Mobility21

A USDOT NATIONAL UNIVERSITY TRANSPORTATION CENTER

Carnegie Mellon University

Penn — UNIVERSITY of PENNSYLVANIA

THE OHIO STATE UNIVERSITY   CCAC

Semi-Annual Progress Performance Report for University Transportation Centers

Agency:	US Department of Transportation Office of the Assistant Secretary for Research and Technology University Transportation Center Program
Federal Grant Number:	69A3551747111
Project Title:	Mobility21, A National University Transportation Center for Improving Mobility of People and Goods
Program Director:	Professor Raj Rajkumar, Director, Mobility21 National UTC rajkumar@cmu.edu, 412-268-8707
Submitting Official:	Stan Caldwell, Executive Director, Mobility21 National UTC stancaldwell@cmu.edu 412-268-9505
Submission Date:	October 26, 2021
DUNS Number:	05-218-4116
EIN Number:	25-0969449
Recipient Organization:	Carnegie Mellon University 5000 Forbes Avenue Pittsburgh, PA 15213
Recipient ID Number:	40459.x.1080266
Project Grant Period:	11/30/2016 – 9/30/2022
Reporting Period End Date:	September 30, 2021
Report Term or Frequency:	Semi-Annual

Signature:

1. ACCOMPLISHMENTS: What was done? What was learned?

What are the major goals of the program?
The primary goal of Mobility21, a National University Transportation Center for Improving Mobility is to develop and deploy technologies, policies, incentives and training programs for improving the mobility of people and goods in the 21st century efficiently and safely. We will accomplish this through a comprehensive program of interdisciplinary research; education and workforce development with a focus on diversity; collaboration with university, deployment, and government partners; and technology transfer and leadership efforts.

Research Metrics
- Faculty scientific leadership as reflected by the number of publications and citations of faculty work in transportation-related areas
- The number of staff, faculty and students involved in leadership positions in academic, industry and government transportation organizations
- New research collaborations in fields related to this work
- Successful technology deployments and their impact
- Patents and start-ups

Education and Workforce Development Metrics
- Number of transportation-related courses
- Students participating in transportation research projects
- Advanced degree programs funding Mobility21 UTC students
- Mobility21 UTC-funded graduate students
- Mobility21 UTC-funded students who receive degrees
- Institutional educational partnerships
- Participants in workforce and educational programs

Technology Transfer Metrics
- Simple adoption of the innovation by a transportation operator, company or public, to more formalized outcomes such as licensing, patents, commercialization, and spin-off companies
- Quantify numbers of meetings, attendance, publications, and social media and website activity

Collaboration Metrics
- Number and diversity of members of both the Mobility21 Consortium and Advisory Council
- Number and impact of deployments achieved through collaboration

In addition, as part of our Technology Transfer Plan (dated July 31, 2018) the following Research Performance Measures were established:

	Research Performance Measure	Annual Target
Output #1	Annual Number of Journal Publications	35
Output #2	Annual Number of Research Pilot Deployments	10
Outcome #1	Annual Number of Media Stories Referencing UTC Research, Faculty, or Spinoff	80
Outcome #2	Annual Number of Instances Providing Exposure to Transportation, Science and Technology for Practitioners, Teachers, Young people, or Other Members of the Public	50
Impact #1	Annual Number of Instances of Technology Adoption or Commercialization	3
Impact #2	Annual Number of Instances of Research Changing Behavior, Practices, Decision Making, Policies (Including Regulatory Policies), or Social Actions	3

What was accomplished under these goals?

Research
Forty-six research projects were active during this report period.

On October 5, 2020, the annual call for proposals was released for CMU researchers to propose projects for the July 1, 2021 – June 30, 2022 period. Twenty-four proposals were received, totaling more than $2 million in requests. Representatives from our

Advisory Council and the UTC management team participated in the review of the proposals. Fourteen of the projects were selected based on the available funding. Mobility21 UTC management personnel worked with the PIs to ensure all US DOT & project requirements were met so the projects could start on July 1, 2021.

During this reporting period, three UTC faculty meetings were held (scheduled twice during each of the spring and fall semesters). The meetings are held to provide the faculty updates on the Mobility21 UTC, share information among the four UTC academic consortium partners, present research being conducted and discuss opportunities for collaboration.

In August 2021, an updated Data Management Plan for Mobility21 was approved by the US DOT. Mobility21 the effort to have CMU's KiltHub, a platform provided by the University Libraries that collects, preserves and provides global access to CMU's research, approved as one of only four United States Department of Transportation Conformant Repositories. Read more here.

Additional accomplishments related to research activity:
- *July 21, 2021* - Mobility21 UTC researcher Fei Fang was recognized by the International Joint Conferences on Artificial Intelligence for significant research in AI. Read more here.
- *July 30, 2021* - Mobility21 UTC researcher Yang Cai and his group have developed a data visualization tool to allow them to see network traffic patterns, as well as a way to hear them. Learn more here.
- *May 27, 2021* – Mobility21 UTC researcher Fei Fang of the CMU School of Computer Science was recently awarded the NSF CAREER award. Fang will use her award to build on research that integrates game theory with machine learning to optimize communication and coordination to tackle real-world problems. Learn more about Fang's research here.
- *May 24, 2021* - Mobility21 UTC researcher Burcu Akinci has been selected to become a member of the National Academy of Construction for her significant contributions to the effectiveness of the engineering and construction industry.
- *May 12, 2021* – Mobility21 researcher, Keith Redmill at The Ohio State University's Department of Electrical and Computer Engineering (ECE) was recently awarded the College of Engineering's Lumley Research Award. Read the full article here.
- *May 11, 2021* - Mobility21 UTC researcher Ding Zhao, an assistant professor of mechanical engineering at Carnegie Mellon University, was awarded a CAREER grant by the National Science Foundation for his work on safety-critical applications of AI, which includes autonomous vehicles and healthcare.
- *April 27, 2021* - Mobility21 UTC researcher Destenie Nock has been awarded the 2021-22 Wimmer Faculty Fellow Award to evaluate how social justice based active learning activities can impact student learning.
- *April 22, 2021* - Mobility21 UTC researcher Maxine Eskenazi, a principal systems scientist in the Language Technologies Institute, has been selected as a fellow of the International Speech Communication Association. Read the full story here.
- *April 22, 2021* - Working with Ph.D. student Weiran Yao, Mobility21 UTC research Sean Qian has extracted information from tweets to provide accuracy in predicting morning traffic patterns. Read the full story here.
- *April 1, 2021* - Mobility21 UTC researchers Burcu Akinci and Pingbo Tang of the CMU College of Engineering are part of a team that is working to design the future *National Institute for Artificial Intelligence (AI) in Construction*. Read story here.

Education and Workforce Development
We view research and education as two sides of the same coin. We cannot educate for future generations without exposing them to research, development and deployment. On the other hand, we cannot do successful research, development and deployment without the input of future generations. Since Traffic21 and the UTC have emerged on CMU's campus they have generated interest among faculty and students, bringing exposure to real-world problems, and engaging faculty and students with **181** deployment partners.

At Carnegie Mellon University, a student transportation club also convenes throughout the fall and spring semesters, of which the Mobility21 Women in Transportation Fellows help lead, and the UTC supports. The UTC also actively engages student groups at its partner universities and colleges.

Highlighted Education Initiatives:
- *September 4, 2021* - Mobility21's RISS Rayna Hata has completed her project centered around the localization of vision or mobility impaired pedestrians as they cross urban intersections using the PedPal app and has this to say about her experience: *"This summer, I had the pleasure of working in the Intelligent Coordination and Logistics Lab under the mentorship of Dr. Stephen Smith and Dr. Isaac Isukapati ..... This research experience was my formal introduction to the field of robotics research. This experience solidified my interest in pursuing a graduate degree and a career in Robotics upon graduation. I cannot thank Mobility21 enough for this sponsorship and support...***"**
- *September 2, 2021* - During summer 2021, Carnegie Mellon University student and Traffic21 Women in Transportation Fellow Hajra Shahab worked with the Government Relations team at Aurora. Hajra details her experience by saying, "*It was an exhilarating experience as I got to work very closely with engineering, safety, and product teams. I was able to deep dive into the understanding of how autonomous vehicles can be made more accessible for people with disabilities. My internship spanned over 12 weeks and I got a chance to learn about different functions of Government Relations…Working at a company that is redefining the future of transportation made each day challenging yet exciting.*"
- *August 27, 2021* - Traffic21 Executive Director Stan Caldwell and Mobility21 Program Manager Lisa Kay Schweyer will serve as advisors for Heinz College student capstone projects throughout the fall 2021 semester. The students engage in semester

long capstone projects to apply coursework to real world scenarios. Stan will work with students engaged with Daimler Trucks North America on the Departure of the Autonomous Truck and Lisa Kay will work with students engaged with Smart Cities, US Ignite, Fort Carson and the City of Colorado Springs.

- *August 12, 2021* - Mobility21 provides a comprehensive list of transportation-related courses offered by Carnegie Mellon University. Check out the updated listing for the fall 2021 semester, here.
- *July 30, 2021* - Mobility21 UTC welcomes Traffic21 Women in Transportation Fellow for 2021-2023, Maggie Harger… Maggie is pursuing her Master of Science in Public Policy and Management with an interest in transportation policy. Prior to her time at Carnegie Mellon, she completed her undergraduate degree in Environmental Studies from Gonzaga University in Spokane, WA, and worked as a mobility coordinator for the North King County region near Seattle. This role involved working with city planners, local human service providers, elected officials, and regional transit agencies to identify transportation challenges for populations with unique mobility needs, including older adults, people with disabilities, and low-income individuals. Learn more about the Mobility21 student leaders here.
- *July 30, 2021* - Mobility21 UTC researchers Pingbo Tang and Rick Grahn, along with other faculty, presented virtually at the 2021 Summer Engineering Experience at CMU. The camp offered two sessions (July 19-23 and July 26-30) and provided students ages 13-16 with a chance explore engineering & transportation in a variety of disciplines, in addition to creating and showcasing their own projects in a presentation at the end of the week.
- *July 21, 2021* – CMU Ph.D. students N Dinesh Reddy and Gengshan Yang have been selected into Qualcomm's class of Innovation Fellows. Mobility21 UTC researcher Srinivas Narasimhan is N Dinesh Reddy's advisor. Read more here.
- *July 16, 2021* - Mobility21 UTC researcher Bob Iannucci worked with students as faculty advisor for the 2021 CPS-IoT Week virtual conference. The student team won second place at the competition with their presentation "One Program to Rule the Intersection." Learn more here.
- *June 22, 2021* - The Robotics Institute Summer Scholars program of Carnegie Mellon University hosted "*Materials & Career Paths in Robotics & Tech*" in conjunction with the Technology & Engineering Education Association to prepare students for 21st century careers in technology.
- *June 5, 2021* - Mobility21 academic partners at the University of Pennsylvania's F1Tenth Team organized a Virtual Autonomous Racing Competition at Trinity College, Dublin. This was a student run event where participants submitted their racecar software agents to race against autonomous driving algorithms developed by others.
- *June 1, 2021* - Members of The University of Pennsylvania's F1Tenth autonomous racing team have teamed up with Riders.AI to conduct a series of virtual autonomous racing events. Riders.AI has developed a professional virtual racing cloud-based platform to organize international competitions.
- *June 1, 2021* - The Ohio State University, is forming their inaugural team to compete in the SAE AutoDrive Challenge II this fall, joining nine other universities who are taking on the challenge to develop and demonstrate an autonomous vehicle that can navigate urban driving courses. Click here to learn more about the competition.
- *May 12, 2021* - Abhinav Jauhri, CMU ECE Ph.D. Candidate presented his thesis defense on *Real-World Data Driven Characterization of Urban Human Mobility Patterns.* Mobility21 Program Manager Lisa Kay Schweyer attended his defense. Abhinav's work was conducted as part of the Mobility21 UTC project, "Real Time Traffic Congestion Prediction and Mitigation at the City Scale." UTC Researcher John Paul Shen, was Abhinav's advisor and his committee included Anupam Datta, Jason Hong, and another UTC researcher Sean Qian.
- *May 6, 2021* - Students of the CMU Heinz College engage in semester long *"Capstone Projects"* to apply coursework to real-world scenarios. Today, students shared the results of their semester long research projects during a poster fair. The projects featured today included the following transportation related projects: Team US Ignite/Colorado Springs: *Reducing Traffic Congestion at Fort Carson Army Base,* Team Port Authority of Allegheny County: *Parking Management Scenario Planning for the Port Authority of Allegheny County (PAAC),* Department of Labor & Industry: *Online Platforms in the PA Trucking and Construction Sectors: Measurement Challenges and Policy Implications,* Beneficial State Foundation: *Projecting the Future Growth of the Used Clean Vehicle Market in California,* Allies for Children: *School Bus Optimization for Meal Delivery in the Age of COVID-19.*
- *May 5, 2021* – Heinz College MPPM students Aly Caito, Ali Iftikhar, Erika Montana, Sanjay Renduchintala, and Shirish Verma, presented their Systems Synthesis class project "*Parking Management Scenario Planning for the Port Authority of Allegheny Count*y." The course was advised by Professor Stan Caldwell and the client was Amy Silbermann, Director of Planning and Service Development at the Port Authority of Allegheny County.
- *April 30, 2021* - The CMU Student Transportation Club hosted their annual career panel to provide students with real-world insight from individuals who work in the transportation field. Panelists were volunteers from the Pittsburgh Chapter of WTS.
- *April 26, 2021* - Professor Jeremy Michalek, a Mobility21 UTC researcher, hosted a student debate on electric vehicle policy for his course "*Electric Vehicles: Technology, Economics, Environment and Policy"* which also featured an expert panel.

Technology Transfer

As the nature of transportation continues to evolve, Carnegie Mellon University has students and faculty conducting transportation related research in data analytics, robotics, public policy, engineering, architecture and design, and more. Since not all of these efforts are co-located in the same building, or even the same department or college, there was a need to help building a "community space" to bring together people interested in transportation on CMU's campus. This was the impetus for Mobility21's launching of the Smart Mobility Connections (SMC) seminar series. One of the UTC faculty is featured at each hour-long session; half of the

time is reserved for questions and answers as well as networking. All Mobility21 SMC seminars are advertised on the DOT webinar website, UTC website and publicized through faculty, student and government and industry partner distribution lists. Recordings of each session are saved to our YouTube channel and links posted to the Mobility21 UTC website's *What's Happening* section. The information and links are also sent to our US DOT Grants Manager for posting on the US DOT website. Below are the SMCs held during this reporting period.

Date	Speaker(s)	University	Title	Video Recording Link
9/24/2021	Erick Guerra	UPENN	What the Heck is a Choice Rider? A Theoretical Framework and Empirical Model	youtu.be/O3NxyVUbOmA
9/10/2021	Allanté Whitmore	CMU	Opportunities for Shared Autonomous Mobility Technology in Public Transit Systems To Improve Equitable Transit Coverage	youtu.be/PviI-UcIU0w
4/23/2021	Umit Ozguner	OSU	Research on pedestrian vehicle interaction	youtu.be/ZXgBIt70aXk
4/9/2021	Justin Starr	CCAC	Using a Virtual Racing League to Learn Artificial Intelligence Autonomy as a Skilled Trade	youtu.be/4WYX0LBCybQ

As both a workforce development and technology transfer initiative, the **UTC launched a new Managing Artificial Intelligence in Transportation executive education Certificate Program** in collaboration with CMU's Heinz College. The week of May 3, 2021, the first cohort of students attended the executive education program focusing on the role of artificial intelligence in the transportation industry. The inaugural cohort included representatives of government, non-profit, industry and association leaders. Participants explored the impact of disruptive technology on transportation; AI in traffic control devices; AI in connected and autonomous vehicles; the role of AI in predictive analytics; AI in transportation asset management; the equitable application of AI for safe and efficient transportation; and how to develop and implement an enterprise AI strategy. One participant reflected, *"As a company, we're always looking for ways to use new technologies to make our business better. Better understanding what AI can and can't do, what it needs to succeed, and ways of thinking about problems using an AI "lens" will all be long term beneficial."* Plans are already underway for the 2022 session, which will be held May 2 – 6, 2022.

Additional technology transfer activities:

- *September 23, 2021* – Mobility2121 Executive Director Stan Caldwell was featured on the recent SAE International podcast with host Grayson Brulte, to discuss how Traffic21 and its UTCs have helped place Pittsburgh at the forefront of the intelligent transportation field, improving the economy and attracting new businesses along the way. Listen to the full podcast here.
- *September 22, 2021* - Metro21 Executive Director Karen Lightman moderated the first of three Justice & Technology Seminars which featured Lilian Coral of Knight Foundation, Kim Davis of City of Pittsburgh DOMI, Rayid Ghani of Carnegie Mellon University, and Marimba Milliones of Hill District CDC. This seminar series provides an opportunity for researchers and community stakeholders to openly discuss issues with technology and justice and find opportunities to collaborate on advancing justice. The series is sponsored by the Metro21 in cooperation with Traffic21 Institute. Watch the inaugural seminar.
- *September 9, 2021* - Mobility21 Executive Director Stan Caldwell and Program Manager, Lisa Kay Schweyer, presented an overview of the executive education session "*Managing Artificial Intelligence in Transportation"* at the Southwestern Pennsylvania Commission's Transportation Safety & Operations Committee.
- *September 1, 2021* - Mobility21 deployment partner RobotWits LLC will be brought on board by Waymo as they open their engineering office in Pittsburgh. In addition to its work on self-driving vehicles, RobotWits teamed with the Pennsylvania Rural Robotics Initiative and WQED/PBS with support from Mobility21 in 2020 to create "The Robot Doctor," an eight-episode regional Emmy-nominated TV series aimed at increasing interest in STEM careers among high-school students. Read the full article here.
- *June 25, 2021* - As Stage 1 winners of the National Science Foundation's Civic Innovation Challenge, two Mobility21 UTC researchers were featured in the closing event film festival: Megan Ryerson of the University of Pennsylvania's "*Data-Driven and Community Engaged Planning Tools for Addressing Spatial Mismatch*" and Lee Branstetter of CMU's "*City of Bridges: Using New Transportation Options to Drive Low-Income Mothers to Greater Success in Pittsburgh."*
- *June 16, 2021* - Mobility21 UTC researcher Dr. Destenie Nock was recently featured on *The Energy Gang* podcast to discuss her research on the equity outcome of decarbonization and the models she is creating for energy-systems planning that factor in positive social objectives. Listen to the full podcast here.
- *May 19, 2021* - Mobility21 UTC researcher Christoph Mertz was recently invited to discuss how university research is advancing transportation technology. Mertz explained his work using a smartphone app to provide the data about potholes and cracks in the road to local governments so they can make data driven decisions about their infrastructure on the recent Roadsigns podcast. Listen to the full podcast here.
- *April 25, 2021* - Carnegie Mellon spin-off company Roadbotics, Inc. president was featured in the latest Pittsburgh Business Times "*Personalities of Pittsburgh*." The article highlights Roadbotics, Inc. President Ben Schmidt and his interests and thoughts for the future. Read the full article here.

Collaboration
At the core of our efforts, is collaboration. During this reporting period Stan Caldwell and Lisa Kay Schweyer had several meetings with each of the Mobility21 leads at the University of Pennsylvania, the Ohio State University and Community College of Allegheny County, to ensure continued collaboration among UTC academic partners.

Additional Collaboration Activity during the report period:

- *September 25, 2021* - Mobility21 UTC researcher & Director of the Remaking Cities Institute, Ray Gastil participated in the 2021 Shaler Area Homecoming Festivities, which brought together the community for a parade, picnic, and football game and turned Mount Royal Boulevard into a vibrant, walkable main street. Ray is working with Walk Bike Shaler, in partnership with the Township of Shaler, to inform and contribute to his research project, *Better Boulevard Analytics.*

- *September 23, 2021* - Stan Caldwell participated in the quarterly meeting of the Smart Belt Coalition, which included academic and state transportation agencies from Ohio, Michigan and Pennsylvania. The group discussed efforts on vehicle electrification and associated infrastructure, as well as strategic planning.

- *September 1, 2021* - Mobility21 Executive Director Stan Caldwell participated in the Intelligent Transportation Society of PA's 2021 Annual Meeting which included session on connected, automated & electric vehicles and incident management.

- *August 11, 2021* - Pop-Up Metro, a battery-powered, modular train that can be inserted onto existing infrastructure is a rail-based mass transit system in the United States was developed by Henry Posner III, adjunct professor at Carnegie Mellon University (he is also the chairman of Railroad Development Corporation, a Mobility21 deployment partner). Read the full article here.

- *August 1, 2021* - The TRB TDM Committee held its mid-year meeting today. The group reviewed the committee's mission and its draft strategic plan. Lisa Kay Schweyer, Mobility21 Program Manager, was added to the committee membership earlier this year and this was her first meeting as a member.

- *July 29, 2021* – A two-day Federal Highway Administration workshop on *Planning for Multimodal Networks for a Connected and Automated Future* was held with a diverse group of stakeholders to help FHWA define and refine the critical questions around planning for active transportation and CAV. As an expert panel member for this study, Stan Caldwell participated and applied his UTC research in disruptive transportation technology policy.

- *July 26, 2021* - Stan Caldwell joined the Intelligent Transportation Society of America's inaugural meeting of the AV Safety Task Force consisting of representatives from the public, private and academic sectors to discuss the public perception of automated vehicle safety.

- *July 20, 2021* - Chris Hendrickson, Director of the Traffic21 Institute and a Mobility21 researcher, attended the TRB Technical Activities Group meeting on July 16 and the TRB Executive Committee meeting on July 19-20.

- *July 21, 2021* - Mobility21 Executive Director Stan Caldwell participated in the quarterly meeting of the PennDOT/ FHWA State Transportation Innovation Council where PennDOT's efforts on Unmanned Arial Systems were highlighted.

- *July 20, 2021* - Stan Caldwell participated in the final meeting of the NEXTransit Stakeholder Advisory Meeting where the Port Authority of Allegheny County presented long-range plan and discussed implementation and public outreach efforts.

- *July 9, 2021* - The Pittsburgh Mobility Collective, unveiled MovePGH, an initiative combining multiple mobility options for easy and equitable travel. The Pittsburgh Mobility Collective is a new initiative of the City of Pittsburgh that has been supported by multiple UTC researchers. Read more here.

- *July 8, 2021* - Chris Hendrickson, Director of the Traffic21 Institute and Mobility21 researcher, attended the TRB Diversity, Equity and Inclusion Committee meeting July 8. The committee is helping to implement TRB's strategic goal of increasing the diversity, equity and inclusiveness of TRB participants.

- *June 21, 2021* - The Unmanned Aerial Systems (UAS) Task Force was organized by the Pennsylvania Department of Transportation at the direction of the Governor's office with the with the vision of "*The Safe and Strategic Integration of UAS Technologies Into Pennsylvania's Transportation System.*" PennDOT Secretary Yassmin Gramian kicked off the inaugural meeting and Mobility21 Executive Director Stan Caldwell was appointed to the task force as a founding member and subcommittee chair.

- *June 17, 2021* - Metro21 Executive Director Karen Lightman represented President Jahanian on behalf of Carnegie Mellon University as a member of the World Economic Forum's Council on the Connected World's inaugural convening for 2021.

- *June 15-16, 2021* - The Annual Council of University Transportation Center's summer meeting brings together the nation's leading transportation professionals from academia and industry, along with U.S. DOT and other transportation agency officials. Raj Rajkumar, Director, Stan Caldwell, Executive Director and Lisa Kay Schweyer, Program Manager of Mobility21 participated in the meeting.

- *June 9, 2021* - As chair of the Intelligent Transportation Society of America Standing Committee on Emerging Technologies, Stan Caldwell presented updates at the ITSA Board of Directors Meeting on activities of three working groups for: Personal Delivery Devices, Urban Air Mobility and Digital Twinning. Stan's current University Transportation Center research on disruptive transportation technology supports the efforts of this committee.

- *May 20, 2021* - Because of Mobility21 Director Stan Caldwell's research on transportation technology and policy, he was appointed to the Greater Pittsburgh Chamber of Commerce Smart Transportation Working Group to study regional transportation technology needs. Caldwell, along with other members of the working group, presented findings and policy recommendations today at the Chamber Board of Director's meeting.

- *May 10, 2021* - Working through the Metro21: Smart Cities Institute at CMU, Mobility21 UTC faculty are meeting with the US Postal Service Office of Inspector General to discuss potential research on analysis of and current state of electric vehicles, and USPS challenges as they transition to electric vehicle use.

- *April 27, 2021* - The Association for Commuter Transportation held the *2021 Future of Commuting Summit*. The event brought together 350+ employers, thought leaders, government agencies, and private sector leaders. Mobility21 Program Manager & ACT Board Member, Lisa Kay Schweyer led 2 small group discussion breakout sessions during the event.

- *April 22, 2021* - Stan Caldwell participated in the quarterly meeting of the CAT Coalition Strategic Working Group where initiatives such as the Virginia C-V2X Deployment for Work Zone Safety were discussed. CAT serves as a collaborative focal point for federal, state and local government officials, academia, industry and their related associations to address critical program and technical issues associated with the nationwide deployment of connected and automated vehicles on streets and highways. CAT is supported by AASHTO, ITSA, ITE and US DOT.
- *April 20, 2021* - Stan Caldwell participated in the inaugural meeting of the Urban Air Mobility Task Force which is exploring education and policy initiatives around the electric vertical take-off and landing systems (eVTOLs). The task force is supported by the Intelligent Transportation Society of America Standing Committee on Emerging Technologies, chaired by Stan Caldwell along with Andrew Liu from AECOM.
- *April 14, 2021* - Lisa Kay Schweyer of Mobility21 participated in the 2021 Annual Transportation Forum, hosted by the University of Pittsburgh Center for Sustainable Transportation Infrastructure. The Transportation Forum is open to students, consultants, government agencies and other professionals that are involved in the planning, design, research, construction and operation of transportation systems.
- *April 7, 2021* - Stan Caldwell participated in the quarterly meeting of the Pennsylvania Department of Transportation and the Pennsylvania Division of the Federal Highway Administration State Transportation Innovation Council where he was re-appointed to the board for another two-year term.
- *April 5, 2021* - Stan Caldwell participated in a meeting with southwestern Pennsylvania leaders and hosted by the Hillman Foundation on strategies for expanding broadband access. There was a presentation by Kathryn de Wit, Manager of the Broadband Research Initiative at The Pew Charitable Trusts and an update from the Southwestern Pennsylvania Commission on their broadband plan.

How have the results been disseminated?

A blog and weekly e-newsletter that highlights UTC research and efforts in the news as well as smart transportation industry news, *The Smart Transportation Dispatch*, is **distributed to 4,466 subscribers**. The readership represents individuals in industry, government, academia and community organizations **from 17 countries**.

A monthly e-publication is also distributed, called *What's Happened at Traffic21?* This e-publication, sent to the same distribution list as *The Smart Transportation Dispatch*, as well as the Council for University Transportation Centers' list-serve, specifically highlights the UTC impacts, accomplishments, student work, involvement in conferences, and other news.

Before updates are sent out in either publication, they appear as individual updates/articles on the website, and are also posted through our Facebook and Twitter social media accounts. **960 articles were posted** in this reporting period.

During this report period, we continued submitting newly published final research reports to the TRB e-newsletter for inclusion in the *University Research News* Section. Sixteen reports were submitted to be mentioned in the e-newsletter.

We also publish *Research Recaps*. The recaps are easily digestible one-page overviews of the UTC funded research that describe the research project's purpose, approach, key findings, conclusions, contact information for the research team and a link to the final research report. During this report period, the following recaps were distributed through our *What's Happened at Traffic21?* publication and posted to our Mobility21 website:

- *Platooning for Improved Safety and Efficiency of Semi-Trucks (PISES) II,* Venkat Viswanathan
- *Taxi-for-all: Incentivized Taxi Actuation System for Balanced Area-wide Service*, Carlee Joe-Wong
- *Spectrum for Connected Vehicles*, Jon Peha
- *Driving Low-Income Mothers to Greater Success: The Impact of Ride-Hailing on Income and Employment*, Lee Branstetter
- *Assessment of Prospective Mileage-Based Fee System to Replace Fuel Taxes for Passenger Vehicles in Pennsylvania*, H. Scott Matthews
- *Proactive Management of Mobility Impact of Interdependent Subsurface Utility and Roadway Construction*, Burcu Akinci
- *Integration of Autonomous Vehicles with Adaptive Signal Control to Enhance Mobility*, Stephen Smith
- *Using Municipal Vehicles as Sensor Platforms to Monitor the Health and Performance of the Traffic Control System*, Mark McCord, Rabi G. Mishalani, and Benjamin Coifman
- *Labeling Roads with Different Types of Automated Driving Functional Requirements using Machine Learning*, Ding Zhao

The Third Annual National Mobility Summit was held on April 15, 2021. The National Mobility Summit is an opportunity for US DOT University Transportation Centers to come together to discuss the real-world problems, opportunities and innovations in today's transportation landscape. **Over 200 people from 121 organizations were registered for this event. 88% of all UTCs and 100% of the mobility-themed UTCs participated**. The day included 2 panels and poster session. Caesar Singh helped open the event and **Robert Hampshire**, Acting Assistant Secretary for Research and Technology was the keynote.

Federal Representative Panel – *Moderator*, Shari Schaftlein, Director, Office of Human Environment at FHWA – watch recording
- David Corman, Program Director, National Science Foundation, Cyber-Physical Systems, Future of Work at the Human-Technology Frontier: Core Research, Smart and Connected Communities

- Prasad Gupte, Technology Manager, Department of Energy Vehicle Technologies Office and the Energy Efficient Mobility Systems Program
- Scott Michael Robertson, PhD, Senior Policy Advisor, U.S. Department of Labor, Office of Disability Employment Policy, Employment-Related Supports Team
- Stanley E. Young, PE, PhD, Advanced Transportation & Urban Scientist, Mobility Systems Team Lead, National Renewable Energy Laboratory

Improving Mobility for All: Infrastructure and Opportunities Panel - *Moderator*, Carol Wright, Director of Easterseals Transportation Group and co-director of the National Aging and Disability Transportation Center - watch recording here
- Sheryl Gross-Glaser, President, SGG Consulting LLC and former Director, Community Transportation Association of America's National Center for Applied Transit Technology (N-CATT)
- Ken McLeod, Policy Director at The League of American Bicyclists
- Thomas Weakley, Director of Operations of the Owner-Operator Independent Driver's Association Foundation, Inc.

Poster Session – watch recording here
- Automated Vehicle Services for People with Disabilities – Involved Responsive Engineering (ASPIRE Center) – powerpoint
- Center for Advanced Transportation Mobility – powerpoint
- Connected Cities with Smart Transportation (C2SMART) – poster and powerpoint
- Cooperative Mobility for Competitive Megaregions (CM2) – video
- Freight Mobility Research Institute – poster and video about the institute
- Mineta Consortium for Transportation Mobility – poster and fact sheet
- Mobility21 – poster
- National Institute for Transportation and Communities (NITC) – powerpoint
- Pacific Southwest Region – powerpoint
- PacTrans – poster and powerpoint
- Safety through Disruption (Safe-D) – poster and powerpoint
- Small Urban, Rural and Tribal Center on Mobility (SURTCOM) – poster
- Teaching Old Models New Tricks (TOMNET) – poster and powerpoint
- Transit-Serving Communities Optimally, Responsively, and Efficiently Center (T-SCORE) – poster and powerpoint
- Urban Mobility & Equity Center – video

In addition, the participants worked in small groups to discuss several mobility related topics. Find more information about the discussions and the overall National Mobility Summit, click here.

What do you plan to do during the next reporting period to accomplish the goals?
Plans are underway for the next annual meeting of the Mobility21 UTC Advisory Council and Deployment Partner Consortium scheduled for early November 2021.

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2. PARTICIPANTS & COLLABORATING ORGANIZATIONS: Who has been involved?

What organizations have been involved as partners?
Our Deployment Partner Consortium is utilized for identifying real-world transportation needs, research project development and deployment, technology licensing and commercialization, student recruitment for jobs and internships, class and capstone projects.

The list of partners is continually updated on the Mobility21 website based on the research projects being conducted, https://mobility21.cmu.edu/about/leadership/deployment-partners/. There are currently 181 deployment partners.

The list below indicates **new** partners added this reporting period.

Partner Organization Name	Location	Contribution to the Project				
		Financial support	In-kind support	Facilities	Collaborative research	Personnel exchanges
Technical University of Munich	Germany				X	
Regional Industrial Development Corp	Pittsburgh, PA		X		X	
Urbanism Next	Portland, OR				X	
City of San Jose	San Jose, CA		X		X	
Transport Workers Union of America (AFL-CIO)	Washington, DC		X		X	
AFL-CIO	Washington, DC		X		X	

Have other collaborators or contacts been involved?
The UTC also utilizes a distinguished Advisory Council of national leaders to provide strategic guidance and counsel. We sought to achieve modal and demographic diversity. The individual members provide significant collaboration opportunities with their extensive professional affiliations. During the summer, Vincent Valdes, Executive Director of the Southwestern Pennsylvania Commission joined the Mobility21 UTC Advisory Council as the newest member. The Advisory Council listing can be found on our website.

3. OUTPUTS: What new research, technology or process has the program produced?

Publications, conference papers, and presentations

Title	Citation	Type	Date
Driver Warning Technologies and Partial Vehicle Automation: Save Lives and Money	Stan Caldwell, Chris Hendrickson, Corey Harper and Costa Samaras. Driver Warning Technologies and Partial Vehicle Automation: Save Lives and Money. Carnegie Mellon University. 2021	Other	2021-09-30
Stateful Strategic Regression	Keegan Harris, Hoda Heidari, Zhiwei Steven Wu: Stateful Strategic Regression. Advances in Neural Information Processing Systems 34: Annual Conference on Neural Information Processing Systems 2021, NeurIPS 2021	Peer Reviewed	2021-09-30
Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving	Koc, M., Yurtsever, E., Redmill, K., & Ozguner, U. (2021). Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving	Other	2021-09-24
Air Pollution, Greenhouse Gas, and Traffic Externality Benefits and Costs of Shifting Private Vehicle Travel to Ridesourcing Services	Ward, J. W., Michalek, J. J., & Samaras, C. (2021). Air Pollution, Greenhouse Gas, and Traffic Externality Benefits and Costs of Shifting Private Vehicle Travel to Ridesourcing Services. Environmental Science & Technology.	Peer Reviewed	2021-09-20
Faraway-Frustrum" Dealing with LiDAR Sparsity for 3D Object Detection using Fusion	Haolin Zhang, Dongfang Yang, Ekim Yurtsever, Keith Redmill, "Faraway-Frustrum" Dealing with LiDAR Sparsity for 3D Object Detection using Fusion", 2021 IEEE Intelligent Transportation Systems Conference, p. 2646-2652.	Other	2021-09-20
Evaluation of Driver's Sense of Control in Lane Change Maneuvers with a Cooperative Steering Control System	Tatsumi, K., Utsumi, A., Ikeda, T., O. Kato, Y., Nagasawa, I., & Takahashi, K. (2021, September). Evaluation of Driver's Sense of Control in Lane Change Maneuvers with a Cooperative Steering Control System. In 13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (pp. 107-111).	Other	2021-09-21
Evaluating cyclist biometrics to develop urban transportation safety metrics	Ryerson, M. S., Long, C. S., Fichman, M., Davidson, J. H., Scudder, K. N., Kim, M., ... & Harris, M. D. (2021). Evaluating cyclist biometrics to develop urban transportation safety metrics. Accident Analysis & Prevention, 159, 106287.	Peer Reviewed	2021-09-01
Aggregating Traffic Volumes Estimated from Video Imagery Collected on Repeated Bus Passes: Empirical Evaluation of Different Approaches	Shahrzad Charmchi Toosi, Aggregating Traffic Volumes Estimated from Video Imagery Collected on Repeated Bus Passes: Empirical Evaluation of Different Approaches. M.S. Thesis, The Ohio State University, 2021	Other	2021-08-20
Impact of TNC on travel behavior and mode choice: a comparative analysis of Boston and Philadelphia Autonomous Racing Overtake Maneuvers with RRT	Dong, X., Guerra, E., & Daziano, R. A. (2021). Impact of TNC on travel behavior and mode choice: a comparative analysis of Boston and Philadelphia. Transportation, 1-21.	Peer Reviewed	2021-08-09
Track based Offline Policy Learning for Overtaking Maneuvers with Autonomous Racecars	Bhargav, J., Betz, J., Zheng, H., & Mangharam, R. (2021). Track based Offline Policy Learning for Overtaking Maneuvers with Autonomous Racecars. arXiv preprint arXiv:2107.09782.	Other	2021-07-20
Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving	Koc, M., Yurtsever, E., Redmill, K., & Ozguner, U. (2021). Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving. arXiv preprint arXiv:2107.02326.	Other	2021-07-06

A Vision-based Social Distancing and Critical Density Detection System for COVID-19	Dongfang Yang, Ekim Yurtsever, Vishnu Rendnathan, Keith Redmill, Umit Ozguner, "A Vision-based Social Distancing and Critical Density Detection System for COVID-19", Sensors, 21:13 (4608), MDPI. 2021.	Peer Reviewed	2021-07-05
TesseTrack: End-to-End Learnable Multi-Person Articulated 3D Pose Tracking	N. Dinesh Reddy, Laurent Guigues, Leonid Pischulini, Jayan Eledath and Srinivasa Narasimhan, "TesseTrack: End-to-End Learnable Multi-Person Articulated 3D Pose Tracking", Proceedings of (CVPR) Computer Vision and Pattern Recognition, June, 2021	Other	2021-06-30
Temp-Frustrum Net: 3D Object Detection with Temporal Fusion	Erçelik, E., Yurtsever, E., & Knoll, A. (2021). Temp-Frustum Net: 3D Object Detection with Temporal Fusion. Presented at IEEE Intelligent Vehicles Symposium, June 2021.	Other	2021-06-01
A Modeled Approach for Online Adversarial Test of Operational Vehicle Safety	Linda Capito, Bowen Wang, Umit Ozguner, and Keith Redmill, "A Modeled Approach for Online Adversarial Test of Operational Vehicle Safety", 2021 American Control Conference (ACC), 25-28 May 2021, pp. 398-404, doi: 10.23919/ACC50511.2021.9482763.	Other	2021-05-25
On the Generalizability of Motion Models for Road Users in Heterogeneous Shared Traffic Spaces	Johora, Fatema, Dongfang Yang, Jörg Müller, and Ümit Özgüner. "On the Generalizability of Motion Models for Road Users in Heterogeneous Shared Traffic Spaces." submitted to IEEE Transactions on Intelligent Transportation Systems.	Other	2021-04-13
Predicting Pedestrian Crossing Intention with Feature Fusion and Spatio-Temporal Attention.	Yang, Dongfang, Haolin Zhang, Ekim Yurtsever, Keith Redmill, and Ümit Özgüner. "Predicting Pedestrian Crossing Intention with Feature Fusion and Spatio-Temporal Attention." submitted to the 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).	Other	2021-04-13
Building trust in self-driving - developing a safe hands on experience for drivers of all ages and abilities	Loeb, H., Mangharam, R., Upadhyay, S., Sharma, L., Building trust in self-driving - developing a safe hands on experience for drivers of all ages and abilities, Submitted to the 18th TRB Conference on Transportation Planning Applications (AppCon 2021).	Other	2021-04-12
Vehicle automation emergency scenario: using a driving simulator to assess the impact of hand and foot placement on reaction time	Loeb, H. S., Vo-Phamhi, E., Seacrist, T., Maheshwari, J., & Yang, C. (2021). Vehicle automation emergency scenario: using a driving simulator to assess the impact of hand and foot placement on reaction time (No. 2021-01-0861). SAE Technical Paper.	Trade/ Professional	2021-04-06

*Other publications, conference papers and **presentations***:

Title	Event	Type	Attended	Date
Decentralized Control Problems in ITS	IEEE ITS Conference - Plenary Talk	Symposium-Professional	50	2021-09-24
CHARIoT AR Challenge Final Presentation	NIST CHARIoT AR Challenge Final Presentation	Other-Professional	10	2021-09-16
Managing AI in Transportation Course Overview	Southwestern Pennsylvania Commission Safety and Operations Committee Meeting	Workshop-Professional	30	2021-09-09
Towards Data-Driven and Continuous Safety Inspection of Commercial Trucks and Trailers	CMU-Compuspections-Clarience Research Seminar	Other-Professional	5	2021-08-27
Advancing Towards a Smarter and More Sustainable Transportation System	CMU NREL Visit Day	Other-Academic	15	2021-08-05
Incorporating Equity in Hydrologic and Transportation Resilience Modeling	Civil and Environmental Engineering Summer Research Poster Session	Symposium-Academic	75	2021-07-30
Overview of Executive Education Course on Managing AI in Transportation	Mid Atlantic Section of the Institute of Transportation Engineers	Conference-Professional	50	2021-06-23
Technology Trends in Vehicle Automation	Pennsylvania Society of Professional Engineers Continuing Education Course	Workshop-Professional	30	2021-06-09
Accelerating Deep Decarbonization	American Society of Civil Engineers'	Conference-	100	2021-06-08

for US Transportation Modes	International Conference on Transportation and Development	Professional		
Accelerating Decarbonization in the U.S. Transportation System	Illinois Center for Transportation Kent Seminar	Seminar-Academic	100	2021-04-22
Technology Trends in Vehicle Automation	Philadelphia Chapter of Pennsylvania Society of Professional Engineers Continuing Education Course	Workshop-Professional	20	2021-04-01

Website(s) or other Internet site(s)

URL for Internet site(s) that disseminates the results of the research and/or program activities	Short description of the site	Metrics
https://www.cmu.edu/traffic21/	The Carnegie Mellon University's Traffic21 Institute website	New Posts: 960
http://mobility21.cmu.edu/	The Carnegie Mellon University's Mobility21 National University Transportation Center website	New Posts: 960
https://www.facebook.com/traffic21.tset	The Carnegie Mellon University's Facebook Page for Mobility21, a National University Transportation Center for Improving Mobility of People and Goods, and the former Technologies for Safe and Efficient Transportation National University Transportation Center	Followers: 236
https://www.youtube.com/user/Traffic21TSET	The Carnegie Mellon University's YouTube Page for Mobility21, a National University Transportation Center for Improving Mobility of People and Goods, and the former Technologies for Safe and Efficient Transportation National University Transportation Center	Videos: 70 Views: 3,669
https://twitter.com/Traffic21_CMU	The Carnegie Mellon University's Twitter Page for Mobility21, a National University Transportation Center for Improving Mobility of People and Goods, and the former Technologies for Safe and Efficient Transportation National University Transportation Center	Followers: 1,732 Following: 1,188

Technologies or techniques
- Starting in October 2020, Luke Lyle, a postdoctoral researcher in the College of Engineering at Carnegie Mellon University and a Swartz Center 2020 – 2021 Innovation Fellow is being supported by Mobility21 and the Swartz Center for Entrepreneurship to commercialize this technology. The focus of his doctoral research was gallium oxide, a wide bandgap semiconducting material for high power electronic applications. In these applications, gallium oxide is poised to have vastly higher efficiencies than competing materials. This material is critical for developing renewable energy technology by increasing the efficiency of power electronics in electric vehicles, wind turbines, solar cells, and batteries. He is working on commercializing this technology with the development of an industrially scalable, novel technique to grow gallium oxide aiming to leverage this material for use in renewable energy systems.
- May 20, 2021 - Mobility21 UTC researcher Venkat Viswanathan, along with his colleagues at CMU, have invented the first software, INCEPTS, that can predict the charge of electric vehicles in different geographic and climate conditions to improve location of charging stations. Learn more here.

Inventions, patent applications, and/or licenses
Three intellectual property disclosures were filed:
- Vehicle Detection, Tracking, and Counting for Traffic Surveillance, Alex Hauptmann
- Hardware Designs and Software for Intelligent Vehicles, Raj Rajkumar
- Holographic AR Glasses for Improving Mobility of Low-Vision Users, Yang Cai

Discuss the performance measures (a minimum of two) for research outcome your Center identified in your Technology Transfer Plan Report and the targets (goals) for each measure.

	Research Performance Measure	Annual Target	Previous Reporting Period	Current Reporting Period	Annual Total
Output #1	Annual Number of Journal Publications	35	17	19	**36**
Output #2	Annual Number of Research Pilot Deployments	10	8	2	**10**

Please see "Section #3 Publications" for publications.

Some examples of these research pilot deployments include:
- As part of research project, Image Processing Approaches to Traffic Situation Understanding, Risk Assessment, and Safety, researchers led by Umit Ozunger from the Ohio State University conducted a collaborative study with Technical University of Munich about developing robust vision-based perception algorithms for automated driving. They introduced a novel multi-frame Lidar-Camera fusion method for detecting vehicles, pedestrians, and cyclists using end-to-end neural networks. This work has been presented and published in the proceedings of 2021 IEEE Intelligent Vehicles Symposium.
- Sean Qian, through his project Design and Demonstration of an Arterial-friendly Local Ramp Metering Control System, has worked closely with the Office of the Transportation Mobility and Operations (formerly the Office of CHART and ITS Development) at MDOT to implement this research results.

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4. OUTCOMES: What outcomes has the program produced? How are the research outputs described in section (3) above being used to create outcomes?

Outcomes are the application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework, resulting from research and development outputs.

Discuss the performance measures (a minimum of two) for research outcomes your Center identified in your Technology Transfer Plan Report and the targets (goals) for each measure.

	Research Performance Measure	**Annual Target**	**Previous Reporting Period**	**Current Reporting Period**	**Annual Total**
Outcome #1	Annual Number of Media Stories Referencing UTC Research, Faculty, or Spinoff	**80**	39	64	**103**
Outcome #2	Annual Number of Instances Providing Exposure to Transportation, Science and Technology for Practitioners, Teachers, Young people, or Other Members of the Public *(other publications, conference papers and presentations)*	**50**	73	77	**150**

Some examples of the Media Stories Referencing UTC Research, Faculty, or Spinoff:
- *October 6, 2021 - **De Blasio Vowed to Make City Streets Safer. They've Turned More Deadly** –* "Traffic deaths have surged this year to their highest level in nearly a decade. Officials blame an excess of reckless driving, but critics say the city has failed to make streets safer…Even with traffic deaths on the rise, New York's fatality rate was still far lower than the national average, according to Erick Guerra, an associate professor of city and regional planning at the University of Pennsylvania. "In some ways, Vision Zero is aspirational," Professor Guerra said. "Even in cities that have success, you still see traffic fatalities."' *Link to Article*
- *September 29, 2021 - **Taking an Uber is worse for the climate than driving in your own car** –* "Trips in ride-share cars are more damaging to the climate, and impose a greater cost to society in terms of traffic congestion and public safety, than journeys in private vehicles, according to a new study from engineering and public policy researchers at Carnegie Mellon University." *Link to Article*
- *September 27, 2021 - **A life and death question for regulators: Is Tesla's Autopilot safe?** -* The current NHTSA investigation of Autopilot in effect reopens the question of whether the technology is safe. It represents the latest significant challenge for Elon Musk, the Tesla chief executive whose advocacy of driverless cars has helped his company become the world's most valuable automaker…'Today's computer vision is far from perfect and will be for the foreseeable future,' said Raj Rajkumar, a professor of electrical and computer engineering at Carnegie Mellon University. *Link to Article*
- *September 17, 2021 - **Wabtec, Genesee & Wyoming, Carnegie Mellon form consortium for rail sustainability effort** –* "Pittsburgh-based Wabtec Corp.; Carnegie Mellon University, known for its engineering curriculum; and shortline and regional railroad operator Genesee & Wyoming announced Friday, Sept. 10, that they have signed a memorandum of understanding to work to create a more sustainable rail freight network. … Elected officials and other speakers hailed the effort as a first step toward 'decarbonizing rail freight transport.' U.S. Senator Robert P. Casey, Jr. (D-Pa.) noted Pennsylvania's longstanding transportation leadership role, from the Main Line of Public Works canal-and-rail system of the 1830s to the consummate railroad town, Altoona, Pa., which once employed 16,000 workers in the Pennsylvania Railroad shops complex there." *Link to Article*
- *September 8, 2021 - **How electric autonomous planes could change the logistics industry** –* "Will fleets of hybrid-electric ghost planes replace trucks as the delivery's dominant vehicle? Stan Caldwell, Carnegie Mellon University's Adjunct Associate Professor of Transportation and Public Policy, thinks it's feasible. 'We're seeing rapid increase in serious consideration of drones for freight delivery, especially last-mile freight,' he says. 'Last mile' is the part of a delivery process

that reaches the consumer – normally from a distribution center. Some of the world's biggest retailers and logistics companies – like Google, UPS and DHL – are already experimenting with drone delivery.*' Link to Article*

- *August 31, 2021 -* **Musk says Tesla likely to launch humanoid robot prototype next year** – "Elon Musk on Thursday said the electric automaker will probably launch a 'Tesla Bot' humanoid robot prototype next year, designed for dangerous, repetitive, or boring work that people don't like to do… 'Is the 'Tesla Bot' the next dream shot to pump up the hype machine?' said Raj Rajkumar, professor of electrical and computer engineering at Carnegie Mellon University." *Link to Article*

- *August 31, 2021 -* **Why Are Uber And Lyft So Expensive Right Now? -** "'The pandemic demonstrated the volatility of the ride-hailing industry with early sharp reductions in passenger demand and subsequent reductions in driver supply,' said Stan Caldwell, executive director of Carnegie Mellon's Traffic21 Institute." *Link to Article*

- *August 30, 2021 -* **Spin Scooters Spark Outrage As Users Abandon Them in Dangerous Places** – "Although Spin doesn't release its daily ridership figures, Shoman said the company will be working with Carnegie Mellon University and the Urban Institute to do a research study on the Pittsburgh pilot program in order to learn more about who, exactly, has been using the scooters the most." *Link to Article*

- *August 25, 2021 -* **U.S. Will Investigate Tesla's Autopilot System Over Crashes With Emergency Vehicles** – "The U.S. auto safety regulator said Monday that it had opened a broad investigation of the Autopilot system used in hundreds of thousands of Tesla's electric cars…'Driver monitoring has been a big deficiency in Autopilot,' said Raj Rajkumar, an engineering professor at Carnegie Mellon University who focuses on autonomous vehicles. 'I think this investigation should have been initiated some time ago, but it's better late than never.'" *Link to Article*

- *August 25, 2021 -* **Why Teslas Keep Striking Parked Firetrucks and Police Cars** – "The NHTSA is narrowing in on the company's Autopilot system, noting that the Teslas in these incidents "were all confirmed to have been engaged in either Autopilot or Traffic Aware Cruise Control during the approach to the crashes." The investigation will cover Tesla models Y, X, S, and 3 that were released between 2014 and 2021. … To better understand the issue, I spoke with Raj Rajkumar, an electrical and computer engineering professor at Carnegie Mellon University who specializes in self-driving vehicles. Our conversation has been condensed and edited for clarity." *Link to Article*

- *August 24, 2021 -* **Cities to test commercial EV fleets, smart traffic, curbside management using federal funds** – "The Los Angeles Cleantech Incubator (LACI) will study zero-emission delivery and electric vehicle (EV) use by commercial fleets with the support of a $3.8 million grant from the U.S. Department of Energy (DOE), part of a broader federal grant program to decarbonize transportation…The LACI grant will support work exploring commercial electric trucks in three cities — Los Angeles, Pittsburgh, and Santa Monica, California ... In Pittsburgh, the funding will support a curbside parking pilot on smart loading zones in high-traffic areas and examine the role electrification could play in those areas." *Link to Article*

- *August 20, 2021 -* **Infrastructure bill could boost EV charging stations, but who's in charge of the stations?** – "If approved, several billion dollars would go towards electric vehicle charging stations. But who should install and maintain those stations? In addition to charging their cars at home, future EV owners are going to want to do that on long treks too, said Carnegie Mellon professor Jeremy Michalek." *Link to Article*

- *August 18, 2021 -* **Biden Wants More EVs on Roads. What About Charging Stations?** – "A few years ago, Jeremy Michalek used a plug-in hybrid car for work. At the time, he lived in an apartment in Pittsburgh. If he wanted to charge his car at home, he had to snag the parking spot in front of his house, then snake a long extension cord up a flight and a half of stairs, to an outlet he could call his own. The thing created a tripping hazard on the sidewalk. Fortunately, he could mostly charge at work, at Carnegie Mellon University, where he studies electric vehicle policy as a professor." *Link to Article*

- *August 16, 2021 -* **Next-Generation Battery Pioneer Sees Breakthroughs Coming** – "About every eight minutes in Venkat Viswanathan's laboratory at Carnegie Mellon University's mechanical engineering department, two robots—Otto and Clio— complete an experiment that could help accelerate breakthroughs in lithium-ion batteries. Viswanathan … leads a group at Carnegie Mellon focused on improvements that could help power passenger aircraft with a technology that, 30 years ago, was only for camcorders…Viswanathan also has insights into looming advances as an adviser to QuantumScape Corp., the developer in San Jose that raced to a $20 billion valuation with a promise to increase the range of battery-powered electric cars by 50%, and as chief scientist for Aionics Inc., which is using artificial intelligence to speed up battery development." *Link to Article*

- *August 13, 2021 -* **Rust? Trains? Why clean energy is turning to exotic ideas to fix its storage problem** – "Traces of rust on iron have been a sign of decay for thousands of years. But now this chemical process — the oxidation of iron into iron oxide — forms the basis of a battery that Jaramillo said could offer a way to store energy on power grids for more than 100 hours, but at about one-tenth of the cost of an equivalent facility powered by lithium-ion batteries, the leading battery technology…'Cost-effective, durable and reliable energy storage opens up whole new areas of possibility for grid decarbonization,' said Costa Samaras, an associate professor of environmental engineering at Carnegie Mellon University in Pittsburgh who studies efforts to create a power grid with effectively no carbon emissions. *Link to Article*

- *August 3, 2021 -* **Investigation: No review of Amazon Churchill project impact on Parkway East** – "Developer Hillwood Investment Properties did a 600-page traffic study last year and a 55-page follow-up study last month. The studies said there will be more than 5,000 vehicle trips per day at the Amazon site, including nearly 700 trucks. But the Parkway East impact was not part of either study…Action News Investigates asked Carnegie Mellon University engineering professor and transportation expert Sean Qian to review the traffic studies. He said he was surprised they did not look at the impact on the parkway or nearby communities like Monroeville and Forest Hills." *Link to Article*

- *July 30, 2021* - **Electric trucks can travel (short) distances** – "The state of California passed the regulation in June 2020, mandating that most of the heavy-duty trucks sold by 2035 have zero emissions. The state also has an extensive voucher system to subsidize the cost of purchasing a new electric vehicle… Venkat Viswanathan, a mechanical engineer at Carnegie Mellon University, said: And as batteries get cheaper and lighter, trucks that can travel up to about 500 miles between charges look more realistic, says Viswanathan." *Link to Article*

- "A new study published in Accident Analysis & Prevention shows how biometric data can be used to find potentially challenging and dangerous areas of urban infrastructure before a crash occurs. Lead author Megan Ryerson led a team of researchers in the Stuart Weitzman School of Design and the School of Engineering and Applied Science in collecting and analyzing eye-tracking data from cyclists navigating Philadelphia's streets. The team found that individual-based metrics can provide a more proactive approach for designing safer roadways for bicyclists and pedestrians." *Link to Article*

- *July 23, 2021* - **SEPTA's cracking battery buses raise questions about the future of electric transit** – "It's been nearly a year and a half since a passenger set foot inside one of SEPTA's Proterra buses, which cost nearly a million dollars apiece when they rolled out in 2019. Most are now gathering dust in a South Philly bus depot, riven by cracked chassis and other defects. The diesel and hybrid buses that SEPTA planned to replace with the all-electric fleet remain in service, with no timeline for the e-buses to return…Proponents, like engineering professor Jeremy J. Michalek, director of Carnegie Mellon University's Vehicle Electrification Group, said he worries incidents like the mysterious failure of SEPTA's ballyhooed battery fleet will scare others away from zero-emission vehicles. *Link to Article*

- *July 20, 2021* - **How Germany Hopes to Get the Edge in Driverless Technology** – "Raj Rajkumar, who leads the autonomous driving program at Carnegie Mellon University in Pittsburgh, which has produced many of the leading scientists in the field, said the new legislation would give German companies an advantage. But he said he was concerned that the United States and Europe were both at risk of falling behind China in technology and regulations. *Link to Article*

- *July 16, 2021* - **Why the grid is ready for fleets of electric trucks** – "While short-range electric trucks seem relatively close to commercial reality, some researchers have cautioned that stretching the range of electric trucks might not be technologically or economically feasible in the short term. 'For sure you would do short haul, there's no question about it, because the economics are in favor, everything is in favor,' says Venkat Viswanathan, a mechanical engineer at CMU." *Link to Article*

- *July 16, 2021* - **City of Pittsburgh and partners launch MaaS-focused, basic mobility initiatives** – "The city of Pittsburgh, Pa., the city's Department of Mobility and Infrastructure (DOMI) and private company partners celebrated the launch of two innovative initiatives – MovePGH and Universal Basic Mobility – aimed at easing access to mobility options…Spin is providing funding to researchers at Carnegie Mellon University and will also be working with Urban Institute to evaluate the demonstration to potentially serve as a national model." *Link to Article*

- *July 12, 2021* - **Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills.** – "Similar systems offered by General Motors, Ford Motor and other automakers use cameras to track a driver's eyes and issue warnings when they look away from the road. After a few warnings, G.M.'s Super Cruise system shuts down and requires the driver to take control…'This monitoring system is fundamentally weak because it's easy to cheat and doesn't monitor very consistently,' said Raj Rajkumar, a professor at Carnegie Mellon University who focuses on autonomous driving technology. *Link to Article*

- *July 7, 2021* - **A Global Smart-City Competition Highlights China's Rise in AI** – "FOUR YEARS AGO, organizers created the international AI City Challenge to spur the development of artificial intelligence for real-world scenarios like counting cars traveling through intersections or spotting accidents on freeways. In the first years, teams representing American companies or universities took top spots in the competition. Last year, Chinese companies won three out of four competitions. Last week, Chinese tech giants Alibaba and Baidu swept the AI City Challenge, beating competitors from nearly 40 nations…Stan Caldwell is executive director of Mobility21, a project at Carnegie Mellon University assisting smart-city development in Pittsburgh. Caldwell laments that China invests twice as much as the US in research and development as a share of GDP, which he calls key to staying competitive in areas of emerging technology…" *Link to Article*

- *July 2, 2021* - **It's so hot in Portland that transit power cables are melting** – "Oregon's Portland Streetcar was forced to suspend transit service on Sunday because the 'insane, bonkers, and incredible' heat dome boiling the Pacific Northwest is apparently melting streetcar power cables…'We have a climate crisis fueling cascading health, power, and transportation crises,' said Constantine Samaras, associate professor of civil and environmental engineering at CMU." *Link to Article*

- *June 29, 2021* - **Hyperdrive Daily: Lincoln Bills Its Cars as Driveway Sanctuaries** – "For Apple and other tech behemoths that are diving into self-driving tech or have grand plans for their own cars, the push isn't just about breaking into a new market — it's about defending valuable turf, Bloomberg's Reed Stevenson and Mark Gurman write. Americans were behind the wheel for 307.8 hours in 2016, or around six hours a week, according to the latest available data from the American Automobile Association. That's a fair bit of time not spent using iPhone apps or searching on Google. 'Even for companies like Apple and Google, this is a massive market,' said Raj Rajkumar, who leads the robotics institute at Carnegie Mellon University. 'CFOs and CEOs literally drool, since first movers are likely to have a major edge. Each of these companies wants to be the predator, and not become the prey.'" *Link to Article*

- *June 23, 2021* - **Trial lawyers, unions seen hobbling U.S. in race to beat China on driverless cars** – "While progress stalls in Congress, China is moving forward aggressively, Raj Rajkumar, an electrical and computer engineering professor at Carnegie Mellon University, said in an interview. 'They were initially stumbling and bumbling around and not making progress. But they've been improving and improving. Now there's a lot of players in the Chinese market and a lot of money,' he said. Hanging in limbo is a bipartisan bill that would create safety regulations for driverless vehicles and allow more testing." *Link to Article*

- *June 22, 2021* - **America's Electric Vehicle Future -** National Public Radio – On Point, "President Biden took a spin in Ford's new all electric F-150. American automakers say it's not long before they'll completely stop making cars that run on gas. Is this the turning point towards an all-electric future? Jeremy J. Michalek, professor of mechanical engineering and public policy at Carnegie Mellon University. Director of CMU's Vehicle Electrification Group…'This is an enormous change and it's really a revolution. I mean, if you think about it, the past century we have relied almost entirely on petroleum for moving us around, moving people around, moving goods around.'" *Link to Article*

- *June 16, 2021* - **Will charging electric cars ever be as fast as pumping gas? –** "New research may be pushing these super batteries closer to reality. Recently, a team led by Harvard University materials scientist Xin Li designed a solid state lithium metal battery cell that uses several different layers of materials …If the advantages of lithium metal can be harnessed, says Venkat Viswanathan, an engineer at Carnegie Mellon University whose lab also develops next-generation batteries, 'a lot of the assumptions that you have made in terms of fast charging actually go out the window.'" *Link to Article*

- *June 14, 2021* - **Infrastructure talks stuck on EVs, clean energy –** "The price of installing a charging station depends on a range of factors — including hardware, permitting and electrical grid capacity — making it difficult even for industry players to assess the cost of a charging network, according to a recent RMI study. But assuming a ballpark estimate of $100,000 per fast charging station, the Republican offer could potentially fund 40,000 chargers, said Costa Samaras, a Carnegie Mellon University professor who researches energy and climate policy." *Link to Article*

- *June 9, 2021* - **Self-Driving Cars Could Be Decades Away, No Matter What Elon Musk Said –** "A growing number of experts suggest that the path to full autonomy isn't primarily AI-based after all. Engineers have solved countless other complicated problems—including landing spacecraft on Mars—by dividing the problem into small chunks, so that clever humans can craft systems to handle each part. Raj Rajkumar, a professor of engineering at Carnegie Mellon University with a long history of working on self-driving cars, is optimistic about this path. 'It's not going to happen overnight, but I can see the light at the end of the tunnel,' he says. *Link to Article*

- *June 8, 2021* - **Tesla drops radar sensors from cars. But how safe is camera-based autopilot system 'Tesla Vision'?** - "Most automakers and self-driving vehicle companies such as Alphabet Inc's Waymo use three types of sensors: Cameras, radar and lidar. Radar systems, like cameras, are relatively inexpensive. They work in poor weather but lack resolution to accurately determine the shape of objects. Lidar has higher resolution, but is vulnerable to weather conditions. "You need to use all the different kinds of sensors and then combine them," said Raj Rajkumar, professor of electrical and computer engineering at Carnegie Mellon University, reflecting a common industry view. *Link to Article*

- *May 28, 2021* - **Giving traffic jams the heave-ho with the help of A.I. and data –** "Six years ago, the city of Pittsburgh collaborated with Carnegie Mellon University to develop adaptive traffic control signals in a section of town that was plagued by terrible traffic. 'Pittsburgh doesn't have a regular grid. Because we're so hilly [with] rivers and hollows, there aren't a lot of redundant streets,' says Karina Ricks, director of the Pittsburgh Department of Mobility and Infrastructure. …The program put artificial intelligence to work to analyze the traffic flow throughout the day—and change the signals when it makes sense instead of on a predetermined schedule." *Link to Article*

- *May 25, 2021* - **How Is This A Good Idea?: EV Battery Swapping -** Jeremy Michalek, a mechanical engineering professor and director of Carnegie Mellon's vehicle electrification group, calls battery swapping a relic of a bygone EV age. Today's new EVs routinely deliver 200 to 400 miles of range, with a potential 517 miles for the forthcoming Lucid Air. …'When you're looking at 300 miles of range from a fast charge, it changes the game for how convenient EVs are,' Michalek said. 'You're going to spend 20 minutes going to the bathroom and getting coffee anyway.'" *Link to Article*

- *May 10, 2021* - **Colorado Mayor Wants All Electric Car Chargers To Be Universal –** "A gas-powered car can refuel at any pump, but electric vehicles need special chargers. Tesla, for example, built fast chargers for its own drivers, and another luxury brand, Rivian, is planning its own exclusive network of chargers. … COSTA SAMARAS: If you want the same functionality as today's gas station network, we'll need something that's more standardized." *Link to Article*

- *May 3, 2021* - ***Will Elon Musk's StarLink Fix Internet Issues in Western Pa.? –*** "*StarLink,* owned by the Tesla CEO, has put more than 1,400 satellites into orbit, building a network — or constellation, as the company calls it — to provide Internet service to people across the country. …The satellites will work with a ground network called gateways, which will be placed up to 700 miles apart and utilize fiber optic cable, according to Karen Lightman, executive director of Metro21: Smart Cities Institute at Carnegie Mellon University. Internet service will then be connected via dishes placed on homes and buildings. 'They're considered a carrier of last resort because there's a gap' in Internet service, Lightman said. 'Nobody's filling it because the Comcasts and the DQEs and the AT&Ts are like, 'We're not going to lay fiber. There's nobody living there for 200 miles.' But you can do it with satellite.'' *Link to Article*

- *May 3, 2021* - **Feeding the Needy with the Help of Machine Learning –** "Researchers at Carnegie Mellon University have set up a data sharing partnership between the Penn Hills School District and the Allegheny County Department of Human Services. This was done in order to serve those students who used to rely on free breakfast and lunch at school. Along with all the data gathered, the researchers at the Carnegie Mellon University loaded the address information into the computer and identified the locations and the routes. According to Stephen Smith, who developed the delivery algorithms and is currently serving as the research professor in the Robotics Institute, 'The existing bus routes used to transport students weren't ideal for meal distribution for a number of reasons. Stopping every few blocks isn't very efficient…. Our goal was to identify stops and routes to reach as many people as possible.'" *Link to Article*

- *April 26, 2021 -* **Are user fees a middle-class tax hike or a fairer way to pay for infrastructure in Pittsburgh region? –** "'We have a grasp of what this stuff costs, but we don't have a grasp on long-term financing of it,' said Stan Caldwell, adjunct associate professor of transportation and public policy at Carnegie Mellon University. As the Highway Trust Fund has eroded over time, project fixes have been kicked down the road, and user fees have become more disconnected from the people who pay them, transportation experts said." *Link to Article*

- *April 19, 2021 -* **BMW's Virtual Factory Uses AI to Hone the Assembly Line –** "Encouraged by recent progress in AI, some startups are focused on having robots learn in simulation how to perform fiendishly difficult tasks like grasping irregular objects, technology that could eventually help automate much ecommerce and logistics work. This often uses an AI approach called reinforcement learning, which involves an algorithm experimenting and learning, from positive feedback, how to achieve a specific goal. 'This is definitely the way to go,' says Ding Zhao, a professor at Carnegie Mellon University who focuses on AI and digital simulations. *Link to Article*

- *April 12, 2021 -* **Testing how navigable SEPTA is, with glasses that see what riders see –** "Cameron Adamez was outfitted with Tobii Pro eye-tracker glasses on a recent Friday afternoon and dispatched to the caverns beneath City Hall Station on a mission from SEPTA to find out just how difficult it is to get around its rail transit system. Adamez was a volunteer test subject in an experiment designed and conducted by Megan Ryerson, the UPS chair of transportation at the University of Pennsylvania, to generate data for SEPTA planners overhauling the system's way-finding: the maps, signs, and branding that clue riders where to go for what line." *Link to Article*

- *April 9, 2021 -* **The professor who built a self-driving car decades ago –** "Decades before the race to build a self-driving vehicle became a multibillion-dollar contest between tech giants such as Tesla Inc and Google, a South Korean professor built an autonomous vehicle and test-drove it across the country — only for his research to be consigned to the scrapheap. Han Min-hong, now 79, successfully tested his self-driving car on the roads of Seoul in 1993 — a decade before Tesla was even founded…Raj Rajkumar, an engineering professor at Carnegie Mellon University's Robotics Institute, who reviewed the 1990s footage for Agence France-Presse, said that it 'appears to be on par with some of the best work on autonomous vehicles during that period.'" *Link to Article*

- *April 6, 2021 -* **Why Joe Biden is pitching his infrastructure plan in Pittsburgh, where he launched and ended his campaign –** "When Joe Biden began his presidential campaign, he chose a Pittsburgh union hall for his first rally. He returned to the city for his first event after accepting the Democratic nomination last summer. And on the night before Election Day, he closed his campaign at the Steelers' home stadium, Heinz Field. Now, as he launches his second major initiative as president — a potentially $3 trillion infrastructure plan that could be his most ambitious legislation — Biden is returning Wednesday to the Southwestern Pennsylvania city long associated with labor unions and heavy industry… 'We're a template for what you can do to do it right,' said Karen Lightman, executive director of Metro21, which connects research and development at Carnegie Mellon University with real-world uses in the Pittsburgh region." *Link to Article*

Some examples of the instances providing exposure to transportation, science and technology for practitioners, teachers, young people, or other members of the public (other publications, conference papers and presentations):

- *September 15, 2021 -* Pennsylvania State Representative and Transportation Committee Member, Austin Davis met with Mobility21 researcher Christoph Mertz to tour the NavLab at the Robotics Institute and learn road surface monitoring research and subsequent spin-off company Roadbotics, which is based in Pittsburgh and commercializing the UTC research.

- *September 10, 2021 -* United States Senator Bob Casey and Congressman Conor Lamb visited Carnegie Mellon University to speak at the launch of Freight 2030 (an initiative to create a freight rail innovation institute with partners Wabtec, Genesee & Wyoming Railroad and CMU). Mobility21 Director Raj Rajkumar has been involved with the planning of Freight 2030 with the goal of decarbonizing the rail freight industry.

- *July 1, 2021 -* Mobility21 UTC Program Manager, Lisa Kay Schweyer provided an overview of the Traffic21 & Mobility21 programs to the CMU Center for Shared Prosperity's Center Community Committee. This presentation concluded with discussion on how the Traffic21/Mobility21 can help support the new center.

- *June 21, 2021 -* Mobility21 UTC researcher Sean Qian, along with students Xiaohui Liu, Lei Xu and Wei Ma, presented their work "*A Data-Driven Approach to Manage the Curbside Ride-Hailing Pick-Ups and Drop-Offs*" at the 2021 International Symposium on Transportation Data & Modeling. ISTDM 2021 aims to gather transportation researchers and practitioners across the globe for exploring the frontiers of big data, modeling and simulation to advance transportation research to support the connected, cooperative and automated mobility.

- *June 18, 2021 –* Raj Rajkumar met with representations of Hyundai to discuss partnership opportunities and discuss his work in the AV field.

- *June 9, 2021 -* Mobility21 Executive Director Stan Caldwell presented the continuing education course *"Technology and Trends in Vehicle Automation"* to the Pennsylvania Society of Professional Engineers. The course explained AV technology and trends and highlighted infrastructure applications and AV policy in Pennsylvania, and ended with a robust discussion on AV technology and policy. View the recording here.

- *June 8, 2021* - Chris Hendrickson, Director of Traffic21 and researcher with Mobility21, gave a plenary talk for the American Society of Civil Engineers' International Conference on Transportation and Development entitled "*Accelerating Deep Decarbonization for US Transportation Modes*."
- *June 2, 2021* - Metro21 Executive Director Karen Lightman recently spoke as part of panel with industry leaders, including Jim Misener of Qualcomm and a member of the Mobility21 UTC Advisory Council, to discuss how and when autonomous vehicles will penetrate markets, understanding things such as technical, regional and consumer acceptance. Listen to the podcast here.
- *May 31, 2021* - Mobility21 UTC researcher Rahul Mangharam from the University of Pennsylvania organized the "*Opportunities and Challenges with Autonomous Racing*" workshop which had over 175 participants and invited speakers from MIT, Stanford, ETHz, GTech, Caltech and others who are balancing safety and performance at the limits of perception, planning and control of autonomous racing machines. Learn more details about the event here.
- *May 12, 2021* - Today, 5 Pennsylvania University Transportation Center representatives joined together to present the "*Get to Know the PA UTCs*" workshop during the American Council of Engineering Companies of Pennsylvania Spring Conference. The workshop began with a general overview of the UTCs. This included history on the establishment of the UTC program, what UTCs do (research, education and workforce development, technology transfer, collaboration), how to find UTCs, and how to get involved in UTC activities. Then, each UTC provided an overview of their specific research areas and programs: Automated Vehicle Services for People with Disabilities–Involved Responsive Engineering Center, University of Pittsburgh – Rory Cooper, Human Engineering Research Laboratory, Center for Integrated Asset Management for Multi-Modal Transportation Infrastructure Systems, Penn State University – Dr. Eric Donnell, Professor of Civil Engineering, Director of Larson Transportation Institute, Center for Underground Transportation Infrastructure, Lehigh University – Spencer Quiel, Ph.D., PE, Associate Professor, Cooperative Mobility for Competitive Megaregions, University of Pennsylvania – Erick Guerra, Associate Professor, Mobility21, Carnegie Mellon University – Lisa Kay Schweyer, TDM-CP, MPM, Program Manager. The group encouraged the attendees to learn more about the UTCs and to get involved: *Sign-up for Newsletters, Propose Research Ideas, Attend Webinars/Seminars, Share Internship & Job Opportunities, and Invite UTC researchers to speak at events/conferences.*
- *May 4, 2021* - Stan Caldwell served on the advisory panel and attended the final presentation of the Department of Engineering and Public Policy's undergraduate capstone project course on the local and national implications of vehicle electrification.
- *April 22, 2021* - Traffic21 Director Chris Hendrickson was featured as the Kent Seminar Distinguished Speaker for 2021 by the Illinois Center for Transportation presenting his project, "*Accelerating Decarbonization in the US Transportation System*."
- *April 22, 2021* - Traffic21 Director Chris Hendrickson and Executive Director Stan Caldwell, alongside Laurence Rilett of the University of Nebraska recently published an article for the ASCE Journal of Transportation Engineering, Part A: Systems titled "*It is Time to Recognize Communications as a Mode of Transportation.*"
- *April 21, 2021* - Mobility21 academic partners Bob Koch & Justin Starr of Community College of Allegheny County and Mobility21 Program Manager, Lisa Kay Schweyer, participated and provided workgroup updates during today's USDOT ITS Joint Program Office's All-Levels Academic Virtual Forum, where educators at universities, two-year colleges, and high schools, as well as practitioners and industry leaders came together to learn, share, and strategize about ITS education and workforce development.
- *April 20, 2021* - Stan Caldwell provided an update to the Pennsylvania Transportation Alliance on research of Mobility21 faculty Sarah Fox, Patrick Carrington and Nik Martelaro supported by the US DOT Inclusive Design Challenge. Alliance members, including Chairman John Tague, are community partners in this research.
- *April 20, 2021* - Mobility21 UTC researcher Sean Qian participated in the University of Texas at Austin's Smart Cities consortium to discuss his project, "*Strategic and Operational Strategies to Inform First- and Last- Mile Services: Case Studies for Robinson and Moon Townships, PA*."
- *April 1, 2021* - Stan Caldwell instructed a course for 20 members of the Philadelphia Chapter of Pennsylvania Society of Professional Engineers. The course was based on his Mobility21 research, "*Technology Trends in Vehicle Automation.*"

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5. **IMPACTS**: What is the impact of the program? How has it contributed to improve the transportation system: safety, reliability, durability, etc.; transportation education; and the workforce?

What is the impact on the effectiveness of the transportation system?
- Through his project, *Transit dependents, choice riders, and service criticality: an analysis of the determinants of bus ridership in the Philadelphia Region*, Erick Guerra has been working with SEPTA and City of Philadelphia staff to discuss how findings might help support and inform the city's transit plan and SEPTA's forthcoming bus network redesign.

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?
- *September 27, 2021* - Mobility21 Innovation Fellow and Robotics Institute alum Joe Bartels is the CEO of a CMU spinout Phlux Technologies. Phlux is enabling advanced capabilities in robotics and automation with a new class of

programmable 3D sensors that were developed in CMU's Imaging and Illumination Lab. As a Mobility21 Innovation Fellow, Joe focused on early commercialization activities including prototype development and customer discovery research in robotics, autonomous vehicles, smart cities, and industrial automation. During this process, Joe worked with Tepper MBA students supported by Mobility21 to tune Phlux's early business model, value proposition, and customer profile.

- *September 16, 2021* - During the Summer 2021, Chenxin Xu served as an intern for Traffic21/Mobility21 and the Center for Technology Transfer and Enterprise Creation (CTTEC). She is a dual degree student at CMU seeking masters degrees in Engineering & Technology Innovation Management and in Mechanical Engineering. Chenxin collaborated with two other interns at CTTEC supported by the CMU Scott Institute for Energy Innovation, bringing a range of skills, training and experiences to their projects for CMU startup efforts. The two Traffic21/Mobility21 supported startup projects that Chenxin worked on were:
  - ✓ Phlux Technologies: a spinout company from CMU's Robotics Institute from the lab of Professor Srinivasa Narasimhan, led by PhD graduate Joe Bartels. The intern conducted customer discovery interviews to help to segment market opportunities and to identify market entry and partnering strategies.
  - ✓ Oxide Enterprises: a pre-company project from CMU's Materials Science and Engineering Department, from the lab of Professor Lisa Porter, led by PhD graduate Luke Lyle. The intern conducted secondary market research and customer discovery interviews.
    - o Joe & Luke have been working for the past year as Swartz Innovation Fellows in collaboration with Mobility21 to commercialize their technology.

What is the impact on the body of scientific knowledge?
Outside of the previously listed peer-review publications and listed inventions, patent applications, and/or licenses in Section 3, nothing new to report this reporting period.

What is the impact on the development of transportation workforce development?
In addition to the transportation workforce development activities mentioned earlier, this grant has expanded workforce development efforts through a partnership with the Community College of Allegheny County (CCAC). CCAC continues to engage students and industry partners about the various employment opportunities within "Intelligent Transportation Systems," "Advanced Driver Assist Systems," and "Connected & Autonomous Vehicles." Collaborations with high school faculty have continued to assist them to modify their mechatronics and industrial maintenance programs to include content that will help students troubleshoot the sensors and connected systems in the autonomous vehicles that are becoming more and more prominent. Students studying automotive technology continue to receive training on ADAS specific systems and repair procedures and mechatronics students received their first exposure to lidar data streams and signal troubleshooting techniques.

Students from the Engineering Technologies and Mechatronics program continued to participate in the Virtual Racing League with more than 20 students participating in virtual autonomous races. CCAC also developed curriculum for the future of autonomous aerial vehicles and launched a comprehensive website offering the FAA's TRUST certification for recreational drone pilots – the only school in Pennsylvania to do so. Content in this course includes current state of the art drone regulations as well as information about the future of autonomous flight, and has certified more than 300 individuals to date.

CCAC's Automotive programs educated over 300 secondary and post-secondary students with some ITS, and ADAS information. Our outreach events at local High Schools Career and Technology Centers exposed many different students to "Transportation & Transportation Related Careers and Information." COVID-19 limited the number of schools we could visit to only 6 in and around Allegheny and surrounding counties. CCAC held 2 in-person events August 10th and 11th, with Ingevity discussing the absorbed natural gas technology used in the new Ford Super Duty pickup. About 25 students and attendees had a chance to see the truck and learn how the system operates.

At Career and Technology Centers Advisory meetings, we brought existing opportunities for automotive students, and others in the field of advanced intelligent transportation.

In addition, CCAC has been involved in:
- Testing the CAVe-in-a-Box system. The unit was damaged in shipping and did not work correctly out of the box. Several calls and troubleshooting sessions with DOT were held.
- More than 15 hours were spent developing the TRUST certification and obtaining FAA approval for the future of drone technology.
- Site visit to Sto Rox high school to speak with instructor about sensors and connected systems.

- Attended ITS PCB Working Group #2.
- Site visit to Beattie Career and Technology Center on May 6th speaking to students on automotive and ITS transportation careers.
- Site visit to Brashear CTC on May 13th speaking to students on automotive and ITS transportation careers.
- Site visit to Central Westmoreland CTC on May 20th speaking to students on automotive and ITS transportation careers.
- Presented advances in transportation related to mechatronics to the Technology & Engineering Education Association of PA.
- Outreach to PA Cyber Charter school on robotics and autonomous transportation.
- Site visit to Butler CTC on June 3rd speaking to both am & pm students on automotive and ITS transportation careers.
- Discussed with the state inspection class how ADS, and other advanced technologies affect the procedure for state inspection.
- PRCC stakeholder meeting discussing upcoming clean city projects.
- CCAC ARM Endorsement site visit; included overview of ITS related curriculum.
- Planning Odyssey Day event for October 1st.

Discuss the performance measures (a minimum of two) for research outcome your Center identified in your Technology Transfer Plan Report and the targets (goals) for each measure.

	Research Performance Measure	**Annual Target**	**Previous Reporting Period**	**Current Reporting Period**	**Annual Total**
Impact #1	Annual Number of Instances of Technology Adoption or Commercialization	**3**	2	4	**6**
Impact #2	Annual Number of Instances of Research Changing Behavior, Practices, Decision Making, Policies (Including Regulatory Policies), or Social Actions	**3**	4	6	**10**

In addition to what has been previously reported, additional examples of technology adoption and research changing behavior are:
- *October 5, 2021* - **Miovision Secures an Adaptive Partner** - *"*Miovision, which helps municipalities get more out of their road network by providing solutions that collect multimodal traffic data and uncover actionable insights, announced today that it is partnering with Rapid Flow Technologies to become the exclusive Canadian solution provider of the Surtrac adaptive traffic signal control system…Surtrac adapts the timing of traffic signals – how long they stay green to serve different directions of traffic – second-by-second using advanced artificial intelligence optimization." Link to Article
- *October 4, 2021* - **Pittsburgh Pilots New Smart Loading Zones To Ease Congestion And Air Pollution From Delivery Vehicles –** "As the amount of stuff you can order online becomes more abundant, something else has grown very scarce: curbside parking for delivery vehicles. According to the World Economic Forum, the number of delivery vehicles in the top 100 cities worldwide will increase by 36 percent by 2030. That new traffic will bring with it more air pollution and congestion to urban centers…But the city of Pittsburgh's Department of Mobility and Transportation is trying a new approach to managing curbside delivery parking." *Link to Article*
- *August 16, 2021* - **Pittsburgh's mobility platform aims to expand transportation options –** "The app also provides the location of the city's mobility hubs … where residents can access a range of last-mile services and see real-time transit and mobility information on TransitScreens. The goal is to increase the number of hubs to 50 by the end of the year. The placement of these hubs was informed by the existing transportation infrastructure, but the needs of lower-income communities were also considered. Data from a 2017 project that assessed the city's annual progress toward equitable opportunities was combined with 'an aggregate value of [transit] stops, frequency of service and routes being served,' said CMU graduate research assistant Allanté Whitmore, who helped develop DOMI's mobility principles." *Link to Article*
- *August 11, 2021* - **Philly has the best roads in the country, according to AI study of major US cities –** "Philadelphia's roads … the best in the country, the U.S. Chamber of Commerce determined by using artificial intelligence to survey conditions in 20 metropolitan areas. Here's how the study worked: Analysts with Pittsburgh-based RoadBotics mounted smartphones to cars' windshields and drove roughly 75 miles through cities across the country. The phones' captured video of pavement, from which artificial intelligence identified potholes, cracks and other distresses. Cities were then ranked based on an aggregated score. The survey of Philly spanned only 72 miles of the 2,575 miles that comprise the city." *Link to Article*
- *July 13, 2021* - Stan Caldwell met with Pennsylvania State Senator Ryan Aument to discuss policy research in emerging transportation technologies and impacts in the commonwealth.
- *July 12, 2021* - **Smart city success through connected sensors and edge analytics –** "As an example, Atlanta, Georgia, has employed surveillance cameras and analytics to create a 'smart corridor' for traffic on one of the main midcity routes… Traffic data—including vehicle counts, speed, and occupancy —is used by SURTRAC, an adaptive traffic signal control technology developed at the Robotics Institute at Carnegie Mellon University (Pittsburgh, PA, USA; www.ri.cmu.edu) that optimizes the performance of traffic signals. *Link to Article*
- *June 28, 2021* - Mobility21 UTC researcher Dr. Destenie Nock and Akshaya Jha were recently asked for their expert opinions regarding President Biden's climate plan on a panel by State Impact Pennsylvania and The Allegheny Front. *Link here.*

- *June 8, 2021* – **PA Legislators Hosted at CMU. 'The opportunity is here, but the threats are real': Officials push for state support of Hazelwood Green to keep tech innovations in Pittsburgh** – "Regional leaders got to show off progress in the development of the Hazelwood Green complex to a team of state senators Thursday, including demonstrations in a self-driving car and rides on electric scooters. But the high-level tour came with a message for members of the Senate Transportation Committee: The state needs to take steps to ensure technology developed at that site leads to the manufacturing of products and development of industries in this area rather than elsewhere across the country…Sen. Wayne Langerholc, R-Cambria and chairman of the transportation committee, said supporting transportation industries is part of a package of bills he proposed this week to deal with transportation funding." *Link to Article*
- *May 28, 2021* - **Increased road deaths prompt calls for improved vehicle tech** – "Amid skyrocketing road deaths in the United States, members of Congress emphasized at a hearing Tuesday the role autonomous vehicles can play in improving safety but called for other technology to be implemented in the short term. Lawmakers remain determined to encourage faster AV development and deployment and to legislate on the nascent technology… 'China's ability to catch up with our advances has been aided in part by their relatively lax regulatory environment,' said Raj Rajkumar, a professor in the Department of Electrical and Computer Engineering at Carnegie Mellon University. *Link to Article*
- May 18, 2021 - Professor Raj Rajkumar, Director of the Mobility21 National University Transportation Center provided testimony at the US House Committee on Energy and Commerce, Subcommittee on Consumer Protection and Commerce hearing on "*Promises and Perils: The Potential of Automobile Technologies*," alongside fellow panelists Jason Levine, Executive Director for the Center on Auto Safety and Greg Regan, President of the Transportation Trades Department of the AFL-CIO. Congressman Mike Doyle, member the House Energy and Commerce Committee, representing CMU's hometown of Pittsburgh, introduced Professor Rajkumar. The Subcommittee Hearing was chaired by Congresswoman Janice D. Schakowsky (Illinois-09) along with Ranking Member Congressman Gus M. Bilirakis (Florida-12). Professor Rajkumar's testimony included the history of autonomous vehicles (AVs), a current assessment of AV technology and the steps necessary to maintain domestic competitiveness and achieve the social and economic benefits of the AV industry.

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6. CHANGES/PROBLEMS

- *Changes in approach and reasons for change* - Nothing to report.
- *Actual or anticipated problems or delays and actions or plans to resolve them* - Nothing to report.
- *Changes that have a significant impact on expenditures* - Nothing to report.
- *Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards* - Nothing to report.
- *Change of primary performance site location from that originally proposed* - Nothing to report.

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7. SPECIAL REPORTING REQUIREMENTS

Submission status of Final Research Reports: Sixteen reports have been submitted to the repositories as indicated in the Grants Deliverables and Reporting Requirements.