
Conduct year 2 research proposal solicitation, review, and award process	Complete	100%
Continue making progress on year 1 projects	On schedule	45%
Education, Outreach, and Workforce Development Activities		
Develop community college transportation model curriculum	Behind schedule	0%
Hold STI 25th Anniversary Celebration	Complete	100%
Help plan the 2017 Southeastern Region UTC conference	Complete	100%
Take NC A&T students to 2017 Southeastern Region UTC conference	Complete	100%
Implement NC A&T Transportation Shark Tank Competition	Behind schedule	0%
Take NC A&T students to 2018 TRB conference	Complete	100%
Identify students for 2018 Summer Transportation Research Internship	On schedule	75%
Develop research project for 2018 research interns	On schedule	40%
Distribute application packets for TRB Minority Research Fellowship	Forthcoming	0%
Complete 2018 TRB Minority Research Fellowship application process	On schedule	80%
Distribute applications for Transportation Scholarship program	Complete	100%
Select Transportation Scholarship program awardees	Forthcoming	0%

Recruit and select participants for 2018 Summer High School Transportation Institute (STI)	On schedule	50%
Develop and conduct student-to-student K-12 initiative workshops	On schedule	25%
Develop and hold transportation awareness day	Behind schedule	0%
Develop teacher/counselor transportation workshops	Behind schedule	0%
Develop transportation case for Fall case competition	On schedule	25%
Technology Transfer Activities		
Host the inaugural CATM annual symposium	Complete	100%
Organize the 2nd CATM annual symposium	On schedule	10%
Hire communications specialist	Complete	100%
Distribute 2017-18 CATM newsletter	Behind schedule	90%
Assist with 2018 Southeastern Region UTC Conference planning	On schedule	5%
US DOT Reporting Activities		
Complete and submit PPPR#1	Complete	100%
Complete and submit 2017 performance indicator report	Complete	100%
Complete and submit SF425 for Q2, Q3, Q4, and Q5	Complete	100%
Complete and submit recipient share report	Complete	100%
Submit year 2 research project descriptions through RiP	Complete	100%
Post year 2 research project descriptions on website	Complete	100%
Review year 1 final research reports	On schedule	50%
Upload year 1 final research reports to TRID database	Forthcoming	0%
Create Technology Transfer Plan	Forthcoming	0%
Complete and submit PPPR#2	Complete	100%

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

In October 2017, a request for proposals (RFP) was distributed to the consortium member institutions by CATM's key personnel. This resulted in a total of seven research proposals (3 NCA&T, 3 ERAU, and 1 VTTI student). Out of the 7 proposals, 5 were funded. One project funded in Year 1 was completed and the other three projects continued into year 2 as expected. Table 2 provides a list of the year 1 and year 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 the year 1 projects.

Table 2: Funded projects

Project Title	Status	Research Priority Area(s)	Project Link
Analysis of the Non-Driving Mobility Needs of People with Disabilities	New	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	New	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	New	IM	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/8-pedestrianperceptionsabstract.pdf

Travelers' Rationality in Anticipatory Online Emergency Response	New	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	New	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/9-particledynamicsabstract.pdf
Automated Last Mile Connectivity for Vulnerable Road Users	Continuing	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/1-last-mile-abstract.pdf
Public Dialysis Transport Efficiency using Digital Media	Completed	IM, TS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/2-paratransitabstract.pdf
Development, Design, and Calibration of the Vulnerable Road User Mobility Assistance Platform (VRU-MAP)	Continuing	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	IM, RC, TS	https://www.ncat.edu/cobe/transportation-institute/catm/catm_documents/4_2-emergencyabstract.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

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

VTTI met with several suppliers of low-speed automated vehicles (LSAV) to understand the capabilities of current technology, the barriers to deploying the vehicles with vulnerable road users (VRUs), and the policy issues that surround their efforts to accommodate VRUs. VTTI created a list of specifications for a test vehicle based on these meetings and published a request for bids in order to acquire an appropriate vehicle to perform testing around these issues. VTTI and NCA&T continued the development of surveys that would help developers understand the needs and desires of VRUs. The NCA&T team completed a literature review on Automated Last Mile Connectivity for VRUs and completed the development of a questionnaire on the adoption of automation based on the literature review. The questionnaire is designed to capture multiple constructs that lead to acceptance and adoption, including attitudes, efficiencies, sustainability, and safety.

Public Dialysis Transport Efficiency using Digital Media (Paratransit)

A preliminary survey containing Likert scaled, short answer and open-ended questions was developed and pre-tested in two counties. Based on comments and suggestions, adjustments were made to the survey. County transportation agencies were then contacted and interviewed by phone to complete the survey. A total of 91 out of 100 North Carolina counties provided information for this study. These counties were geographically dispersed throughout the state and populations were compared to those counties that participated in the study. Disparities between the lower income areas of the state and the higher income levels of the state were expected and supported by the data. For instance, the poverty levels and county populations have a significant negative correlation. This finding suggests that the counties with larger populations have lower poverty levels (and vice versa). Another interesting finding was that county population has a negative correlation with the percentage of dialysis patients in the population suggesting that smaller counties have a larger proportion of dialysis patients. The data also show a significant positive correlation between the perception that overall funding is

adequate and the adoption of technologies. More details on these and additional findings can be found in the final report which will be posted on the CATM website within the next couple of months.

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

Significant progress has been made on the application platform in both higher-level conceptual development and in code/physical implementation. The core of the application is a pedestrian-focused routing function that is modifiable by a series of modules that will be available depending on location and user need. A functioning prototype routing application complete with a user interface and definable user functional characteristics has been completed. Current prototype modules include steepness defined using NASA elevation data and crowdsourcing for the identification and localization of sidewalk hazards. The application is currently deployed on a Samsung Galaxy S8 smartphone. A prototype model for emergency online optimization with visualization was developed during this reporting period. Using computer vision, a MATLAB/Simulink-based software package was developed to detect, track and recognize traffic-relevant signs in real-time using the Android app platform and devices with sensors on them. The software is being implemented with additional support packages for Android cameras. Upgrades continue to be made to increase reliability by obtaining a clear result even if the image is in poor contrast with a glare.

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

During the current reporting period, the following tasks were completed: 1. Revised the literature search scope as peer-reviewed papers published from 2007-2017 that focus on air, land or water transportation system management and decision making during disaster preparedness and response phases. 2. Conducted a comprehensive literature search in ABI/INFORMS (Pre-Quest), Compendex and Transportation Research Record, and found more than 30 relevant review papers and about 80 papers of individual studies within the search scope. 3. Reviewed the papers found and wrote summaries for 50 highly relevant papers. 4. Consolidated the data of North Carolina emergency response activities during Hurricane Matthew and analyzed the vulnerability of the highway transportation system in southeastern North Carolina to a hurricane using Hurricane Matthew data.

There were a total of 17 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	5	1	6
Master's	1	2	3
Doctoral	3	5	8
Total	**9**	**8**	**17**

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, NCA&T students participated in experiential learning activities which included the CATM Summer Transportation Research Internship Program, 2018 Transportation Research Board (TRB) meeting, the UTC Conference for the Southeastern Region, and the GM/SAE Autodrive Challenge.

Four undergraduate students participated in the CATM Summer Transportation Research Internship Program from June 2017 through July 2017. This 8-week program started off with a research workshop to prepare them for the research experience and consisted of faculty-led research activities, professional development seminars, and transportation-related field trips (Figure 1). In addition to the invaluable knowledge students gained from the research experience, they received a stipend plus a housing allowance. Several of these students also took advantage of the opportunity to present their research at the CATM symposium and attend the 2018 TRB meeting.

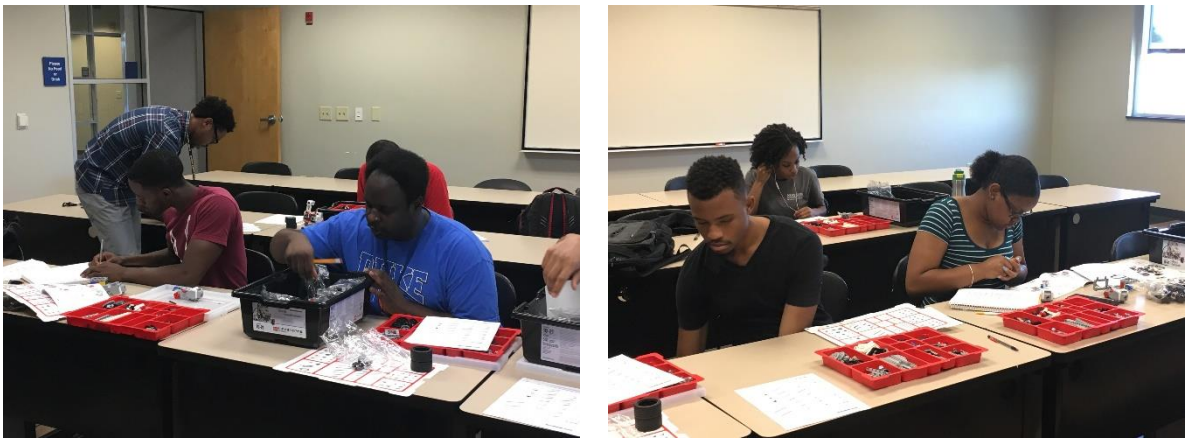


Figure 1: Students engaging in a research workshop during the 2017 CATM Summer Transportation Research Internship program.

CATM and the Southeastern Transportation Center (STC) Education program supported 8 undergraduates for the Fall 2017 and Spring 2018 semesters. These award recipients received opportunities to engage in experiential learning activities such as the Annual UTC Conference for the Southeastern Region and Transportation Research Board Meeting (Figure 2: Students and staff at the 2018 TRB Annual Meeting. From left: Deborah Underwood, Kristian Conner, Nicole Perry, Ebone Martin, Tyler Huggins, Rashmi Kumari, Aleckzandrya Jackson, Malik Norwood, Patrick Stanley, Charles Young and Brandon Rogers.). Students from the NCA&T chapter of the Institute of Transportation Engineers (ITE) were also given the opportunity to

participate in the 2018 TRB meeting. While at the TRB meeting, students participated in the STC event as well.

Figure 2: Students and staff at the 2018 TRB Annual Meeting. From left: Deborah Underwood, Kristian Conner, Nicole Perry, Ebone Martin, Tyler Huggins, Rashmi Kumari, Aleckzandrya Jackson, Malik Norwood, Patrick Stanley, Charles Young and Brandon Rogers.

Also supported through the STC Education program for the 2017-18 academic year were 2 freshmen Incentive Award students. The Incentive Award is given to incoming freshmen who are alumni of the NCA&T Summer High School Transportation Institute (STI) and have declared transportation/supply chain management as an undergraduate major.

NCA&T students traveled to Gainesville, Florida in November 2017 to attend the 5th Annual UTC Conference for the Southeastern Region. This conference was hosted by STRIDE Center at the University of Florida in Gainesville. While at the conference, a tour of the Dollar General warehouse was arranged (Figure 3). Students learned about the warehouse operations and discussed internship and employment opportunities. They also attended the 2018 TRB Meeting and the STC Event held at the TRB meeting.

Figure 3: Students and staff at the Dollar General Warehouse. From left: Dr. Maranda McBride, Carletta Dudley, Janelle Horton, Trey Cash, Kristian Conner, Brandon Rogers, Aleckzandriya Jackson, Nafi Tucker, Malik Norwood, Joseph Smith, Jala Haitt, Jacob Smith and Deborah Underwood.

During the 2017 spring semester one civil engineering student was selected to participate in the Transportation Research Board Minority Student Research Fellows program. Rueben Ortega received this distinction. He is a Civil Engineering major. Rueben spent the summer of writing a transportation research paper on the topic of his choosing and presented it at the 2018 TRB meeting. He was assigned a faculty mentor, Dr. Mahour Parast - Associate Professor of Technology Management, to guide him through the writing process. Travel funds were provided for the student and faculty mentor to attend the TRB meeting.

One NCA&T supply chain management student, Malik Norwood, was selected as the Dwight David Eisenhower Transportation Fellow. Malik participated in the Eisenhower Showcase and Poster Sessions at the TRB meeting. Malik is transportation/supply chain student and former Summer High School Transportation Institute participant. Malik's research mentor is Dr. Ahren Johnston, Assistant Professor of Supply Chain Management.

In 2017, NCA&T was one of eight North American universities selected by the Society of Automotive Engineers (SAE) World Congress Experience, General Motors Co. (GM) and SAE International to compete in the AutoDrive Challenge. The new autonomous vehicle design competition is a three-year challenge to develop and demonstrate a fully autonomous passenger vehicle. The competition's technical goal is navigating an urban driving course in an automated driving mode as described by SAE Standard (J3016) Level 4 definition by year three of the challenge. CATM is supporting this effort by providing funding for both undergraduate and graduate students working on the project. A few of the students on the team are shown in Figure 4. The Aggies Autonomous Auto (A3) team has developed a Facebook page to chronicle their experiences (https://aggiesautonomousauto.github.io).

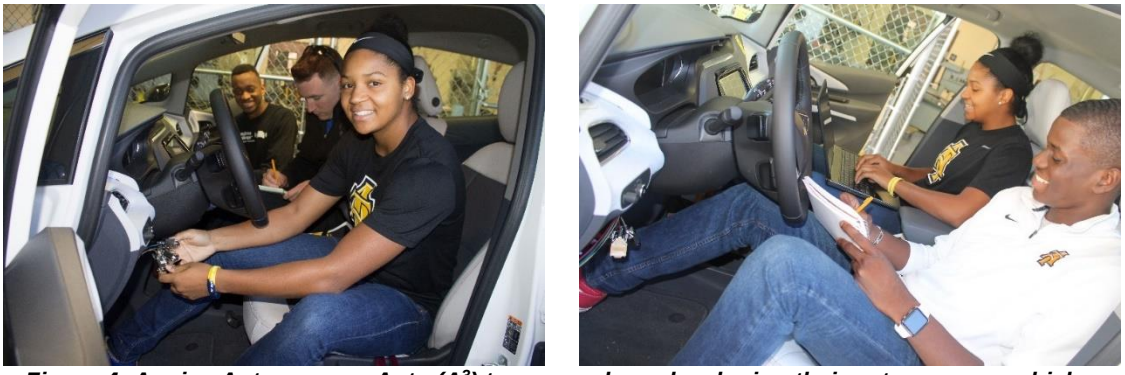


Figure 4: Aggies Autonomous Auto (A^3) team members developing their autonomous vehicle.

Workforce Development and Outreach

The 2017 STI marked the twenty-fifth year of the program at NCA&T. A 25th anniversary program was held during the STI Closing Ceremony in August 2017. Former participants, former staff, program partners, university, state and federal officials were invited to participate. A number of people who have supported the program since its inception were recognized, especially financial and in-kind partners who assisted in making the STI a success. The STC received a plaque of appreciation for its financial contributions to the STI over the years. The highlight of the program was the keynote address from Virginia Tsu, the Director of the Center for Transportation Workforce Development of the Federal Highway Administration. The National Summer Transportation Institute (NSTI) falls under Ms. Tsu's leadership. The STI's ultimate goal is to increase the number of transportation professionals entering the workforce. Four

former STI participants were showcased during the celebration. The audience heard the success stories of three former STI participants who are currently in the transportation workforce and one student who is a rising senior transportation/supply chain major. They all talked about how the STI influenced their academic degree program choice and, ultimately, their career choice. They described the opportunities during the STI and college that helped to make their professional positions attainable, including the experiential learning activities.

Figure 5: 2017 STI students during NCA&T's 25th STI Anniversary Celebration. From left: Kaiya Maye, Kierston Bankston, Nevaeh McEachirn, Morgan Goins, Taylor Edwards, Annie Long, Jayla Wade, Zafira Harris, Alize Hopkins, Marquise Moore, Zachary Headden, Jaden Nesbitt, Winston Griffin, Miles Staton, Chavez Chapman and Jameson Cunningham.

The application process for the 2018 Summer High School Transportation Institute was initiated during this reporting period. Applications were sent out to high schools in a four-county area to seek rising high school juniors and seniors interested in attending the program. The STI program has a commuter format and is held for five and one-half weeks during the second session of summer school. Students take a for-credit English course during the second session of summer school, participate in lectures and interactive presentations that support academic and career choices in transportation, SAT preparation and personal development sessions, and field trips to support classroom experiences. Additionally, they study a different mode of transportation each week along with career choices in each mode. The 2018 application deadline is April 27, 2018.

CATM's Student-to-Student Initiative was implemented during this reporting period and led by Carletta Dudley. Along with consultation with Ms. Underwood, a power point presentation on "What is Supply Chain" was developed. Undergraduate students were identified to go to the designated high schools and present the power point and other pertinent information to the high school students. The undergraduates will talk about internship experiences, scholarship opportunities, study abroad opportunities, the summer high school transportation institute experience, transportation research opportunities and lucrative careers in supply chain and transportation. Four high schools have committed to the presentation during the month of April. The first presentation is scheduled for April 17, 2018.

<u>Technology Transfer</u>

The inaugural CATM Symposium was held at the NCA&T Alumni-Foundation Event Center on October 17, 2017. The purpose of the event was to introduce CATM to the community and to facilitate interaction between students, faculty, practitioners and public and private entities with interests in transportation. The keynote speaker was the former United States Secretary of Transportation and former mayor of Charlotte, North Carolina, the Honorable Anthony Foxx. During his address, Foxx discussed the expanding mobility crisis, the role freight movement is playing in the growth of road congestion, how technology can be leveraged to decrease the number of trips taken, and the importance of integrating various modes of transportation. In the end, he encouraged the audience to never lose sight of what transportation is about – the people.

Approximately 72 individuals attended the symposium. Along with members from CATM's consortium institutions, the audience included people from other educational institutions, such as the University of North Carolina at Chapel-Hill, University of North Carolina at Charlotte, and University of Kentucky. Representatives from the North Carolina Department of Transportation, Piedmont Authority for Regional Transportation, Virginia Department of Transportation as well as Federal Motor Carrier Safety Administration were in attendance. Additionally, transportation and logistics organizations such as Transplace and the National Complete Streets Coalition were represented at the event. CATM held its first Executive Advisory Committee meeting directly after the symposium.

Figure 6: Staff with the Honorable Anthony Foxx during the CATM Symposium luncheon. From left: Deborah Underwood, Carletta Dudley, Anthony Foxx, and Maranda McBride.

CATM's communications specialist, Debbie Hampton, was hired in March 2018. She is currently working on completing the newsletter and will begin working on social media outlets once it has been distributed.

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

During this reporting period, undergraduate and graduate students were given the opportunity to practice their research and presentation skills by conducting research and presenting the results of their research at the CATM Annual Symposium and UTC Conference for the Southeastern Region. Both undergraduate and graduate students participated in the 4-day research workshop held for the CATM summer transportation research interns. Through this training, students 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 7).

Figure 7: CATM summer transportation research intern presentations.

Training continues to take place for graduate students from different fields of study as part of their CATM funded graduate research. Both undergraduate and graduate students are obtaining research experience and professional development as they engage with researchers and faculty members on research projects. For instance, two doctoral students and one undergraduate student have been involved in a highway vulnerability assessment study. The two doctoral students also learned skills of data pre-processing, data integration and data analysis in this study. In addition, they learned how to use an EXCEL-based vulnerability analysis tool and a GIS (Geographic Information System) software.

During this reporting period, outreach activities took place at the Daytona Beach Airport by the ERAU affiliate researchers. In addition, outreach to Daytona Beach elementary schools planned through the 'Hour of code' included the participation of CATM affiliate researchers from ERAU.

Have the results been disseminated?

Two poster presentations and one oral presentation for the Emergency project were given at the 2017 CATM Annual Symposium on October 17th. A conference paper has been accepted by the 2018 IISE (Institute of Industrial and Systems Engineers) Annul Research Conference for presentation in May 2018. Dr. Shengbin Wang presented the progress of the Last Mile project in a CATM Transportation Research Seminar in November 2017. Dr. Mary Lind presented the progress of the Paratransit project in a CATM Transportation Research Seminar in February 2018. Presentations of the Paratransit study were also given at the Hawaii Conference on System Sciences in January 2018 and the Southeast Decision Sciences Institute in March 2018. Results of both the Emergency project and Paratransit projects were presented by the research interns to STI students in July 2017.

Pilot study results of the Pedestrian Safety and Personal Listening Devices project funded by the STC were disseminated by a graduate student during a poster presentation session at the STRIDE conference in November 2017. In addition, the summer research intern working on this

project presented his work to the STI students in July 2017 as well. Both the undergraduate and graduate student working on this project presented a joint poster at the 2017 CATM Annual Symposium.

All scholarship opportunities are emailed to our supply chain and civil engineering majors. An announcement is placed on the NCA&T communications network throughout College of Business and Economics building and hard copies are available in the Transportation Institute office. Students who are fortunate enough to receive the STC Award, Eisenhower Fellowship, and TRB Fellowship are highlighted at TRB annual meeting through the STC event, the Eisenhower Showcase and the TRB Fellows paper presentations, respectively.

The applications for the 2018 Summer High School Transportation Institute has been disseminated through the Guidance Counselors' offices at all the schools within the targeted four-county area. Also, the electronic application is available on the Transportation Institute website and hardcopies are available in the Transportation Institute. Applications are emailed directly to students upon request. Students who are selected are showcased throughout the program via news articles, the opening and closing program, COMTO conference attendance, etc.

CATM is in the process of finalizing the 2017-18 newsletter. It was determined that it will continue to be combined with the Transportation Institute newsletter since the activities are intertwined. The results of center activities will also be disseminated through the CATM website and social media outlets.

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 performing the activities required to achieve the objectives associated with each research project.
- Distribute the 2017-18 newsletter.
- Require timely submission of quarterly research progress reports in order to gauge the need for mitigation or contingency plans.
- Conduct the first set of Student-to-Student Initiative sessions.
- Implement the second CATM Summer Transportation Internship Program.
- Implement the 26th NCA&T Summer High School Transportation Institute.
- Hold the second CATM Executive Advisory Committee Meeting.
- Update the CATM website with newsworthy information.
- Establish social media outlets.
- Review and post final reports for completed projects.
- Plan NCA&T Transportation Shark Tank Competition.
- Develop case for Transportation Case Competition.
- Continue assisting with the planning of the UTC Conference for the Southeastern Region.
- Participate in the 2018 UTC Conference for the Southeastern Region.
- Develop and distribute the request for proposals for year 3 research projects.
- Conduct additional brown bag seminars to disseminate research activities.
- Conduct transportation industry and research laboratory visits for students.

2. PRODUCTS:

Publications, conference papers, and presentations

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

JOURNALS

- McBride, M., Carter, L., and Phillips, B.; Integrating the Theory of Planned Behavior and Behavioral Attitudes to Explore Texting among Adolescent Drivers in the US; Transportation Research Part F: Psychology and Behaviour; under review; Acknowledged federal support.
- Park, H., Gao, S., and Samuel, S., 2017. Modeling effects of forward roadway glance durations on latent hazard detection. Transportation Research Record: Journal of the Transportation Research Board No. 2663, 90-98; published.
- Park, H., Haghani, A., Knodler, M.A., and Samuel, S., 2018. Real-time crash prediction and avoidance under unexpected traffic congestion. Accident Analysis & Prevention, 112, 39-49; published.
- Park, H., Haghani, A., Gao, S., Knodler, M.A., and Samuel, S. Anticipatory Dynamic Traffic Sensor Location Problems with Connected Vehicle Technologies, Transportation Science; awaiting publication.
- Park, H. and Pugh, N. Generalized estimating equation model based recursive partitioning. Journal of Advanced Transportation; under revision.
- Park, H., Waddell, D., and Haghani, A. Online emergency vehicle dispatching with look-ahead on a transportation network. Transportation Research Part C: Emerging Technologies; under revision.

CONFERENCE PAPERS AND PRESENTATIONS

- Ayaz, S., Gao, S., Park, H., 2018. Cooperative Scheme - An alternative approach to an equitable and pareto- improving transportation system. Proceedings of the 2018 TRB Annual Meeting.
- Chen, J., Liu, D., et al (2018), Effects of exits and number of passengers on airport evacuation efficiency using simulation, 2018 IISE Annual Conference, Orlando, Florida, May 19-22, 2018
- Chen, J, Liu, D., Cheng, Y., and Namilae, S., 2017. Effects of Exit Doors and Number of Passengers on Airport Evacuation Efficiency Using Simulation, Presented at the CATM University Transportation Center Symposium; Acknowledged Federal Support.
- Cheng, Y., Liu, D. et. al (2018), Human behavior under emergency and models used to simulate the changes: A review, Applied Human Factors and Ergonomics (AHFE) International Conference, Orlando, July 21-25, 2018.
- Chilukuri, D., Seong, Y, and Yi, S.; 2018. Development of a Mobile Application using Augmented Reality to Support Aged Drivers and Pedestrians on April 24, 2018, COE Graduate Poster Competition at NCAT; accepted for presentation, Acknowledged Federal Support.
- Chilukuri, D., Seong, Y, and Yi, S. Development of mobile application for VRU's using computer vision; 2018 IEEE SoutheastCon, Tampa Bay Area, Florida (April 19, 2018 through April 22, 2018); accepted for publication; Acknowledged Federal Support.
- Derjany, P., Namilae, S., Seong, Y. and Liu, D., 2017. Modeling the Fundamental Diagram of Pedestrian Motion using Social Force Approach; Presented at the 2017 CATM Annual Symposium; Acknowledged Federal Support.
- Derjany, P., Namilae, S., Seong, Y. and Liu, D., 2017. Modeling the Fundamental Diagram of Pedestrian Motion using Social Force Approach; Presented at the 5th Annual UTC conference for the Southeastern Region; Acknowledged Federal Support.
- Derjany, P., Namilae, S., Liu, D., Mubayi, A., and Srinivasan, A. Multiscale Pedestrian Dynamics and Infection Spread Model for Policy Analysis; PED 2018; Accepted, awaiting publication; Acknowledged Federal Support.
- Headen, J., and Park, H., 2017. Infrastructure Redeployment Based on Traffic Data Using Wireless Sensors. The first symposium of Center for Advanced Transportation Mobility (CATM 2017) Poster Presentation.

- Hensley, R.L. and Lind, M.R., 2018. A Preliminary Examination of Public Dialysis Transport Efficiency Using Available Technologies, Southeast Decision Sciences Institute Proceedings, p. 1-12; Acknowledged Federal Support.
- Horton, J., McBride, M., and Smith-Jackson, T., 2017. Pedestrian Safety with Personal Listening Devices, Poster presentation at the 5th Annual UTC Conference for the Southeastern Region; Acknowledged Federal Support.
- Horton, J., McBride, M., and Smith-Jackson, T., 2017. Pedestrian Safety With Personal Listening Devices, 2018 IISE (Institute of Industrial and Systems Engineers) Annul Research Conference, May 2018; accepted for presentation; Acknowledged Federal Support.
- Lind, M.R. and Hensley, R.L., 2017. Public Dialysis Transport Efficiency Using Digital Media, Presented at 2017 CATM Annual Symposium; Acknowledged Federal Support.
- Lind, M. and Hensley, R., 2018. Public Dialysis Transport Efficiency Using Digital Media, Presented at the Hawaii International Conference on System Sciences; Acknowledged Federal Support.
- Lind, M. and Hensley, R., 2018. Public Dialysis Transport Efficiency Using Digital Media. Presented at the CATM Transportation Research Seminar; Acknowledged Federal Support.
- Mhatre, S., Richmond, D., Qu, X., and Davis, L., 2018. Vulnerability Assessment of the Southeastern North Carolina Highway Transportation System to a Hurricane. 2018 IISE (Institute of Industrial and Systems Engineers) Annul Research Conference, May 2018; accepted for publication; Acknowledged Federal Support.
- Mohseni, M., Seong, Y., and Yi, S., 2018. Requirement analysis and prototyping an application for wheelchair riders. Industrial Engineering Research Annual Conference and Exposition (May 20-23, 2018); accepted for publication; Acknowledged Federal Support.
- Miller, A. M., Owens, J. M., Seong, Y., and Yi, S., 2017. Project Overview: Vulnerable Road User Mobility Assistance Platform. Talk presented at 5th Annual UTC Conference for the Southeastern Region, Gainesville, FL; Acknowledged Federal Support.
- Namilae, S., 2017. Multiscale Model for Pedestrian and Infection Dynamics During Air Travel, Presented at the International Conference for Risk Analysis; Acknowledged Federal Support.
- Owens, J. M., Miller, A. M., Seong, Y., and Yi, S., 2017. Project Overview: Vulnerable Road User Mobility Assistance Platform. Talk presented at 1st Annual CATM Symposium, Greensboro, NC. Acknowledged Federal Support.
- Park, H., 2017. Explicit forward glance duration hidden Markov model for inference of hazard detection. Presented at the 97th Annual Meeting of Human Factors and Ergonomics Society (HFES 2017).
- Park, H., 2017. Airline and passenger incentive optimization models for airport congestion mitigation. Top-13 Finalist Poster Competition presented at INFORMS 2017 Annual Conference.
- Park, H., 2018. Simulation-based Optimization for Reconfiguration of Mobile Wireless Sensor Network. IEEE Wireless Telecommunications Symposium 2018 (WTS 2018); accepted for publication.
- Park, H. Portable traffic sensors to enhance arterial mobility. IEEE SoutheastCon 2018, April 2018; accepted for publication.
- Park, H., Schonfeld, P., and Haghani, A., Effect of demand shifting on security checkpoint operation. Accepted for Proceeding of the 22nd Air Transport Research Society World Conference (ATRS 2018), Seoul, Korea, July 2018.
- Pugh, N., and Park, H., 2017. Generalized Estimating Equation Model Based Recursive Partitioning in Distracted Driving. The first symposium of Center for Advanced Transportation Mobility (CATM 2017) Poster Presentation.
- Pugh, N., and Park, H., 2018. Generalized Estimating Equation Models Based on Recursive Partitioning in Distracted Driving. Accepted for proceeding of the International Conference on Applied Human Factors and Ergonomics (AHFE 2018), Orlando, Florida.
- Pugh, N and Park, H. Prediction of Red-Light Running using an Artificial Neural Network. Accepted for Proceedings of IEEE SoutheastCon 2018, St. Petersburg, FL, April, 2018.

- Qu, X., 2017. Multi-Scale Models for Transportation Systems Under Emergency. Presentation at the 1st CATM Annual Symposium, Oct. 17, 2017; Acknowledged Federal Support.
- Stanley, P. Mhatre, S., Qu, X., and Davis, L., 2017. Systematic Study of Emergency Response Activities During Hurricane Matthew. Poster presented at the 1st CATM Annual Symposium, Oct. 17, 2017; acknowledgement of federal support (yes)
- Yu, X., Gao, S., Park, H., 2018. Multi-cycle optimal taxi routing with e-hailing. Proceedings of the 2018 TRB Annual Meeting.
- Wang, S., 2017. Automated Last Mile Connectivity for Vulnerable Users: an Introduction; Presented at the CATM Transportation Research Seminar; Acknowledged Federal Support.

BOOKS AND NON-PERIODICAL, ONE-TIME PUBLICATIONS

Websites or other internet material

- The research abstracts for the newly funded projects and the Exhibit F form for each project were posted in March 2018: https://www.ncat.edu/cobe/transportation-institute/catm/research-projects.php.
- The Autodrive competition website was developed and can be found at https://aggiesautonomousauto.github.io/.
- The results of the Emergency project have been disseminated through several news stories.
  - Information week article – 'Disasters: Tech to Map Human Behavior in Crises' https://www.informationweek.com/disasters-tech-to-map-human-behavior-in-crises/d/d-id/1330910?
  - ERAU News – 'With a Rise in Natural Disasters and Active Shooters, an Embry-Riddle Team Seeks to Protect More Lives during Evacuations' https://news.erau.edu/headlines/with-a-rise-in-natural-disasters-and-active-shooters-an-embry-riddle-team-seeks-to-protect/
  - WFTV-TV-9 – Local news show- '9 Investigates: Saving lives during mass evacuations'
  - https://www.wftv.com/news/9-investigates/9-investigates-saving-lives-during-mass-evacuations/658526113
- Dr. Hyoshin (John) Park maintains a list of his research activities on the following website: https://johnpark.club.

Technologies or techniques

- The VRU-MAP application (in progress) - Machine vision: Vision data is collected using an Android device and transmitted to PC through WIFI. Then, using pattern recognition techniques, traffic warning signs like STOP, DO NOT ENTER and YIELD are detected and recognized using MATLAB/Simulink model in real time.

Inventions, patent applications, and/or licenses

- Park, H., Explicit Duration Hidden Markov for Vehicle Automation with Distraction. U.S. Patent Provisional Application USSN 62/615,795. Filed 1/10/2018 as a sole investigator.
- Park, H., Anticipator Dynamic Traffic Sensor Location Problems with Connected Vehicle Technologies. U.S. Patent Provisional Application USSN 62/620,232. Filed 1/22/2018 as a sole investigator.

Other products

<u>Data</u>

- Data of North Carolina highway closures caused by Hurricane Matthew.
- Floor and rainfall data in North Carolina during Hurricane Matthew.
- Data collected from the Daytona Beach airport and from the review of the literature – includes the total evacuation time per certain number of passengers, walking speed (average and standard

deviation), speed by age group and by gender, and difference by handicapped person and travel in groups.

Software

- Ongoing development of crowd-source database for intermittent hazards.
- Hosting routing and mapping software at VTTI.
- A Fortran – MPI massively parallel code for Pedestrian dynamics in emergencies.
- Self-propelled pedestrian entity dynamics in emergencies (SPEDE).

3. PARTICIPANTS & COLLABORATING ORGANIZATIONS:

Organizations that have been involved as partners

Not including the center staff at NCA&T, Table 5 provides a list of the individuals who have been involved in the center activities 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.	NCA&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Shengbin Wang, Ph.D.	NCA&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Laquanda Leaven, Ph.D.	NCA&T
Dept. of Marketing, Transportation, and Supply Chain	Greensboro, NC	Collaborative Research	Omar Woodham, Ph.D.	NCA&T
Dept. of Management	Greensboro, NC	Collaborative Research	Jeanne Holmes, Ph.D.	NCA&T
Dept. of Management	Greensboro, NC	Collaborative Research	Mary Lind, Ph.D.	NCA&T
Dept. of Management	Greensboro, NC	Collaborative Research	Rhonda Hensley, Ph.D.	NCA&T
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Lauren Davis, Ph.D.	NCA&T
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Xiuli Qu, Ph.D.	NCA&T
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Younho Seong, Ph.D.	NCA&T
Dept. of Computational Science and Engineering	Greensboro, NC	Collaborative Research	Hyoshin (John) Park, Ph.D.	NCA&T
Dept. of Electrical and Computer Engineering	Greensboro, NC	Collaborative Research	Ali Karimoddini, Ph.D.	NCA&T
Dept. of Electrical and Computer Engineering	Greensboro, NC	Collaborative Research	Abdollah Homaifar, Ph.D.	NCA&T
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Sachin Mhatre (doctoral student)	NCA&T

Dept. of Mechanical Engineering	Greensboro, NC	Collaborative Research	Sun Yi, Ph.D.	NCA&T
Dept. of Mechanical Engineering	Greensboro, NC	Collaborative Research	Dekkata Sai Charan (master's student)	NCA&T
Dept. of Mechanical Engineering	Greensboro, NC	Collaborative Research	Devi Mounika Chilukuri (master's student)	NCA&T
Dept. of Computational Science and Engineering	Greensboro, NC	Collaborative Research	Cynthia Glass (doctoral student)	NCA&T
Dept. of Computational Science and Engineering	Greensboro, NC	Collaborative Research	Mian Li (doctoral student)	NCA&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.	Virginia Tech
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Kevin Grove, Ph.D.	Virginia Tech
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Justin Owens, Ph.D.	Virginia Tech
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Andrew Miller, Ph.D.	Virginia Tech
Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Erin Mabry, Ph.D.	Virginia Tech
Dept. of Computer Science	Blacksburg, VA	Collaborative Research	Daniel Kavanaugh	Virginia Tech
Institute for Transportation Research and Education (ITRE)	Raleigh, NC	Financial support, Collaborative Research	James Martin, P.E.	NC State University
Institute for Transportation Research and Education (ITRE)	Raleigh, NC	Collaborative Research	Brittany Gaustad	NC State University
Savannah State University	Savannah, GA	Collaborative Research	Suman Niranjan, Ph.D.	Savannah State University
Dept. of Psychology	Birmingham, AL	Collaborative Research	David Schwebel, Ph.D.	UAB - Birmingham
Dept. of Psychology	Birmingham, AL	Collaborative Research	Despina Stavrinos, Ph.D.	UAB - Birmingham
Dept. of Graduate Studies, College of Aviation	Daytona Beach, FL	Collaborative Research	Dahai Liu, Ph.D.	ERAU
Dept. of Aerospace Engineering	Daytona Beach, FL	Collaborative Research	Namilae Sirish, Ph.D.	ERAU
School of Graduate Studies	Daytona Beach, FL	Collaborative Research	Scott Winter, Ph.D.	ERAU
Dept. of Aerospace Engineering	Daytona Beach, FL	Collaborative Research	Pierrot Derjany (doctoral student)	ERAU
Dept. of Aeronautics	Daytona Beach, FL	Collaborative Research	Jie Chen (master's student)	ERAU
Dept. of Aeronautics	Daytona Beach, FL	Collaborative Research	Yixuan Chen (master's student)	ERAU

Center for Sustainable Development	Washington, DC	Collaborative Research	Dwane Jones, Ph.D.	UDC
Conference of Minority Transportation Officials (COMTO)	Washington, DC	NC A&T Scholarship	Brad Mims	NCA&T
NC Department of Transportation	Raleigh, NC	In-kind support-presentations, financial support-internship program	JoAna McCoy, Director of Education Initiatives	
NC FHWA Division	Raleigh, NC	In-kind support-presentations, collaborative support	Lynise DeVance, Program Manager, Civil Rights Office	
NC Department of Transportation	Raleigh, NC	Collaborative Research	John Kirby, P.E.	
NC Department of Transportation	Raleigh, NC	Collaborative Research	Donna Boone	
Smith High School	Greensboro, NC	Support CATM Student-to-student Initiative	Gwendolyn Atkinson	
Dudley High School	Greensboro, NC	Support CATM Student-to-student Initiative	Kiyah McDermid	
STEM Early College	Greensboro, NC	Support CATM Student-to-student Initiative	Sequilla McLean	
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 NCA&T Eisenhower and TRB Fellows, respectively. They mentored students during the writing process of their research papers over the course of the reporting period.

A collaborative NSF proposal relevant to the Emergency project was submitted with the following researchers outside the UTC program: Burcu Adivar, Department of Management, Fayetteville State University, Fayetteville, NC; Mohd Anwar, Department of Computer Science, North Carolina A&T State University, Greensboro, NC.

4. IMPACT:

Impact on the development of the principal discipline(s) of the program

The principal disciplines for CATM are human factors, psychology, information science, and operations research. Within these disciplines, the Last Mile project is helping to identify policy barriers or initiatives that could impact the research and deployment of LSAVs to improve VRU transit. The research will raise awareness of how VRUs could be assisted by LSAVs, how VRUs

would like to use LSAVs, and how LSAVs could be implemented to build trust in the technology and operation.

The outcomes of the Last Mile projects will include new tools for evaluation of user interaction with automated vehicles/systems as well as novel insight on the technical, logistical, and personal usability challenges faced by VRUs when accessing and using these services. Transit, governmental, and regulatory agencies and their stakeholders will also be provided with a better understanding of the economic and sustainability impacts and trade-offs associated with the expansion of localized transit and the potential replacement of paratransit with alternative systems. Additional benefits include those derived from the respective education and hands-on experience gained by participating as student interns from Virginia Tech's Human Factors of Transportation Safety Graduate Certificate Program (HFTS GCP). Students from NCA&T and UDC-CC will also be recruited to serve as research assistants for this project and will benefit from valuable hands-on research and educational experiences.

Findings associated with the Emergency project will likely to be beneficial to a variety of disciplines, especially for the human factors and modeling and simulation field. Currently, there are no well-defined methods in the field of human factors to address human behavior under emergency. Due to the unique nature of the emergency, it is difficult to apply the traditional experimental design to investigate the effect of these factors. The mathematical models and simulation models applied in this study will be of special interest to researchers in these fields seeking innovative approaches to address these situations.

The VRU-MAP project will ultimately enable safe and efficient mobility for vulnerable road users. Results of the work performed for the Travelers' Rationality project will provide quicker responses to emergency requests to decrease the chance of secondary crashes and delay to travelers.

Impact on other disciplines

The work performed within the Last Mile project will help improve public awareness and trust in LSAV technologies and add to the body of knowledge about how different populations perceive, trust, and use automated technologies. The VRU-MAP team is collaborating with a professor and students in the VT Department of Human Development on a related project that will benefit the larger disability community and the HDD field. The VRU-MAP NCA&T team is also participating in an autonomous vehicle development project that will benefit general users as well as VRUs by improving safety and comfort. Relevant engineering technologies and the societal impact of them are being studied by the research teams.

Due to the complex nature of the evacuation process, understanding of the effects of the various factors is extremely limited. The Emergency study developed a framework of the impacting factors, including human factors, environmental factors and policy factors, to provide a comprehensive model that integrates these factors together. The simulation models based on queuing theory and the social force model are quite innovative. The methods and results will contribute to the general knowledge and understanding of human responses under emergency.

The advanced operations research models developed as a component of the Travelers' Rationality project will be applied to other research domains, such as sensor location problems, to improve the mobility of travelers. Results of the modeling of paratransit scheduling processes will help to identify transportation bottlenecks and produce a dynamic modeling approach to prevent bottlenecks from occurring.

Impact on the development of transportation workforce development.

In terms of research, the work associated with the Travelers' Rationality project will provide a module to be used in training emergency responders to protect themselves from secondary crashes. Additionally, the Last Mile research will impact how the transportation workforce interacts with VRUs. For instance, VRUs could have new methods of interfacing with the existing transit infrastructure and new usage patterns if LSAVs effectively expand their mobility. Furthermore, the Paratransit project should lead to improved efficiency and greater effectiveness for paratransit reservations personnel and dispatchers.

Results of the Emergency project will be beneficial for transportation workforce development, particularly for workforce training and education. Understanding the effects of various factors on the evacuation process will help the workforce develop better training programs for handling such situations and develop better decision-making strategies for emergent situations.

Undergraduate, masters, and doctoral students are integrally involved in the research activities taking place within CATM. Most of these students are not from traditional "transportation" disciplines; however, the work in which they are engaging is influencing them to seek transportation-related positions once they complete their studies and enter the workforce.

In terms of the education and workforce development activities, one of the students who attended the Dollar General warehouse tour was offered an internship for the upcoming summer. The students who received the Eisenhower and TRB fellowships gained valuable transportation experience as they conducted the research required for completing their papers. In addition, all of the students who attended the TRB meeting and UTC Conference for the Southeastern Region had multiple opportunities to engage in networking and professional development activities with transportation students, researchers, and practitioners.

Most of the high school students who attended the STI program were considering majoring in a wide assortment of disciplines and most were not considering working in the transportation industry. However, as a result of the activities that took place during the program, out of 16 students, 15 students indicated the project activities that took place during the program helped them understand transportation better, 10 indicated they plan to continue to study transportation in the future, and 10 indicated that they want to pursue a career in the transportation industry. Overall, every STI participant left the program with a greater understanding and more knowledge of the career opportunities in transportation.

Impact on physical, institutional, and informational resources at the university or other partner institutions

The consolidated data of North Carolina highway closures caused by Hurricane Matthew, floor and rainfall in North Carolina during Hurricane Matthew, and North Carolina's emergency response activities to Hurricane Matthew are shared within the Emergency project team through a shared Google drive. These data will be available to other researchers by request. In addition, a Samsung Galaxy S8 has been acquired to run the VRU-MAP application.

VTTI's facilities, hardware, and software engineering team have prepared to work on a LSAV that will be acquired in the next reporting period. VTTI has expanded its test track to include a low-speed urban environment that would facilitate testing for LSAVs.

Impact on technology transfer

The Last Mile project is expected to identify best practices for LSAV developers to accommodate VRU needs. The project may also identify policy needs to address any barriers to testing or deployment. The program will help LSAVs expand the mobility VRUs, raise public trust in LSAV technologies, and generate valuable data for iterating LSAV technologies as they rapidly evolve.

The VRU-MAP team has been in regular contact with officials in state and federal departments of transportation about their project and how it can integrate and complement their ongoing efforts. The VRU-MAP application is designed to improve mobility of individuals with difficulties navigating or maneuvering.

Publications resulting from the Paratransit project have raised awareness of the importance of paratransit and particularly for dialysis patients. The year 2 project is expected to contribute to the use of Bayesian modeling of reservation systems to reduce hold time and busy signals.

The outreach activities to the Florida DOT and local airports (DAB and MCO) have resulted in greater awareness of the Emergency project research and possible use of the research in policy/procedure development for emergencies.

Impact on society beyond science and technology

The technology developed for the Last Mile project may facilitate the sharing of the transportation infrastructure between VRUs and other users. This, in turn, can reduce costs within the system. The VRU-MAP project will provide safer, more convenient mobility options for VRUs, particularly pedestrians and multi-modal transit users. The results of the Emergency project will provide transportation officials with a means by which they can better plan and prepare for emergency situations to increase public safety in the case of unexpected events that adversely affect the transportation system.

The Paratransit project has already attracted the attention of several transportation officials and service providers. It has become apparent that solutions to the scheduling problem are long sought after. The information provided by this study is enlightening those involved in the paratransit industry and teams are being formed to address the issues.

5. CHANGES/PROBLEMS:

During this reporting period, the issue associated with UDC's participation in the center activities has still lingered on. Although the subcontract between NC A&T and UDC was executed in September, no meaningful progress has been made on the Community College Transportation Model Curriculum project. They have been asked to submit an updated project plan and timeline in April.

6. SPECIAL REPORTING REQUIREMENTS

Nothing to report for this period.