UTC Semi-Annual Performance Report

Federal Agency and Organization Element to Which Report is Submitted:

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

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Project Title: Center for Advanced Transportation Mobility

Center Director Name, Title, and Contact Information

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Recipient Organization:

North Carolina Agricultural and Technical State University

1601 E. Market Street, Greensboro, NC 27411

Recipient Identifying Number or Account Number: 270128

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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 education 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, 2022.

Table 1: Progress of period 9 activities

Research	**Status**	**% Complete**
Complete Year 1 projects	Behind schedule	95%
Complete Year 3 projects	Complete	100%
Complete Year 4 projects	Behind schedule	50%
Complete Year 5 projects	Behind schedule	45%
Complete Year 6 projects	On schedule	0%
Conduct annual visit to member institutions – Year 6	Cancelled	0%
Education, Outreach, and Workforce Development Activities		
Student participation in the 2022 TRB conference	Complete	100%
Conduct Spring 2022 student-to-student K-12 initiative workshops	Complete	100%
Student participation in the 2022 SE Region UTC conference	Complete	100%
Recruit/select 2022 STI participants	Complete	100%
Prepare for and hold 2022 STI	Complete	100%
Distribute 2022-23 CATM Transportation Scholarship applications	Complete	100%
Select 2022-23 CATM Transportation Scholarship recipients	Behind schedule	90%
Hold the 2022-23 Dwight David Eisenhower Transportation Fellowship Local Competition	Complete	100%
Recruit/select 2023 STI participants	Forthcoming	0%
Prepare for and hold 2023 STI	Forthcoming	0%
Hold the 2023-24 Dwight David Eisenhower Transportation Fellowship Local Competition	Forthcoming	0%

Technology Transfer Activities		
Assist with the 2022 SE Region UTC Conference planning	Complete	100%
Plan and hold the 2021-22 Annual CATM Symposium	Complete	100%
Create and distribute Spring 2022 newsletter	Complete	80%
Create and distribute Fall/Winter 2022 newsletter	On schedule	80%
Conduct 2022 research webinars	On schedule	50%
Plan 5th Annual CATM Symposium	Forthcoming	0%
US DOT Reporting Activities		
Update records in RiP database	Complete	100%
Complete and submit PPPR#10	Complete	100%
Complete and submit SF425 for Q21 and Q22	Complete	100%
Complete and submit 2022 recipient share report	On schedule	50%
Complete and submit 2022 performance indicator report	On schedule	50%
Complete and submit PPPR#11	On schedule	75%
Review year 3 final reports for completed research projects	Complete	100%
Upload year 3 final reports to TRID database	Behind Schedule	90%
Review year 4 final reports for completed research projects	On schedule	50%
Upload year 4 final reports to TRID database	On schedule	25%
Review year 5 final reports for completed research projects	On schedule	17%
Upload year 5 final reports to TRID database	On schedule	17%
Complete and submit 2023 recipient share report	Forthcoming	0%
Complete and submit SF425 for Q22 and Q23	Forthcoming	0%

What was accomplished under these goals?

During the reporting period, a variety of accomplishments were made in the areas of research, education/workforce development, and technology transfer. A summary of the activities and the associated accomplishments are described below.

Research

Table 2 provides a running list of the year 1 through 6 projects that were active at the beginning of the reporting period along with their 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 reported for each project.

Table 2: Funded projects active during reporting period

Project Title	Status/Award Year	Research Priority Area(s)	Project Link
Development, Design, and Calibration of the Vulnerable Road User Mobility Assistance Platform	Continuing/Y1	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/vrumap.php
Multi-agent Reinforcement Learning-based Pedestrian Dynamics Models for Emergency Evacuation	Completed/Y3	IM, RC	https://www.ncat.edu/cobe/transportation-institute/catm/multi-agent-pedestrian-dynamic-models.php
DRONETIM: Dynamic Routing Of uNmanned-aerial and Emergency Team Incident Management	Completed/Y3	IM, RC, PS	https://www.ncat.edu/cobe/transportation-institute/catm/dynamic-routing-unmanned-aerial.php

Equitable Dynamic Pricing for Express Lanes	Completed/Y5	IM, RC	https://www.ncat.edu/cobe/transportation-institute/catm/15-equitabledynamicpricingforexpresslanes.php
Real-Time Recommendations for Traffic Control in an Intelligent Transportation System During an Emergency Evacuation – Part 2	Completed/Y4	IM, RC	https://www.ncat.edu/cobe/transportation-institute/catm/real-time-traffic-control-part2.php
Epidemiological Models for Transportation Applications: Secondary Crashes	Completed/Y4	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/epidemiological-models-secondary-crashes.php
Acoustic Situation Awareness and Its Effects on Pedestrian Safety within a Virtual Environment	Continuing/Y4	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/acoustic-situation-awareness.php
Vulnerable Road Users demand-responsive Transit Optimization with healthcare Privatization (VRUTOP)	Continuing/Y4	IM	https://www.ncat.edu/cobe/transportation-institute/catm/vrutop.php
Evaluation of Web-Based Driving Feedback for Teens and their Parents	Continuing/Y4	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/web-based-driving.php
Detecting Early-Stage Dementia Using Naturalistic Driving	Continuing/Y4	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/detecting-dementia.php
Analyzing the Role of Air-Transportation in COVID-19 Pandemic Disaster	Continuing/Y5	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/24-airtransportationcovid19.php
Machine Learning for Dynamic Airspace Configuration towards Optimized Mobility in Emergency Situations	Continuing /Y5	IM, RC	https://www.ncat.edu/cobe/transportation-institute/catm/25-machinelearningabstract.php
Mask-Wearing Behaviors in Air Travel During Coronavirus Pandemic– An Extended Theory of Planned Behavior Model	Completed/Y5	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/26-maskwearingabstract.php
Modeling Future Outbreaks of COVID-19 Using Traffic as Leading Indicator	Continuing/Y5	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/27-modelingfutureoutbreaks.php
Usability of Urban Air Mobility: Quantitative and Qualitative Assessments of Usage in Emergency Situations	Completed/Y5	IM, PS, RC	https://www.ncat.edu/cobe/transportation-institute/catm/28-urbanairmobilityabstract.php
Connected electric vehicles: Vehicle-pedestrian communications to enhance vision impaired pedestrian safety	Continuing/Y5	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/29-cev-visionimpairedabstract.php
Real-time Deep Reinforcement Learning for Evacuation under Emergencies	Continuing /Y6	IM	https://www.ncat.edu/cobe/transportation-institute/catm/realtime-deep-reinforcement-learning-for-evacuation-under-emergencies.php
Rural Older Adult Driver Tailored Research-Integrated Plan	Continuing /Y6	IM, PS	https://www.ncat.edu/cobe/transportation-institute/catm/rural-older-adult-driver-tailored-research.php
Improving Air Mobility in Emergency Situations	Continuing /Y6	IM, RC	https://www.ncat.edu/cobe/transportation-institute/catm/improving-air-mobility-in-emergency-situations.php

High-speed rail in the US – The intention to use and mode choice behavior	Continuing /Y6	IM, RC, PS, PE	https://www.ncat.edu/cobe/transportation-institute/catm/high-speed-rail-in-the-us1.php

IM = Improving mobility of people and goods; RC = Reducing congestion; PS = Promoting safety; PE = Preserving the environment

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

VRU-MAP team has been testing the prototype system and outlining the final report with the intention of finishing the project in the coming quarter.

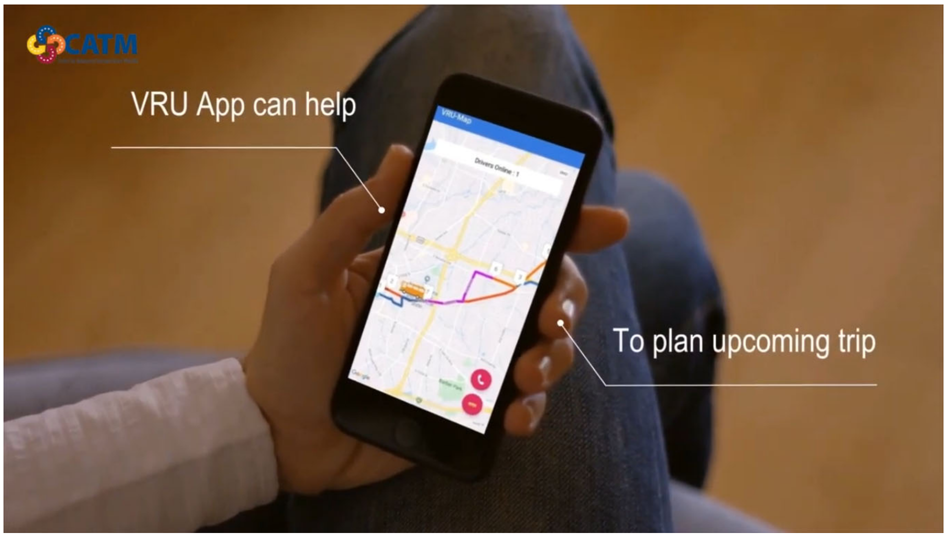

Figure 1: VRU-MAP Prototype

Multi-agent Reinforcement Learning-based Pedestrian Dynamics Models for Emergency Evacuation (Multi-agent)

The Multi-agent team published a journal article related to this project during the reporting period.

DRONETIM: Dynamic Routing Of uNmanned-aerial and Emergency Team Incident Management (DRONETIM)

The DRONETIM project was completed and the final report posted during this reporting period.

Epidemiological Models for Transportation Applications: Secondary Crashes (Secondary Crashes)

The Secondary Crashes project was completed. The final report is in the process of being posted.

Equitable Dynamic Pricing for Express Lanes (Dynamic Pricing)

Over the reporting period, the Dynamic Pricing team conducted further analysis for optimizing alternate tolling schemes, involving designing the tolls to reflect the real-world implementation options. They found that discounts proportional to travelers' value of time address equity differentials across the delay, where the discounts may be a function of current toll and travel time savings at a given gantry. Furthermore, they demonstrate that equitable discounts may result in a 25% to 34% loss of revenue. The research team completed the final report for the project, which is posted on the CATM website. The work was also accepted for presentation at the 2023 Annual Meeting of Transportation Research Board that will take place January 2023.

Real-Time Recommendations for Traffic Control in an Intelligent Transportation System During an Emergency Evacuation – Part 2 (RealTime2)

The RealTime2 team submitted the final report for this project during this reporting period. Additionally, they published and presented the preliminary results of an agent-based simulation of North Carolina hurricane evacuations at the Institute of Industrial and Systems Engineers (IISE) conference in May 2022 and are currently working on several journal papers associated with this project.

Acoustic Situation Awareness and Its Effects on Pedestrian Safety within a Virtual Environment (Situation Awareness)

The Situation Awareness team completed data collection during the reporting period. The results are currently being analyzed and prepared for dissemination. Preliminary findings were reported in June 2022 at the 27th International Conference on Auditory Displays (ICAD 2022) and were well received. Major activities, thus far, include the successful development of a virtual crosswalk simulator, naturalistic observations of university-pedestrian street crosswalk behavior, and user testing of personal listening device usage during simulated crosswalks. Major findings are that the virtual crosswalk simulator worked as designed; however, the development of a portable system could expand possibilities, especially in terms of diversifying the user sample population. In terms of crosswalk observations, non-verbal communication between the pedestrian and driver is critical, individual crossing behavior is dependent upon the crossing factors (e.g., party size, personal listening device usage, non-verbal communication with driver, etc.). Further results are being prepared for publication.

Figure 2: Left: real crosswalk; Right: virtual crosswalk

Vulnerable Road Users demand-responsive Transit Optimization with healthcare Privatization (VRUTOP)

During the reporting period, the VRUTOP team analyzed the transit data from April 2020 to April 2022 to see how the pandemic changed the service quality.

Evaluation of Web-Based Driving Feedback for Teens and their Parents (Driving Feedback)

During this performance period, the Driving Feedback team worked with their collaborators to obtain preliminary data to refine procedures for data transfer. There have been issues with obtaining all of the data needed to provide an effective assessment of participant performance, and thus they have been working to obtain these variables. Additionally, they have been exploring additional options for data visualization in providing participants with feedback regarding their driving performance. Initially, GM was planning to host data on a SharePoint site that would be accessible to participants via individual login information. Data would be provided on the site via a pdf that they planned to automatically update regularly for each participant. However, they found that the ability to automatically update the individual pdf files for each participant and parent was not possible given the limited administrative privileges available to VTTI. Therefore, the team looked at the potential for Virginia Tech to host the data and provide participants with feedback via the web application Grafana, with user authentication being completed by GM. GM is in the process of reviewing the necessary agreements in place to confirm that this option is possible. Finally, the research team continued to refine recruitment procedures in a way that satisfies both GM and Virginia Tech's IRB. This work has included updating recruitment materials and documents related to participant communication, and research protocols and other IRB related documents.

Detecting Early-Stage Dementia Using Naturalistic Driving (Detecting Dementia)

The Detecting Dementia research team continued data collection during the reporting period.

Analyzing the Role of Air-Transportation in COVID-19 Pandemic Disaster (COVID AirTran)

During the reporting period, the COVID AirTran team completed a survey of recent on-flight outbreaks. The survey indicates that some aspects of the COVID-19 spread, such as long-distance superspreading, cannot be explained without also considering the movement of people. Another factor that could be influential but has not gained much attention yet is the unpredictable passenger behavior. Here, the team used a novel infection risk model that is linked with pedestrian dynamics to accurately capture these aspects of infection spread. The team utilized the model to evaluate what-if scenarios on the relative effectiveness of policies and procedures such as masking, social distancing, as well as synergistic effects by combining different approaches in airplanes and other contexts. They found that in certain instances independent strategies can combine synergistically to reduce infection probability, by more than a sum of individual strategies. Additionally, the team analyzed five empirical events of SARS-COV-2 transmission where the spatiotemporal details of the infected persons are known. Three common dose response models, the exponential model, the beta-Poisson model, and the Weibull model, were parameterized for these scenarios. This provided parameter ranges corresponding to high, intermediate, and low-dose scenarios. They used these parameter ranges to analyze the spread in generic transportation modes, including a single aisle airplane, bus, and railway coach. They then examined the effect of mask usage and mask quality, and performed a PRCC sensitivity analysis of the related factors.

Machine Learning for Dynamic Airspace Configuration towards Optimized Mobility in Emergency Situations (Machine Learning)

The Machine Learning team conducted further research on Dynamic Airspace Configuration (DAC) Modeling by focusing on building a machine learning model for DAC.

Mask-Wearing Behaviors in Air Travel During Coronavirus Pandemic– An Extended Theory of Planned Behavior Model (Mask-Wearing)

The Mask-Wearing team completed their final report during the reporting period.

Modeling Future Outbreaks of COVID-19 Using Traffic as Leading Indicator (COVID Outbreaks)

The COVID Outbreaks team conducted preliminary “what if” studies on how traffic effects COVID-19 spread.

Usability of Urban Air Mobility: Quantitative and Qualitative Assessments of Usage in Emergency Situations (Urban Air)

The Urban Air project final report was posted during the reporting period.

Connected electric vehicles: Vehicle-pedestrian communications to enhance vision impaired pedestrian safety (CEV Vision)

During the reporting period, the major research accomplishments of the CEV Vision team was the approval of the IRBs for user-testing sessions - data collection is scheduled to being immediately.

Real-time Deep Reinforcement Learning for Evacuation under Emergencies (Deep Reinforcement)

During the reporting period, the Deep Reinforcement team developed a literature review for their project.

Rural Older Adult Driver Tailored Research-Integrated Plan (ROADTRIP)

The major activities of the ROADTRIP team during the reporting period included securing IRB approval for study protocols and beginning program implementation / data collection. Their first participant sent us a thank you note after the Intervention Session - that has never before happened, so early results suggest that participants may greatly appreciate the benefits of the program to their mobility and overall life satisfaction.

Improving Air Mobility in Emergency Situations (Air Mobility)

The Air Mobility team conducted a comprehensive literature review on air mobility in emergency situations during the reporting period and identified opportunities and challenges of applying machine learning in improving air mobility in emergency situations. They also performed data gathering and started data pre-processing and visualization.

High-speed rail in the US – Intention to Use and Mode Choice Behavior (High-speed Rail)

The High-speed Rail team completed their literature review during the reporting period.

Research Assistants

Twenty-nine students worked as research assistants on CATM products 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	8	2	10
Doctoral	5	4	9
Total	**17**	**12**	**29**

Table 4 lists additional transportation research grants directly connected to the center that were active during the reporting period and the primary agencies funding them.

Table 4: Other active transportation research grants

Project Title	Lead Institution	Funding Agency
Advancing STEM Education Through Transportation Studies	N.C. A&T State University	National Science Foundation

Education

The A^3 team from NC A&T engaged in AutoDrive University Competitions during the reporting period. SAE/GM AutoDrive Challenge took place in June at M-City in Ann Arbor, MI. The A^3 team came in 3rd place (out of 10) in the Concept Design area. They received a trophy and $1,000 cash prize for their accomplishment.

Over the course of the reporting period, the findings from the Dynamic Pricing project have been integrated into classroom learning experiences of the courses taught by the PI. Discussions in the following courses were informed by the project: CIEN 700 Emerging Technologies in Civil Engineering, CIEN 350 Introduction to Transportation Engineering, and CIEN 754 Modeling of Transportation Systems. Students were also encouraged to participate in various Equity-related discussions happening across the nation through organizations like Institute of Transportation Engineers (ITE). As a key outcome, students were made aware of the equity issues associated with infrastructure management and ways to discuss and address these issues.

Throughout the Situation Awareness project, students have been engaged in experiential learning, for credit, through undergraduate research courses. They are intended to provide students with authentic research experiences in preparation for industry and graduate school. During this reporting period, two students received course credit for participation in the project. In terms of graduate student education, an extended abstract was published and presented at the ICAD 2022 virtual conference.

Four undergraduate Industrial and Systems Engineering students are gaining experiential learning credits through undergraduate courses by engaging in the CEV project. In addition, a previous undergraduate researcher who engaged for course credit expressed interest in graduate school due to the experience and has been accepted into the VT ISE program.

Two undergraduate students were awarded scholarships through the Dwight D. Eisenhower Transportation Fellowship Program this reporting period. They will initiate work on their research papers with guidance from their faculty mentors during the next reporting period.

Workforce Development and Outreach

During the reporting period, NC A&T conducted the 30th annual Summer High School Transportation Institute (STI) July 11 through August 5. This year's STI was in-person for the

Figure 3: STI 2022 Cohort

first time in two years. The group included 15 North Carolina 11th and 12th graders: five from Greensboro, three from High Point, and one each from Elon, Gibsonville, Haw River, Kernersville, Mebane and Whitsett. The closing ceremony for the 30th anniversary program took place at the National Civil Rights Center & Museum in Greensboro, NC.

The CATM Summer Transportation Research Internships were awarded to two undergraduate students in civil engineering. One student, Mary Bakre, focused her research on building computer models of intelligent transportation systems which can be used to benefit travelers in day-to-day traffic operations and long-term planning. Over the summer, she mapped the transportation network in Austin, Texas and built a script that evaluates the impacts of real-time information on route choices of travelers, which could potentially reduce travel times. The second student, Anusha Neupane, focused her research on developing a prototype trip planning algorithm that can easily be integrated into a cell phone application using datasets available for the state of North Carolina. The research involved mitigating traffic congestion by learning the spatio-temporal correlation of travel times and recommending alternate routes to travelers based on the revealed traffic information.

Technology Transfer

What opportunities for training and professional development were provided?

The CATM Summer Transportation Research Interns received specialized training and professional development during the course of the summer. Neupane was lead author on a paper selected for presentation at the 2022 Undergraduate Consortium at the ACM Knowledge, Discovery, and Data Mining Conference, which is ranked as the top conference in data science in terms of acceptance rate and quality of presentations.

During the reporting period, undergraduate and graduate research assistants involved with the Dynamic Pricing project were trained to use relevant software and programming tools. These include Python programming, bash scripting, Github source code management, and working with Linux operating systems. Training also involved writing software such as Latex.

The Masters degree student on the Driving Feedback study coordinated IRB efforts during the reporting period, working with the Information Technology department at VTTI to ensure that the data the team is receiving corresponds with what they are expecting, working with the VTTI recruitment team to confirm that the team's recruitment methods match with best practices established from previous recruitment efforts.

Have the results been disseminated?

Various project results were disseminated at conferences and symposia during the reporting period. These presentations and papers are listed in the Outputs section of this report. Elements of the Machine Learning and Urban Air projects, CATM virtual symposium, and 2022 STI program were also highlighted in the Spring 2022 CATM Newsletter.

A 6-minute video highlighting some of the CATM-funded transportation research activities at NC A&T was produced by WebsEdge and spotlighted along with 14 other videos during the 2022 ITS World Congress in Los Angeles in September. Due to the sheer size of the ITS World Congress, there were several different ways in which the videos were broadcast to ensure they were not just seen, but watched on numerous occasions throughout the week. To achieve this, ITS America installed large, branded screens in the Los Angeles Convention Center. The screens were focused in areas like the registration area, lunch and eating areas, coffee areas – basically anywhere that attendees are situated for prolonged periods – and the videos were broadcast on a loop throughout the 5 days. They also had a studio at the meeting where they filmed interviews with the ITS America leadership, government officials and keynote speakers – it often draws a crowd and so they had a screen there broadcasting the videos throughout as well. Copies of the videos were made available to attendees so that they could request copies to take back and share with their departments and organizations afterwards, it was in the online coverage of the event and also broadcast on a dedicated channel through to the attendees hotel bedrooms in Los Angeles so that they could watch them throughout the evenings and mornings as well. The video is also linked to the CATM website homepage.

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
- Hold at least two research webinars
- Distribute the Fall/Winter 2022 newsletter
- Recruit for NC A&T's 31st Summer High School Transportation Institute
- Recruit applicants for the 2023-24 DDETFP
- Plan the next CATM Symposium

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS:

Organizations that have been involved as partners

Table 5 provides a list of the individuals who were involved in center activities as partners during the reporting period and their associated organizations. This list does not include the center staff at NC A&T nor the various students involved in CATM activities.

Table 5: List of partners

Organization Name	Organization Location	Partner's Contribution to the Project	Name (First and Last)	Partner University
Dept. of Industrial and Systems Engineering	Greensboro, NC	Collaborative Research	Xiuli Qu, Ph.D.; Lauren Davis, Ph.D.; & Younho Seong, Ph.D.	NC A&T
Dept. of Computational Science and Engineering	Greensboro, NC	Collaborative Research	Hyoshin (John) Park, Ph.D.	NC A&T
Dept. of Mechanical Engineering	Greensboro, NC	Collaborative Research	Sun Yi, Ph.D.	NC A&T
Dept. of Civil, Architectural, and Environmental Engineering	Greensboro, NC	Collaborative Research	Venktesh Pandey, Ph.D.	NC A&T
Dept. of Industrial and Systems Engineering	Blacksburg, VA	Collaborative Research	Rafael Patrick, Ph.D.; Charlie Klauer, Ph.D.; Myounghoon Jeon, Ph.D.	Virginia Tech

Virginia Tech Transportation Institute	Blacksburg, VA	Collaborative Research	Jon Antin, Ph.D.; Andrew Alden, Ph.D.; Justin Owens; & Andrew Miller	Virginia Tech
Dept. of Graduate Studies, College of Aviation	Daytona Beach, FL	Collaborative Research	Dahai Liu, Ph.D.; Jennifer Thropp, Ph.D.; & Scott Winter, Ph.D.; Jing Yu Pan, Ph.D.	ERAU
Dept. of Electrical Engineering and Computer Science	Daytona Beach, FL	Collaborative Research	Houbing Song, Ph.D.	ERAU
Dept. of Civil Engineering	Daytona Beach, FL	Collaborative Research	Scott Parr, Ph.D.	ERAU
Aerospace Engineering	Daytona Beach, FL	Collaborative Research	Namilae Sirish, Ph.D.	ERAU
Computer Science	Pensacola, FL	In-Kind Support	Dr. Ashok Srinivasan	University of West Florida
National Surface Transportation Safety Center for Excellence	Blacksburg, VA	Financial Support	Dr. Jon Hankey	Virginia Tech
General Motors	Detroit, MI	In-Kind Support	Dan Glaser	

Other collaborators or contacts involved

Dr. Pandey has been collaborating with Dr. John Park at NC A&T and Dr. Md Sami Hasnine at Howard University in the areas of developing models for travel behavior in response to real-time information with an application in express lanes. A recent NSF grant was awarded based on this research collaboration. Dr. Pandey has also been collaborating with Dr. Tarun Rambha at Indian Institute of Science, Bangalore in the areas of developing optimization models for ridesharing systems. A paper on based on this work will be presented at the 2022 INFORMS Annual Meeting and the TRB Annual Meeting.

Stakeholders from the National Surface Transportation Safety Center for Excellence not only provided cost-share for the Detecting Dementia project, but they also provided invaluable advice and guidance for both that project and the ROADTRIP project. In order to develop and distribute a stakeholder-sensitive survey (i.e., the visually impaired), the CEV research team has been in contact with the Virginia Tech ADA compliance department. The purpose of the engagement is to ensure screen reader functionality.

Dr. McBride, Dr. Pandey, and Dr. Park at NC A&T have been working with Suitable to implement a new interface for getting students engaged in transportation activities. The interface is expected to increase student participation outside the classroom, track and assess experiential learning, and enable students to share their skills through popular professional networking and career development platforms.

Drs. Maranda McBride and Joseph Huscroft continued mentoring the 2021 NC A&T Dwight D. Eisenhower Transportation Fellows as they finalized their research papers.

3. OUTPUTS:

The subsections below outline some of the outputs that have resulted from the research projects listed in Table 2 as well as the education, workforce development, and technology transfer activities.

Publications, conference papers, and presentations

Journals

- Dam, A., Oberoi, P., Pierson, J., Jeon, M., & Patrick, R. Technological and social distractions at unsignalized campus crosswalks: A mult-stage naturalistic observation study, Transportation Research Part F: Traffic Psychology and Behaviour (in-Preparation). Acknowledgement of federal support: yes.
- Dekkata, S., Yi, S., Muktadir, M., Garfo, S., Li, X., & Tereda, A. Improved model predictive control system design and implementation for unmanned ground vehicles. Journal of Mechatronics and Robotics (submitted). Acknowledgement of federal support: yes.
- Meda, H., Vogiatzis, C., & Davis, L.B. A graph theoretical approach integrating geospatial information to analyze airport network. INFORMS Journal on Data Science (under revision). Acknowledgement of federal support: yes.
- Meda, H., Vogiatzis, C., & Davis, L.B.. Multimodal rescheduling of airline passengers, Transportation Science (under revision). Acknowledgement of federal support: yes.
- Yang, Y., Yu, J., Liu, D., Lee, S., Namilae, S., Islam, S., Gou, H., Park, H., & Song, H., (2022). Multi-agent collaboration for emergency evacuation using reinforcement learning for transportation systems. IEEE Journal on Miniaturization for Air and Space Systems (published) Acknowledgement of federal support: yes.
- Wu, Y., & Namilae, S. Parametric analysis of COVID-19 dose-response models in transportation scenarios, Journal of Transport and Health (submitted). Acknowledgement of federal support: yes.

Books and Non-Periodical, One-Time Publications

- None

Other Publications, Conferences, and Presentations

- Dam, A., Duff, C., Jeon, M., & Patrick, R. (2022). Effects of personal listening devices on pedestrians' acoustic situation awareness in a virtual reality environment. The 27th International Conference on Auditory Display (published). Acknowledgement of federal support: yes.
- Feng, K., Niu, S., Velasquez, A., Ren, Y., Liu, D., Song, H., (2023). Contrastive Learning with Spatial-Temporal Attention for Flight Delay Prediction, 2023 AIAA SciTech, pp. 1-8; status of publication (accepted, awaiting publication). Acknowledgement of federal support: yes.
- Grant, T., Namilae, S., Parr, S., & Liu, D. (2022). Modeling the effects of traffic reduction on the severity of the COVID-19 epidemic in the US. 63rd International Meeting of the Transportation Research Form, St Louis, MO. Acknowledgement of federal support: yes.
- Karnati, K., Wu, Y., Liu, D., & Namilae, S. (2022). Modeling the spread of COVID-19 in high pedestrian density crosswalks. 63rd International Meeting of the Transportation Research Form, St Louis, MO. Acknowledgement of federal support: yes.
- Keshinro, B., Seong,Y., & Yi, S. Deep learning-based human activity recognition using RGB images in human-robot collaboration. 2022 HFES Annual Meeting, Oct 2022, Atlanta, GA (in press). Acknowledgement of federal support: no.
- Pandey, V., & Khoury, H. (2022). Design of Equitable Discount for Express Lane Pricing. To be presented at the 2023 Annual Meeting of Transportation Research Board, Washington, DC. Acknowledgement of federal support: yes.

- Qu, X., Parvez, M., & Seong, Y. (2022). Simulation modeling of hurricane evacuations in eastern North Carolina, Proceedings of the 2022 IISE - Institute of Industrial and Systems Engineers Annual Research Conference, Seattle, WA. Acknowledgement of federal support: yes.
- Wu, Y., Namilae, S., Mubayi, A., Scotch. M., & Srinivasan, A. (2022). Incorporating pedestrian movement in computational models of COVID-19 spread during air-travel, 2022 IEEE Aerospace Conference (AERO) (published), pp. 1-8, doi: 10.1109/AERO53065.2022.9843497. Acknowledgement of federal support: yes.
- Zhou, Y., Liu, D., & Song, H. (2022). A survey of machine learning algorithms and techniques for air mobility under emergency situations. 2022 IEEE International Conferences on Internet of Things (iThings) and IEEE Green Computing & Communications (GreenCom) and IEEE Cyber, Physical & Social Computing (CPSCom) and IEEE Smart Data (SmartData) and IEEE Congress on Cybermatics (Cybermatics) (published), pp. 582-588. Acknowledgement of federal support: yes.

Websites or other internet material

- CATM Website: https://www.ncat.edu/cobe/transportation-institute/catm/index.php
- CATM Spring 2022 Newsletter: https://www.ncat.edu/cobe/transportation-institute/_files/pdfs/springnwsltr2022.pdf
- CATM Facebook Page: https://www.facebook.com/NCATCATM/
- ITS TV CATM Video: https://www.itsamericaevents.com/world-congress/en-us/press/its-tv.html, https://www.youtube.com/watch?v=h3LArk1rvCI
- STI Article: https://www.blackengineer.com/news/n-c-at-program-marks-30-years-of-inspiring-students-to-pursue-stem-transportation-careers/
- STI Facebook Page: https://www.facebook.com/groups/627756624232070
- STI Webpage: https://www.ncat.edu/cobe/transportation-institute/summer-high-school-transportation-institute.php

Technologies or techniques

- VRU-MAP project: Novel routing algorithms for pedestrians with disabilities has been developed. These algorithms will be shared following the project in accordance with UTC and VT data management policies.
- Situation Awareness project: A virtual crosswalk simulator was developed and is currently being used in an active CATM project.
- COVID AirTran project: New models for studying infection transmission in transportation settings have been developed.

Inventions, patent applications, and/or licenses

- Nothing to report

Other products

- Nothing to report

4. OUTCOMES:

The results of the activities that took place during this reporting period are increasing understanding and awareness of transportation issues in the following ways:

- VRU-MAP project: This project is focused on increasing the understanding of the various needs of and potential solutions for pedestrians with a range of perceptual, cognitive, and motor disabilities.
- Multi-agent project: This research will develop computational models of pedestrian evacuation at the airport through the integration of decision making models and simulated social force models.

- Situation Awareness project: The work associated with this project has increased the understanding and awareness of vital university culture-based pedestrian and driver non-verbal communication modes and self-imposed reductions in acoustic situation awareness due to the use of personal listening devices during street crossings through survey distributions, demos at on-campus student symposia, and oral presentations at an international conference.
- VRUTOP project: This research focuses on increasing understanding and improving transit service for vulnerable road users while addressing recent trends in Medicaid transformation, particularly service performance changes before and after the COVID-19 pandemic.
- COVID AirTran project: The models developed for this project help explain and increase understanding of recent infection spread events in transportation settings and can be used to model what-if scenarios.
- Machine Learning project: This project will result in the development of a prototype for dynamic airspace configuration (DAC) using machine learning (ML) techniques, to achieve optimized mobility in emergency situations. The anticipated outcomes of this project include a greater understanding of how ML can be used in dynamic airspace scenarios and a prototype that will demonstrate the ML-augmented capability supporting DAC.
- Mask Wearing project: Mask-wearing during COVID-19 has been a sensitive issue but its effect on slowing virus transmission has been increasingly recognized. The findings of this study identified key factors that influenced the intention to wear a mask when flying during the COVID-19 pandemic, thus increasing the understanding and awareness of mask use in the air transport context.
- COVID Outbreaks project: The results of this research helped support assertions that travel restrictions are correlated with decreases in COVID-19 cases.
- CEV project: This work has exposed undergraduate students to research and the role of Human Factors Engineering in Transportation. In addition to increasing their research knowledge, the work has increased awareness of pedestrian vulnerabilities.
- ROADTRIP project: This study has a personal impact on participants' awareness of transportation issues and how they can have safer, more effective mobility and interactions with others. In the long run, the research findings will be translated for global stakeholders who work on transportation, mobility, and access for today's and tomorrow's rural older adult population.
- Air Mobility project: The objective of this project is to develop a system for providing pre-alerts for passengers and airport staff when emergency events occur and adjusting the original schedule for the recovery of disrupted air mobility. To date the research activities have offered deep insights into the opportunities and challenges of applying machine learning to improve air mobility in emergency situations.
- High-speed Rail project: While achieving success in many countries in the world, HSR is still new in the US, but it is likely to experience fast development in the near future. The findings of this study will reveal American's acceptance of HSR as a viable option for domestic travel as well as their intention to use HSR. The understanding of HSR from the travelers' perspectives is important, especially for policy makers, to develop suitable strategies for HSR development in the US.

The activities that took place during the reporting period are expected to affect the passage of new policies, regulation, rulemaking, or legislation in the following ways:

- VRUTOP project: Compared to the existing fixed transit system, this project will provide guidelines for new scheduling and routing policies for paratransit service vehicles. It will take into consideration the Medicaid transformation toward private control.

The research activities during the reporting period have led (or will lead) to increases in the body of knowledge in the following ways:

- Dynamic Pricing project: This work has contributed optimization-based methods for addressing equity concerns associated with transportation toll projects. It has also contributed towards model development for the identification of equity issues and optimization of discounts for transportation system welfare.
- Acoustic Situation Awareness project: Symposium and conference presentations yielded discussions with scholars in other disciplines about how the project's findings and technology can be used as a bridge for future collaborations. For example, the team met with another research team from Tokyo, Japan to provide suggestions and insights on human factors in transportation. In addition, published and in-progress manuscripts have and will provide citations and repeatable methodologies for multi-staged naturalistic crosswalk observations and a 1:1 virtual crosswalk simulator used for evaluating acoustic situation awareness while using personal listening devices.
- VRUTOP project: Analyzing the impact of the Managed Care Organization model in a larger community that shows a trade-off between Medicaid recipients and non-recipients requires a significant data collection effort. With this limitation, existing transit service tools have had difficulties capturing essential parameters needed to adjust to new environments. To address this deficiency, this project includes data mining and data-driven optimization of paratransit services.
- COVID AirTran project: New models are being developed to explain recent infection spread events in transportation settings more accurately and predict similar situations.
- Mask-Wearing project: There is a gap in the research of mask use in aircraft cabins during global pandemics. The issue is worth investigating given that air transportation can be a likely vehicle for the spread of infectious disease. By identifying the key determinants of the intention to wear a mask during flight, this study contributes to the knowledge of mask use in global pandemics.
- COVID Outbreaks project: While it was suspected that COVID-19 cases would decrease after travel restrictions, this had not previously been demonstrated using observational data. This study has provided evidence supporting this assertion.
- Deep Reinforcement project: From the review of the literature, a deep understanding of the application of Reinforcement Learning (RL) has been developed, especially with the new Asynchronous Advantage Actor Critic (A3C)/RL integration with applications towards emergent situations.
- High-speed Rail project: HSR has been a research interest for many years, but the research has been mainly conducted in successful HSR countries, such as in Europe and Asia. There is a substantial gap in the research regarding HSR in the US. While some studies focused on challenges and opportunities in HSR development in the US, there has been very limited study examining HSR development from travelers' perspectives. The findings of this study can fill this important research gap.

The following projects are expected to result in improved processes, technologies, techniques, and skills in addressing transportation issues:

- RealTime2 project: The evacuation traffic simulation model for eastern NC can support government agencies' decision making related to traffic control during hurricane evacuation.
- VRUTOP project: Without knowing the effects the privatization of Medicaid will have on various transit use patterns, it is difficult to improve the efficiency of paratransit service. This project seeks to address this problem and improve the process of optimizing paratransit service operations.
- Machine Learning project: Dynamic Airspace Configuration (DAC) is an innovative operational paradigm that migrates from the current structured, static airspace to a dynamic airspace capable of adapting to user demand while simultaneously meeting changing constraints such as weather, traffic congestion, and complexity, as well as highly diverse aircraft fleets. In this study, a novel 3D DAC method is proposed that applies advanced ML techniques to help address these challenges. This method can dynamically adjust the airspace configuration based on the constantly changing demands and unexpected emergency situations resulting in optimized mobility.

- ROADTRIP project: This project has improved the ways in which a mobility plan can be tailored specifically for individual older adult's needs and environment.

The following activities are expected to result in the enlargement of the pool of trained transportation professionals:

- Research projects: Undergraduate and graduate students have been trained and mentored while working on CATM research projects. These students have obtained various skillsets needed to be successful as transportation professionals, including both technical skills and oral/written communication skills.
- STI program: The STI program is the primary recruitment program within CATM that targets high school students. It focuses on demonstrating how transportation professionals use science, technology, engineering, and math (STEM) skills, while concurrently familiarizing the students with the various modes of transportation – from air to highway and rail to water. During the 2022 four-week summer nonresidential program, students took part in classroom lectures as well as personal development workshops. They also saw transportation in action at the Port of Wilmington, Charlotte Motor Speedway, North Carolina Transportation Museum, the U.S. Department of Transportation's Turner-Fairbank Highway Research Center, and several locations in the District of Columbia. Students left the program with a greater understanding of and appreciation for the diverse nature of the transportation industry.
- ASETTS program: The ASETTS program provides opportunities for predominantly minority undergraduate students at NC A&T to learn more about the transportation field. Students in the program attended a regional UTC conference, competed in a regional Traffic Bowl competition, conducted transportation research, attended a TRB annual meeting, networked with transportation professionals, and learned about various transportation projects and activities through webinars. Overall, this program is providing students with experiences that enable them to better align their skills and and interests with transportation career opportunities.

The following research projects have led or will lead to the adoption of new technologies, techniques or practices:

- VRUTOP project: Compared to traditional deterministic paratransit service, the data-driven optimization technique developed for this project is able to address some of the uncertainty within transportation systems.
- Deep Reinforcement project: This project is expected to result in applications of Asynchronous Advantage Actor Critic (A3C) model integration with Reinforcement Learning (RL) under emergency situations.

Table 6 contains the center-specific performance measures for outcomes, the target per year, and the status of each goal.

Table 6: CATM Outcome Performance Measures

Outcome #	Goals	Research Performance Measures	Target per year	Current Status
Outcome #1 (technology focused)	Adoption of new technologies to help vulnerable road users identify suitable transportation services	Number of technology transfer activities that offer implementation or deployment guidance	2	0
Outcome #2 (technology focused)	Enhanced decision-making techniques that improve the efficiency and effectiveness of emergency evacuation processes	Number of decision-making technology training courses or webinars developed and delivered	2	4

Outcome #3	Automated vehicle design guidelines based on an increased understanding and awareness of human perceptions of and interactions with automated vehicles	Number of human factors guideline documents published	2	1
Outcome #4	Dissemination of research results through presentations, publications, conference papers, and technical reports	Number of presentations and workshops given	6	19
		Number of peer-reviewed journal papers published	2	2
		Number of newsletter articles, conference papers, and technical reports published	10	6

5. IMPACTS:

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

- Multi-agent project: This research develops an optimal navigation model based on the social-force model providing more navigation guidance for evacuation emergencies to minimize the total evacuation time while considering the influence of other passengers. The integration of the optimal navigation model was ultimately able to reduce the overall evacuation time of multiple scenarios presented with two different overall pedestrian totals. The overall maximum evacuation time savings presented was 10.6%. This research's optimally guided path planning model incorporates the social force model's density map and assigns highly congested areas to negative reward states. By integrating the two models, mobility in emergency evacuation situations can be further optimized.
- VRUTOP project: The VRUTOP project aims to improve access to health care in underserved areas using public transportation and Mobility as a Service (MaaS). It considers Medicaid shifts towards privatization and models the interactions between key contributing trip characteristics that influence time window uncertainty. Using these unique patterns, a new service tool for paratransit is provided. The temporal time uncertainty will be uniquely formulated by taking advantage of real-world data collected before and after the Medicaid transformation, which will make this research a pioneer in demand response transportation systems.
- ROADTRIP project: Early impacts of this project can be seen in the eagerness of rural older adults to participate in the ROADTRIP effort and their appreciation of its benefits.

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?

- VRU-MAP project: The research being developed is in the form of an app. The implementation of the app may lead to commercialization of this technology for individuals with disabilities.
- Multi-agent project: The team plans to apply this integrated modelling technique to simulated airport emergency evacuations for airport security manager training. With advancements in airport surveillance technology, the video data will confirm pedestrian traffic density in real-time and provide a new model to guide pedestrians to safety more quickly.
- RealTime2 project: The evacuation traffic simulation model for eastern North Carolina is able to support government agencies' traffic control decision-making processes during hurricane evacuation.
- Situation Awareness project: This project is likely to make an indirect impact on commercial technologies, such as virtual reality, in terms of providing additional examples of how the

technology can be used for scientific research, especially when investigating potentially harmful human behaviors.

- VRUTOP project: This project is developing models that adapt to possible changes in paratransit system delay associated with wait or load times of previous pickups. These models can be used to help train transportation service operators.
- Mask-Wearing project: The findings of the study will enhance the understanding of mask-wear intentions and behaviors of passengers flying during COVID-19. This will provide policy makers and airlines information to formulate public health strategies to ensure inflight safety, hence helping the airline industry recover more quickly from a pandemic.
- CEV Vision project: Since this work plans to utilize commercially available technology, outcomes are likely to impact the development of such technologies/devices in terms of capabilities and limitations of usage for visually-impaired communication during pedestrian activities.
- High-speed Rail project: This project will enhance the understanding of passengers' acceptance of HSR, which is still new in the US, and their intention to use HSR once it becomes a viable option for domestic travel. The findings can inform both the industry and government during the creation of guidelines and strategies to prepare for the development of HSR in the US.

What is the impact on the body of scientific knowledge?

- VRU-MAP project: Though literature exists on improving mobility of pedestrians, cyclists, and those utilizing similar modes of travel, the body of knowledge surrounding the mobility of individuals with explicit accessibility needs has, in large part, been limited to research conducted by special interest groups or organizations. The work from this project is expected to extend this body of knowledge to incorporate critical components for the mobility of underrepresented populations that may yet have been identified and addressed on a grander scale. For example, it is relatively unknown what difficulties exist for individuals with certain mental or learning disabilities when traversing the built environment. Some individuals with these disabilities avoid busy roads, loud environments, or crowded sidewalks. Others may need explicit guidelines or overlays while following directions or may need extra assistance when navigating via other modes of transportation. Despite the variability of people's needs, the prototype app seeks to address individualized concerns through its flexible and personalized nature.
- Multi-agent project: The integration of the deep reinforcement model and social force model in transportation system pedestrian evacuation has not been done before and this project will open up a new research path in this domain.
- RealTime2 project: The models developed in the project will support the government's efforts to implement more effective emergency evacuation strategies.
- Situation Awareness project: The project is likely to make an impact because it utilizes a novel multi-stage (e.g., observation, survey, focus group) research methodology to investigate pedestrian, more specifically crosswalk, behavior in a naturalistic and informative manner.
- VRUTOP project: The integration of the data mining model and optimal pick-up and drop off model can handle unexpected paratransit system delays and reduce operating costs.
- COVID AirTran project: A novel infection risk model combining social-force-based pedestrian dynamics is formulated. The model is used to study the COVID-19 spread pattern in superspreading events by incorporating pedestrian movement. The impact of masking is studied by varying the mask filtration efficiency and infection threshold distance. Results suggest that use of high efficiency N95 or equivalent masks can significantly reduce the risk of secondary infections during a potential superspreading event. Lower efficiency masks also reduce infections but not to the same extent. Social distance policies like keeping middle seat vacant are not only effective in themselves, the independent masking and social distancing strategies can combine and compound the efficiency of mitigation. The transmission events examined in this study provide a basis for generating high-, intermediate-, and low-dose model parameterizations. When these models were used to analyze generic transportation systems, the dose level was found to have a significant impact on the number of secondary infections. In general, mask usage reduced

infections at all dose levels. High-quality N-95 masks are effective for all dose levels, while lower-quality masks exhibit a limited mitigation efficiency, especially for high-dose conditions. Dose-response models parameterized for transmission events can be effectively used to analyze the spread of infection at different dose levels in transportation systems. Facial coverings, particularly high-quality N-95 masks, are effective in reducing SARS-COV-2 transmission in transportation settings.

- Mask-Wearing project: There is a research gap in the literature of the intention to wear a mask and actual make wearing during air travel, especially onboard airplanes during pandemics. The findings of this study can expand the knowledge base of behavioral intention of air travelers, especially when it is related to public safety during a pandemic.
- High-speed Rail project: There is little literature of the intention to use HSR in the US. This study aims to fill this important gap by investigating (1) passengers' choice among car, air, and HSR for domestic travel in the US and (2) key determinants of American passengers' intention to use HSR. A new theoretical framework will be proposed based on the theory of planned behavior. By providing empirical evidence from the lens of passenger intention and behavior, this study can expand the knowledge base of mode use intention of American travelers especially following the pandemic.

What is the impact on transportation workforce development?

- VRU-MAP projects: The team has worked with a number of students at the undergraduate and graduate level to develop and implement the concepts in this project, providing them opportunities to learn more both about transportation research and the needs of pedestrians with disabilities.
- Multi-agent project: This multidisciplinary work is training members of the transportation workforce how to use machine learning and artificial intelligence instead of traditional human-only based decision making systems.
- Dynamic Pricing project: Undergraduate and graduate research assistants involved with this project, all from underrepresented backgrounds, have been trained to use relevant software and programming tools. These include Python programming, bash scripting, Github source code management, and working with Linux operating systems. The students have shown consistent improvement over the reporting period and are becoming adept at understanding research problems, asking the right questions, and using tools to solve the research problems. Students have also attended conferences and have learned ways to interact with other professionals and present their research. Furthermore, two students have already obtained jobs in the transportation sector upon their graduation.
- VRUTOP project: This work will teach transportation workers in health care provider and service industries how to identify the most appropriate service deliveries using proposed machine learning and artificial intelligence methods.
- CEV Vision project: The work is likely to develop training systems/processes for visually-impaired pedestrians using vehicle-to-person communication systems.
- Education and Workforce Development activities: The activities that took place at NC A&T during the reporting period are geared primarily towards exposing minority students to transportation career opportunities. In this way, we assist in the diversification of the transportation workforce.

Table 7 contains the center-specific performance measures for impacts, the target per year, and the status of each goal.

Table 7: CATM Impact Performance Measures

Impact #	Goals	Research Performance Measures	Target per year	Current Status
Impact #1 (technology focused)	Increase in the number of vulnerable road users able to acquire transportation services that fit their special needs	Number of instances of vulnerable road user technology adoption or commercialization	2	0 created/ 0 adopted
Impact #2 (technology focused)	More effective and efficient emergency transportation management processes	Number of instances optimization models or technologies are utilized or commercialized	3	4 created/ 0 adopted
Impact #3	Increase the body of knowledge for human factors in automated vehicles	Number of instances of research changing behavior, practices, decision making, policies (including regulatory policies), or social actions	2	2

6. CHANGES/PROBLEMS:
   - Dynamic Pricing project: The final report for this project was delayed for the following reasons: 1) The students working on the project graduated in early December 2021; thus, due to communication challenges, it took more time than expected to synthesize all the findings in the form of a final project report. 2) Another student who was assigned to synthesize and complete the work switched his position to another permanent position outside of NC A&T. 3) The remote-desktop connection with the University's computers was impacted due to a cybersecurity incident near end of March until April 2022. This impacted seamless access to the project data and required additional efforts (such as being physically present on campus for extended periods of time) to ensure the data for the project report was available. The research team prepared ways to back up the data on OneDrive cloud platform to prevent this from happening in the future.
   - Driving Feedback project: There have been issues with obtaining the necessary variables to begin data collection and changes have been made to the recruitment process in order to meet IRB requirements. These changes have been implemented and the IRB application is expected to be submitted early in the next reporting period. Participant recruitment will begin soon after IRB approval is obtained. The team is also continuing weekly meetings with General Motors to ensure that everything is on track to receive the expected variables.
   - COVID Outbreaks project: The project is delayed because the graduate student leading the project has left. The PI is working to transition the project and complete the report.
   - CEV project: Anticipated problems are associated with the following activities: (1) data collection and processing using BioPac software and (2) technical modifications to the virtual crosswalk testbed. The plan for resolving the aforementioned anticipated problems is as follows: (1) the team has been attending BioPac webinars and has scheduled sessions with the technician -- additional software for automated data collection has been developed and will be acquired to expedite the process; and (2) discussions are in process with the developer (recent grad) to apply the necessary technical updates. Once approved, a contract will be developed and executed.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report for this period.