Semi-Annual Progress Performance Report for University Transportation Centers

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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 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-five research projects were active during this report period.

On October 5, 2021, the annual call for proposals was released for CMU researchers to propose projects for the July 1, 2022 – June 30, 2023 period. Twenty-two 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. Sixteen of the projects were selected based on the available funding. Mobility21 UTC management personnel are working with the PIs to ensure all US DOT & project requirements

will be met so the projects can start on July 1, 2022.

During this reporting period, two 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.

Additional accomplishments:
- *March 22, 2022 - Utilizing School Bus Routes and Machine Learning to Deliver Meals to Families in Need* – Wins Award Professor Steve Smith's Mobility21 UTC and Metro21 project, "Utilizing School Bus Routes and Machine Learning to Deliver Meals to Families in Need" has been named winner in the IDC Government Insights' Fifth Annual Smart Cities North America Awards in the field of public health and social services.
- *February 17, 2022 - 2022 Sloan Research Fellowship Awarded to Fei Fang*, an early career honor for scholars whose achievements put them among the very best scientific minds today. Fang is a UTC researcher.
- *February 15, 2022 - Stan Caldwell Receives 2022 CUTC – ARTBA Award for Administrative Leadership*.
- *February 14, 2022 - DOE ARPA-E OPEN 2021 Program Awards CMU $3.2 Million* - Mobility21 UTC researcher Venkat Viswanathan was part of the awarded funding, alongside his team led by Cornell University focused on developing an electrochemically-formed, carbon-favorable cement technology known as ADVENT.
- *February 2, 2022 - Stan Caldwell Awarded ITSPA Person of the Year*.
- *February 1, 2022 - IN2 2022 Channel Partner Strategic Award & Funding* - Mobility21 UTC researchers Corey Harper and Destenie Nock of the Scott Institute have been selected for an IN2 2022 Channel Partner Strategic Award.
- *January 18, 2022 - CMU Faculty Receive Navy NEPTUNE Partnership for Hydrogen Electrolysis and Battery Research* - Mobility21 UTC researcher Venkat Viswanathan, along with his colleagues, have been honored to be the research leads for the Office of Naval Research (ONR 33) NEPTUNE program research team at Carnegie Mellon University.
- *January 11, 2022 - CMU Block Center Highlights Work of Mobility21 UTC Researcher Sarah Fox* for her work on Hospitality Workers in the Age of Automation.
- *January 9, 2022 - Council of University Transportation Centers Awards Lifetime Achievement Award to Al Biehler.* Retired TSET National UTC Executive Director.
- *January 5, 2022 - TVS Motor Company Appoints Venkat Viswanathan as Technical Advisor* - Mobility21 UTC researcher Associate Professor of Mechanical Engineering Venkat Viswanathan appointed as Technical Advisor for electric mobility by TVS Motor Company.
- *December 6, 2021 - Mobility21 Highlights the Work of Professor Steve Smith in U.S. DOT Video* - Mobility21 UTC recently highlighted projects completed by UTC researcher Steve Smith for a U.S. Department of Transportation Video Forum on Artificial Intelligence in Transportation.
- *December 1, 2021 - UTC Researcher Appointed Co-Chair of PennDOT's Advanced Air Mobility Subcommittee* - Mobility21 researcher Stan Caldwell joined Joby Aviation's Max Fenkell in co-chairing the first Advanced Air Mobility Subcommittee of PennDOT's new Unmanned Aerial Systems Task Force.
- *November 15, 2021 - Özgüner earns IEEE Lifetime Achievement Award for Intelligent Transportation Systems Research* - Mobility21 UTC researcher and professor at The Ohio State University Ümit Özgüner was awarded the 2021 IEEE Lifetime Achievement Award for Intelligent Transportation Systems Research.
- *November 12, 2021 - Open Energy Outlook Seeks Input from Mobility21 UTC Researcher* - Mobility21 UTC researcher Destenie Nock has been named to the Uncertainty Assessment team for Open Energy Outlook of the United States.
- *October 25, 2021 - CMU College of Engineering ATLAS Awards Announced* - The CMU Autonomous Technologies for Livability And Sustainability Planning Grant for Engineering Research Centers announced their Year 2 award winners, including projects featuring several UTC researchers: Pingbo Tang, Burcu Akinci, Yorie Nakahira, Corey Harper, Jeremy Michalek, Ding Zhao, Gregg Lowry, Destenie Nock, Costas Samaras, Daniel Armanios, Matteo Pozzi, and Mario Berges.
- *October 1, 2021 - Mobility21 UTC & CCAC faculty member Dr. Justin Starr Named Engineering Unleashed Fellow*.

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 **193** 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:

- *March 25, 2022 - Freight Mobility Research Institute Hosts 7th Annual UTC Conference for the Southeastern Region* - Mobility21 UTC researcher Pingbo Tang's UTC research project, "Towards Data-Driven and Continuous Safety Inspection of Commercial Trucks and Trailers" was presented by his student, Chenyu Yuan.
- *March 24, 2022 - Mobility21 Participated in Fifth Annual WTS Pittsburgh Chapter Scholarship Gala* - CMU students Hajra Shahab, Maggie Harger, and Sreya Vangala, joined by Mobility21 Program Manager Lisa Kay Schweyer, participated in the Fifth Annual Women in Transportation Pittsburgh Scholarship event.
- *March 23, 2022 - Can Pittsburgh Have Mobility and Justice for All?* - Mobility21 Women in Transportation Fellow 2018-2020 Bonnie Fan, along with Paul O'Hanlon from the advocacy group Pittsburghers for Public Transit talked about what it would be like to create a more equitable transit system.
- *March 22, 2022 - Teachers Bring Robotics to Special Education Classrooms Celebrating Champions for Access* - Hundreds more students across the region are now experiencing robotics thanks to innovative teachers and a partnership with the Allegheny Intermediate Unit (AIU). Educators developed and piloted a series of robotic activities & lesson plans for special education and life skills classrooms. Lead schools participating in the pilot included: Baldwin High School, Carlynton High School, Friendship Academy, Hampton Township High School, Northgate High School, Norwin High School, Quaker Valley High School, and Steel Valley High School. … The activities and lesson plans build upon the Emmy-nominated PBS Learning Robot Doctor television series created in 2020 by WQED Media, Robowits, LLC. (a Mobility21 UTC Deployment partner), Carnegie Mellon University faculty and staff, and PA Rural Robotics.
- *March 15, 2022 - Fellows Attend Argo AI Self Driven Women Early Talent Summit* - Mobility21 UTC's Women in Transportation Fellows Hajra Shahab and Maggie Harger participated in Argo AI's Women's History Month celebration at the self-driving tech startup. The Self-Driven Women Early Talent Summit brought together women from STEAM backgrounds who have a shared passion for the technology industry.
- *March 12, 2022 - Mobility21 UTC Women in Transportation Fellows & Transportation Club Members Build Connections with Academic Partner* - Mobility21 UTC's Women in Transportation Fellows Hajra Shahab and Maggie Harger, along with members of the Carnegie Mellon University Transportation Club board, Ken Huang, Brian Hsu and Rajanikant Tenguria traveled to meet with students from Mobility21's academic partner, the University of Pennsylvania. The purpose of this visit was to learn about the academics, research activities and build connections with the students at Penn. During their visit, the students had the opportunity to participate in an exclusive behind the scenes tour of the Southeastern Pennsylvania Transportation Authority's (SEPTA) regional rail network and office headquarters in downtown Philadelphia. ** This visit was conceived in January 2022 when students had the opportunity to meet at the 101st Transportation Research Board Annual Meeting. **
- *March 4, 2022 - Rachel Burcin Has Been Named a 2022 Pennsylvania STEM Ambassador* - Rachel Burcin, Robotics Institute Global Programs Manager of Carnegie Mellon University, has been accepted as one of 19 ambassadors in the Pennsylvania STEM Ambassador 2022 Program. Rachel is a Mobility21 education and workforce development partner working to expand access to robotics research and education programs.
- *February 25, 2022 - Transportation Club Hosts Annual Career Panel* - The Transportation Club hosted its annual "Careers in Transportation" panel discussion, moderated by Jocelyn Malik of Heinz College, with panelists joining from the public and private sector including: Amitai Bin-Nun, Senior Research Scientist, Motional Lauren Doyle, Environmental Scientist, SAI Consulting Ellie Newman, Section Mgr. of Service Development, Allegheny County Port Authority. Students from different colleges within CMU attended to learn how each panelist paved their career path, projects that keep them engaged, and potential opportunities for young professionals in the transportation sector.
- *February 3, 2022 - Traffic21 Women in Transportation Fellows Participate in WTS Event* - Women in Transportation fellows, Hajra Shahab and Maggie Harper, participated in the WTS Pittsburgh Chapter meeting at the Engineers Society of Western PA.
- *January 25, 2022 - SAFE Welcomes Allante' Whitmore as Director of Autonomous Vehicle Initiative* SAFE has announced that former Mobility21 Diversity Fellow Allanté Whitmore has been named Director of their Autonomous Vehicle Initiative, leading efforts to advocate for well-thought out and safe policy solutions to advance critical AV technology.
- *January 14, 2022 - UTC Students Attend Transportation Research Board Annual Meeting* - Students from 3 of the academic partners of Mobility21, Carnegie Mellon University, University of Pennsylvania and The Ohio State University attended the Transportation Research Board's 101st Annual Conference in Washington, DC. The students also met for a networking dinner where they shared experiences working and learning about the field of transportation.
- *January 12, 2022 - Best Presentation Award at Workshop on Doctoral Research in Transportation Analysis, Planning and Policy Goes to Mobility21 Diversity Fellow* - Mobility21 Diversity Fellow Allante' Whitmore was selected for a Best Presentation Award for the Workshop on Doctoral Research in Transportation Analysis, Planning and Policy at TRB.
- *January 8, 2022 - Mobility21 UTC Honors "Student of the Year" Rick Grahn at 31st Annual Awards Ceremony* - Carnegie Mellon University student Rick Grahn was honored as Mobility21 University Transportation Center's "Student of the Year" at the Council of University Transportation Center's annual awards event.
- *December 9, 2021 - Heinz College Masters Students Present Capstone* - CMU Heinz College Masters of Information Systems Management Capstone students Shiyi Liu, Yanwen Peng. Jiaoying Mu, Kehan Li, Yilin Hua and Zhenyuan He made a final presentation of their capstone project developing an automated truck departure user interface. The client was Klara Oberhollenzer, Manager of Development of Autonomous Truck Mission Control Product & Partnerships at Daimler Truck North America and the course advisor was Stan Caldwell, Executive Director, Mobility21 UTC.

- *December 2, 2021 - [CMU Students Share Final Capstone Projects](#)* - 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, advised by Mobility21 Program Manager, Lisa Kay Schweyer and Team Daimler Trucks North America, advised by Mobility21 Executive Director, Stan Caldwell.
- *November 18, 2021 - [Traffic21 Women in Transportation Fellow Attends Western Area MASITE Presentation](#)* - Traffic21 Women in Transportation Fellow 2021-2023 Maggie Harger attended the Western Area MASITE In-Person Presentation and Social hosted by the Mid-Atlantic Section of the Institution of Transportation Engineers, which offered networking opportunities as well as the chance to learn about mobility projects underway in the City of Pittsburgh.
- *October 15, 2021 - [Mobility21 UTC Researchers Host Education Classes](#)* - Mobility21 UTC researchers Dr. Rahul Mangharam and Dr. Johannes Betz of the University of Pennsylvania participated in and hosted classes at Embedded Systems Week 2021.
- *October 1, 2021 - [Traffic21 Women in Transportation Fellow Hajra Shahab Attends Virtual Grace Hopper Celebration](#)* - Women in Transportation Fellow Hajra Shahab participated in the Grace Hopper Celebration (GHC). Hajra enjoyed her experience at GHC, and said she was "...very impressed how they support women who aspire to grow in the field."

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
10/8/2021	Destenie Nock	CMU	Transportation Implications from COVID-19: Food Delivery and Public Transport	https://youtu.be/h3pGnuXHtEQ
10/29/2021	Keith Redmill & Ekim Yurtsever	OSU	End-to-End Driving Automation with Deep Reinforcement Learning: Challenges and Promises	https://youtu.be/WpcFWpGPGEw
11/12/2021	Pulkit Grover	CMU	Towards New Accessible Neural Sensing Technologies for Portable Use During Driving	https://youtu.be/gRQarg4Jmbg
12/3/2021	Sarah Fox	CMU	Centering Operators' Perspectives in Designing the Future of Transit Work	https://youtu.be/BiXRMCNOSpE
2/11/2022	Mark McCord	OSU	Monitoring Roadway Vehicle Miles Traveled using Video Imagery from Transit Buses in Operational Use	https://youtu.be/BHybVaoysQM
3/4/2022	Yang Cai	CMU	Improve Mobility for Low-Vision People with Augmented Reality	n/a
3/18/2022	Helen Loeb	UPENN	Self-Driving Technology and 'Trust' - Can a Driving Simulator Help?	https://youtu.be/m17j6WQhwss

Additional technology transfer activities:
- *March 23, 2022 - [Rail-Volution Hosts Webinar "Communicating to a Changing Rider Base"](#)* – University of Pennsylvania UTC researcher Megan Ryerson joined an expert panel for a Rail-Volution webinar, "Communicating to a Changing Rider Base." The webinar addressed changing ridership patterns and priorities for transit service delivery.
- *March 14, 2022 - [SXSW Panel on Driving AV Technology Forward for Citizens](#)* - Mobility21 UTC Director Raj Rajkumar participated in the South by Southwest conference, along with Mobility21 Advisory Council member Yassmin Gramian, PennDOT Secretary of Transportation, Courtney Ehrlichman of Panasonic Smart Mobility, and Andrew Woelfling of Argo AI to discuss "Driving AV Technology Forward for Citizens." The panel highlighted how the public, private, and academic sectors in Pennsylvania are working together to grow the autonomy industry safely in the state.
- *March 4, 2022 - [UMass INFORMS Speaker Series Features Destenie Nock](#)* - Mobility21 UTC researcher Destenie Nock presented at the OIM and UMass INFORMS Speaker Series. Dr. Nock presented a study that investigates bus ridership from April to September of 2020 and the risk of contracting COVID-19 on the bus by combining a transportation data analysis and an epidemiological model of COVID-19 risk.
- *March 3, 2022 - [Mobility21 Research Highlighted in Course for Building Managers](#)* - The Building Owners and Managers Association Pittsburgh Chapter hosted a continuing education credit course for property managers, owners and brokers real estate license renewal. In a session on drone technology, Stan Caldwell presented his UTC research on industry trends and potential impacts of advanced air mobility and was joined by Pittsburgh based drone company AERAS, who discussed their innovative drone applications for buildings.

- *February 28, 2022 - [Remaking Cities by Design Interviews Chris Reed of Stoss Landscape Urbanism](#)* - Mobility21 UTC researcher Ray Gastil interviewed Chris Reed of Stoss Landscape Urbanism on Remaking Cities Institute on Instagram Live to discuss how a commitment to urbanism can help to rethink and remake cities.
- *January 25, 2022 - [Endgame: Decarbonization-How Do We Get There Features Mobility21 UTC Researcher](#)* - Dr. Jeremy Michalek, Mobility21 UTC researcher, and Director of Vehicle Electrification Group joins a panel discussion on national decarbonization strategies for The Block Center for Technology and Society and the Scott Institute for Energy Innovation.
- *January 19, 2022 - [6th Annual Smart Cities Technology International Symposium Focuses on Infrastructure](#)* - Mobility21 UTC researcher and Community College of Allegheny County Professor of Advanced Technology Justin Starr participated in a panel discussion about the risks and security concerns where AI meets critical infrastructure at the 6th Annual Smart Cities Technology International Symposium. Metro21 Executive Director Karen Lightman also hosted a panel at the symposium entitled "*Smart Isn't Smart Enough - Redefining the Smart City Through Co-Creative Partnership*," which focused on creating equitable and sustainable communities for all.
- *December 28, 2021 - [Latest Consequential Podcast on Transit of the Future Features UTC Researchers](#)* - This episode looks at how the Bipartisan Infrastructure Plan's historic investment in public transit and other targeted policymaking can build the transportation systems of the future, featuring UTC researchers Stan Caldwell and Corey Harper, as well as Eric Goldwyn, and Anthony Foxx. Consequential is a Heinz College of Carnegie Mellon University podcast that looks at the human side of technological change and develops meaningful plans of action for policymakers, technologists and everyday people to build the kind of future that reduces inequality, improves quality of life and considers humanity.
- *December 17, 2021 - [Traffic21 Director Presents Keynote to Chinese Overseas Transportation Association](#)* - Chris Hendrickson, Director of the Traffic21 Institute and researcher in the Mobility21 UTC, presented a keynote talk on "Recent ASCE Journal of Transportation Engineering Editorials" for the Chinese Overseas Transportation Association during the opening ceremony of the 21st COTA International Conference of Transportation Professionals.
- *November 23, 2021 - [Pittsburgh Coro Fellows Learn How Transportation Research Impacts Public Policy](#)* - The 2021-2022 Group of Fellows from the Coro Center for Civic Leadership (Pittsburgh) conducted an "Established Nonprofit Sector Leaders Interview" with Mobility21 Executive Director Stan Caldwell to learn how transportation research, education and technology transfer initiatives from University Transportation Centers impact public policy.
- *November 19, 2021 - [New Executive Education Program Introduced on ICT Policy](#)* - Mobility21 UTC researcher Jon Peha announced a new executive education course on Information and Communication Technology policy to leaders in developing countries through the CMU Department of Engineering & Public Policy.
- *November 4, 2021 - [Leadership Pittsburgh XXXVIII Cohort Visits CMU Campus](#)* - Mobility21 UTC researchers and CMU faculty welcomed the Leadership Pittsburgh XXXVIII cohort to the CMU campus for their class session on infrastructure. They participated in a program highlighting how CMU is leading new development of infrastructure technologies to encourage livability and sustainability (ATLAS moonshot) and is illuminating the social inequities posed by prior infrastructure decisions.
- *November 2, 2021 - [Mobility21 UTC Researcher Erick Guerra Discusses Dynamic-Priced Parking with Axios](#)* - Mobility21 UTC researcher and University of Pennsylvania professor Erick Guerra provided his expertise to Axios on the possibilities of dynamic-priced parking in Philadelphia.
- *October 25, 2021 - [Remaking Cities Institute Hosts Karina Ricks to Discuss "Taking Care: Towards Mobility Justice"](#)* - The CMU Remaking Cities Institute Director, and Mobility21 Researcher, Ray Gastil hosted Karina Ricks, Acting Associate Administrator for Research, Demonstration and Innovation with the Federal Transit Administration to lead a talk focused on the connection between transportation mobility and social mobility, underscoring the importance of connecting communities to better opportunities through better access to transit and other forms of mobility.
- *October 21, 2021 - [Local Government Commission Hosts Inaugural Symposium](#)* - Traffic21 Executive Director Stan Caldwell moderated a panel alongside Metro21 Executive Director Karen Lightman at the Inaugural Local Government Commission Symposium to discuss "Solving Real-World Problems through Collaboration and Innovation with Municipal and Equity Partners" and featured: Kimberly Lucas, Acting Director, Department of Mobility & Infrastructure, City of Pittsburgh Kelly Maurer, Director of Public Works, Cranberry Township.
- *October 7, 2021 - [Ray Gastil Presents "Green Cities: Pittsburgh"](#)* - Mobility21 UTC researcher and Carnegie Mellon University Remaking Cities Institute Director Ray Gastil presented "Green Cities: Pittsburgh" in the Green Cities 2021 Series with the Consortium for Sustainable Urbanism.

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:

- *March 15, 2022 - [Mobility21 Director Joins Insight LiDAR's Technical Advisory Board](#)* - Mobility21 UTC Director Raj Rajkumar has been named to Insight LiDAR's Technical Advisory Board to support their development of next-generation, long-range FMCW LiDAR for Advanced Driver Assistance Systems and the Autonomous Vehicles market.
- *January 12, 2022 - [Transportation Demand Management Showcase at TRB Annual Meeting](#)* - On January 10, Mobility21 Program Manager Lisa Kay Schweyer presided over the Transportation Demand Management Showcase at the 2022 TRB Annual Meeting. The poster session highlighted new TDM strategies, advanced modeling techniques, and innovative visions

for the next generation of demand management, both from employer and worker perspectives. Schweyer is a new member of the TRB TDM Committee and she also participated in the committee meeting held January 11.

- *December 21, 2021 - National Academies Releases New Report on Improving Safety of 'Duck Boats'* - The National Academies released a new report on improving safety of 'Duck Boats' used for commercial passenger service, called Options for Improving the Safety of DUKW Type Amphibious Vessels. The review of the report was overseen by Traffic21 Director and Mobility21 researcher, Chris Hendrickson, and Craig Philip of Vanderbilt University.
- *December 9, 2021 - Mobility21 Presents at Transportation Engineering & Safety Conference* - Mobility21 presented the Transportation Engineering and Safety Conference session "Welcome to the Smart Cities – Managing AI in Transportation." This conference session provided a preview of several topics included in the executive education session, including an overview of technology and AI impacts in transportation today, AI and predictive analytics and how to make a better decision with transportation data, and equitably applying AI for safe and efficient transportation. Lisa Kay Schweyer, Program Manager for Mobility21 moderated the session. The other UTC speakers included: Sean Qian on AI and Predictive Analytics: How to Make Better Decisions with Transportation Data, Allanté Whitmore on Equitably Applying AI for Safe and Efficient Transportation, and Stan Caldwell on the Technology and AI Impacts in Transportation Today.
- *December 8, 2021 - UTC Researchers Attend ITS America Annual Meeting in Charlotte* - UTC researchers attended the ITS America annual meeting in Charlotte this week. CMU Mechanical Engineering Ph.D. Candidate and Swartz Center Innovation Fellow Matt Guttenberg presented his research with Professor Venkat Viswanathan on their INCEPTS software, which optimizes EV charging and is poised for commercialization. Mobility21 Executive Director Stan Caldwell presented annual accomplishments of the Emerging Technologies Standing Committee to the ITSA Board, presented his UTC research in an executive session titled "Equity, Climate, Safety and Infrastructure for Automated and Autonomous Mobility Deployments" and participated in the quarterly meeting of the Smart Belt Coalition.
- *November 11, 2021 - Traffic21 Director Reviewing CUTC Doctoral Dissertation Nominations* - Chris Hendrickson, Director of the Traffic21 Institute and a Mobility21 UTC researcher, is part of a panel reviewing doctoral dissertation nominations for the Council of University Transportation Centers' Charles E. Wootan Memorial Award.
- *November 4, 2021 - CAMMSE Research Symposium Features Traffic21 Director as Keynote Speaker* - Traffic21 Director Chris Hendrickson delivered the keynote presentation during The University of North Carolina at Charlotte Center for Advanced Multimodal Mobility Solutions and Education Fourth Annual Research Symposium.
- *October 4, 2021 - Chris Hendrickson Re-Appointed to the TRB Executive Committee* - Traffic21 Director Chris Hendrickson has been re-appointed to the Transportation Research Board's Executive Committee for 2022-2025.

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 4,368 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. **629 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. Four 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:

- *Real-Time Traffic Analytics at Intersections*, Srinivasa Narasimhan
- *Synthesis of Research Results and Technology Trends to Inform Federal, State, Regional and Local Policies for Smart Mobility of People and Goods: Phase 3,* Stan Caldwell and Chris Hendrickson
- *Platooning for Improved Safety and Efficiency of Semi-Trucks (PISES – III),* Venkat Viswanathan
- *Accessibility with GetGoing,* Maxine Eskenazi, Alan Black, and Yulan Feng
- *Smart Glasses for Improving Mobility of Low Vision People (Phase Two)*, Yang Cai
- *Development of a Safe, Profitable, and Fair Robotaxi Deployment Strategy*, Ding Zhao
- *Analysis of the Potential for Micromobility to Replace Short Car Trips in Urban Areas and Impacts on Congestion,* Corey Harper
- *Joint Optimization of School Bus Routes and Last-Mile Services,* Peter Zhang
- *Smart Right-of-Way Permitting System for the City of Pittsburgh: Coordination, Pricing and Enforcement,* Sean Qian

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 November 2022 and the Fourth Annual National Mobility Summit in 2023.

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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 193 deployment partners.

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

Partner Organization Name	Location	Financial support	In-kind support	Facilities	Collaborative research	Personnel exchanges
Commercial Vehicle Safety Alliance	Maryland		X		X	
The Autoware Foundation	Japan		X		X	
University of Pittsburgh, School of Education	Pennsylvania				X	
Michigan School of Education	Michigan				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 October, AFL-CIO Technology Institute Director Amanda Ballantyne joined the Mobility21 UTC Advisory Council as its newest member. The Advisory Council listing can be found on our website.

On November 3, 2021, the Advisory Council assembled for their annual meeting. Mobility21 UTC Director, Raj Rajkumar welcomed the group and provided an overview of updates of activities and plans. The remaining time was spent in roundtable discussions, where council members were joined by Mobility21 UTC researchers and focused on: *Equity/Justice and Mobility* and *Environment/Climate Change and Mobility*.

On November 4, 2021, the Traffic21/Mobility21 University Transportation Center Deployment Partner Consortium Symposium kicked off with the Mobility21 UTC Director, Raj Rajkumar, providing a welcome and an overview of updates on activities and plans at the Mobility21 National University Transportation Center. The keynote speaker for 2021 Symposium was Yassmin Gramian, Secretary of Transportation, Pennsylvania Department of Transportation.

The Symposium's first panel focused on *Equity/Justice and Mobility*. The panel was moderated by Stan Caldwell and featured:
- Ben Bear, CEO, Spin
- Carol Lewis, Chair, Transportation Research Board, Equity, Diversity and Inclusion Committee
- Irene Marion, Director, Department of Civil Rights, DOT
- Beth Osborne, Director, Transportation for America

The second panel focused on *Environment/Climate Change and Mobility*, was moderated by Chris Hendrickson and featured:
- Rachael Nealer, Deputy Director for Transportation Technology and Policy, White House Council on Environmental Quality
- Rohan Patel, Senior Global Director, Public Policy and Business Development, Tesla
- Kelsey Owens, Environmental Protection Specialist, US Department of Transportation

The Symposium also featured **7** research and academic project presentations, comprising the UTC Academic and Research Showcase. The projects allowed for a brief Q&A with the researchers upon the conclusion of their video presentation. Over 130 people from academia, government, community and industry registered to attend the symposium.

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

Publications, *conference papers, and presentations*

Title	Citation	Type	Date
How to Make Sense of Bus Transit Automation? Considerations for policy makers on the future of human-automation teaming in the transit workforce	Martelaro, N.*, Fox, S.*, Forlizzi, J., Rajkumar, R., Hendrickson, C., Caldwell, S. 2022. "How to Make Sense of Bus Transit Automation? Considerations for policy makers on the future of human-automation teaming in the transit workforce." Traffic21.	Other	3/30/2022
Clustering Heavy Duty Truck Failure Modes for Proactive Safety Inspection and Efficient Operations of Commercial Vehicle Fleets	Yuan, C., and Tang, P. (2022). "Clustering Heavy Duty Truck Failure Modes for Proactive Safety Inspection and Efficient Operations of Commercial Vehicle Fleets." Proceeding of the 7th Annual UTC Conference for the Southeastern Region, Evangelos I. Kaisar, ed., United States Department of Transportation (USDOT), Boca Raton, FL, 1.	Other	3/25/2022
What the heck is a choice rider? A theoretical framework and empirical model	Guerra, E. (2022). What the heck is a choice rider? A theoretical framework and empirical model. Journal of Transport and Land Use, 15(1), 165–182. https://doi.org/10.5198/jtlu.2022.2096	Trade/ Professional	2/25/2022
Congestion and environmental impacts of short car trip replacement with micromobility modes	Fan, Z., & Harper, C. D. (2022). Congestion and environmental impacts of short car trip replacement with micromobility modes. Transportation Research Part D: Transport and Environment, 103, 103173.	Peer-reviewed Journal	2/15/2022
Deriving Spatial Policies for Overtaking Maneuvers with Autonomous Vehicles	J. Bhargav, J. Betz, H. Zehng and R. Mangharam, "Deriving Spatial Policies for Overtaking Maneuvers with Autonomous Vehicles," 2022 14th International Conference on COMmunication Systems & NETworkS (COMSNETS), 2022, pp. 859-864, doi: 10.1109/COMSNETS53615.2022.9668548.	Peer-reviewed Journal	1/4/2022
Deriving Spatial Policies for Overtaking Maneuvers with Autonomous Vehicles	J. Bhargav, J. Betz, H. Zehng and R. Mangharam, "Deriving Spatial Policies for Overtaking Maneuvers with Autonomous Vehicles," 2022 14th International Conference on COMmunication Systems & NETworkS (COMSNETS), 2022, pp. 859-864, doi: 10.1109/COMSNETS53615.2022.9668548.	Peer-reviewed Journal	1/4/2022
Options for Improving the Safety of DUKW Type Amphibious Vessels National Academies of Sciences, Engineering, and Medicine. 2021.	Options for Improving the Safety of DUKW Type Amphibious Vessels. Washington, DC: The National Academies Press. https://nap.nationalacademies.org/catalog/26447/options-for-improving-the-safety-of-dukw-type-amphibious-vessels	Peer-reviewed Journal	12/20/2021
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	11/3/2021
In-depth analysis of crash contributing factors and potential ADAS interventions among at-risk drivers using the SHRP 2 naturalistic driving study. Traffic Injury Prevention	Seacrist, T., Maheshwari, J., Sarfare, S., Chingas, G., Thirkill, M., & Loeb, H. S. (2021). In-depth analysis of crash contributing factors and potential ADAS interventions among at-risk drivers using the SHRP 2 naturalistic driving study. Traffic Injury Prevention.	Trade/ Professional	11/1/2021
The Impact of driver distraction and secondary tasks with and without other co-occurring driving behaviors on the level of road traffic crashes. Accident Analysis & Prevention	Jazayeri, A., Martinez, J. R. B., Loeb, H. S., & Yang, C. C. (2021). The Impact of driver distraction and secondary tasks with and without other co-occurring driving behaviors on the level of road traffic crashes. Accident Analysis & Prevention, 153, 106010	Trade/ Professional	11/1/2021
Fleet Sizing and Allocation for On-demand Last-Mile Transportation Systems	Shehadeh, K. S., Wang, H., & Zhang, P. (2021). Fleet sizing and allocation for on-demand last-mile transportation systems. Transportation Research Part C: Emerging Technologies, 132, 103387.	Peer-reviewed Journal	10/11/2021
Stress Testing Autonomous Racing Overtake Maneuvers with RRT	Bak, S., Betz, J., Chawla, A., Zheng, H., & Mangharam, R. (2021). Stress Testing Autonomous Racing Overtake Maneuvers with RRT. arXiv preprint arXiv:2110.01095.	Other	10/3/2021
Human Detection, Classification & Tracking in Context of Transit Systems	Robotics Institute Summer Scholars working papers journal, Volume 9, pp. 226-230, Fall 2021	Other	10/1/2021
Detecting and Classifying Waste Bin Garbage Levels Along Transit Bus Routes	Robotics Institute Summer Scholars working papers journal, Volume 9, pp. 253-258, Fall 2021	Other	10/1/2021
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 Journal	9/30/2021 *
Learning-'N-Flying: A Learning-Based, Decentralized Mission-Aware UAS Collision Avoidance Scheme	Alëna Rodionova, Yash Vardhan Pant, Connor Kurtz, Kuk Jang, Houssam Abbas, and Rahul Mangharam. 2021. Learning-'N-Flying: A Learning-Based, Decentralized Mission-Aware UAS Collision	Peer-reviewed Journal	9/22/2021 *

	Avoidance Scheme. ACM Trans. Cyber-Phys. Syst. 5, 4, Article 35 (October 2021), 26 pages. DOI:https://doi.org/10.1145/3447624		
Learning-'N-Flying: A Learning-Based, Decentralized Mission-Aware UAS Collision Avoidance Scheme	Alëna Rodionova, Yash Vardhan Pant, Connor Kurtz, Kuk Jang, Houssam Abbas, and Rahul Mangharam. 2021. Learning-'N-Flying: A Learning-Based, Decentralized Mission-Aware UAS Collision Avoidance Scheme. ACM Trans. Cyber-Phys. Syst. 5, 4, Article 35 (October 2021), 26 pages. DOI:https://doi.org/10.1145/3447624	Peer-reviewed Journal	9/22/2021 *
Faraway-Frustum: Dealing with Lidar Sparsity for 3D Object Detection using Fusion	Haolin Zhang, Dongfang Yang, Ekim Yurtsever, Keith A. Redmill and Umit Ozguner, "Faraway-Frustum: Dealing with Lidar Sparsity for 3D Object Detection using Fusion," 2021 IEEE International Intelligent Transportation Systems Conference (ITSC), 2021, pp. 2646-2652, doi: 10.1109/ITSC48978.2021.9564990.	Other	9/19/2021 *
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	9/9/2021 *
FADS: A framework for autonomous drone safety using temporal logic-based trajectory planning	Yash Vardhan Pant, Max Z. Li, Alena Rodionova, Rhudii A. Quaye, Houssam Abbas, Megan S. Ryerson, Rahul Mangharam, FADS: A framework for autonomous drone safety using temporal logic-based trajectory planning, Transportation Research Part C: Emerging Technologies, Volume 130, 2021, 103275, ISSN 0968-090X, https://doi.org/10.1016/j.trc.2021.103275.	Peer-reviewed Journal	9/1/2021 *
FADS: A framework for autonomous drone safety using temporal logic-based trajectory planning	Yash Vardhan Pant, Max Z. Li, Alena Rodionova, Rhudii A. Quaye, Houssam Abbas, Megan S. Ryerson, Rahul Mangharam,FADS: A framework for autonomous drone safety using temporal logic-based trajectory planning, Transportation Research Part C: Emerging Technologies, Volume 130, 2021, 103275.	Peer-reviewed Journal	9/1/2021 *
Impact of TNC on travel behavior and mode choice: a comparative analysis of Boston and Philadelphia in 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 Journal	8/9/2021 *
Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving	Mert Koc, Ekim Yurtsever, Keith Redmill, and Umit Ozguner, "Pedestrian Emergence Estimation and Occlusion-Aware Risk Assessment for Urban Autonomous Driving", 2021 IEEE Intelligent Transportation Systems Conference, 19-21 Sept. 2021, p. 292-297.	Other	7/6/2021 *
Integrating deep reinforcement learning with model-based path planners for automated driving	Ekim Yurtsever, Linda Capito, Keith Redmill, Umit Ozguner, "Integrating deep reinforcement learning with model-based path planners for automated driving", 2020 IEEE Intelligent Vehicles Symposium , p. 1311-1316.	Peer-reviewed Journal	6/20/2021 *

* Not previously reported.

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

Title	Event	Type	Attended	Date
Clustering Heavy Duty Truck Failure Modes for Proactive Safety Inspection and Efficient Operations of Commercial Vehicle Fleets	The 7th Annual UTC Conference for the Southeastern Region	Conference-Academic	100	3/25/2022
Learn to drive (and Race!) autonomous vehicles	IEEE Smart Cities	Symposium-Professional	150	3/25/2022
Adjustability in Robust Linear Optimization	INFORMS 2022 Optimization Society Conference	Conference-Academic	30	3/14/2022
COVID Impacts on Transportation: Buses and Food Delivery	INFORMS Student Chapter Speaker Series	Seminar-Academic	30	3/4/2022
Advance Air Mobility Considerations for Building Managers	The Building Owners and Managers Association (BOMA) Pittsburgh Chapter hosted a continuing education credit course	Workshop-Professional	100	3/3/2022
Advancing Towards a Smarter and More Sustainable Transportation System	Duquesne Environmental Science Seminar	Seminar-Academic	15	2/18/2022
Monitoring Roadway Vehicle Miles Traveled using Video Imagery from Transit Buses in Operational Use	Smart Mobility Connection Seminar	Seminar-Academic	25	2/11/2022
Monessen Mobility Project	Co-PI Robert Tamburo presented project to Mayor and City Council	Other-Academic	20	1/27/2022
Dynamic O-D estimation	Meeting with FHWA Turner Fairbanks Research Center	Other-Professional	4	1/21/2022

Recent ASCE Journal of Transportation Engineering Editorials	21st Chinese Overseas Transportation Association (COTA). International Conference of Transportation Professionals.	Conference-Professional	200	12/17/2021
Emerging Transportation Technology and Industry Trends	Automotive Technician Scholarship Contest & Student / Instructor Transportation Update	Workshop-Academic	50	12/16/2021
What can we learn from autonomous racing?	Lockheed Martin Robotics Seminar, University of Maryland	Seminar-Academic	66	12/10/2021
Managing AI in Transportation	Penn State Transportation Safety and Engineering Conference	Conference-Professional	100	12/9/2021
Landscape Analysis: Transit and Autonomy	Presentation to TWU, ATU, AFL-CIO	Other-Professional	10	12/8/2021
Empirical Monitoring of Vehicle Miles Traveled Using Available Bus-mounted Camera Video Imagery before and during the Covid-19 Pandemic	Ohio Transportation Engineering Conference	Conference-Professional	35	10/27/2021
Revolution in transportation - AI and infrastructure	Transportation class	Other-Academic	30	10/26/2021
Optimality Criteria of Constant and Affine Policies in Adjustable Robust Optimization	INFORMS Annual Meeting	Conference-Academic	50	10/24/2021
Learn to drive (and Race!) autonomous vehicles	Embedded Systems Week (ESWeek 2021)	Symposium-Academic	120	10/7/2021
What can we learn from autonomous racing?	Robotics Seminar, GRASP Lab	Seminar-Academic	42	10/1/2021

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: 629
http://mobility21.cmu.edu/	The Carnegie Mellon University's Mobility21 National University Transportation Cent website	New Posts: 629
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: 240
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: 98 Views: 891
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: 1,200 Following: 1,729

Technologies or techniques
- A new course website for anyone interested in teaching autonomous racing as a way to explain tradeoff in safety and performance with autonomous vehicles was published as part of the F1/10 Autonomous Racing Course and Competition project. https://courses.f1tenth.org/
- The project, Modeling the impact of dynamic tolling in large-scale regional networks: a case study for DVRPC led to a new modeling framework for data-driven multi-modal mesoscopic network flow and an extended simulation framework on passenger and freight transportation to include the tolling facilities, particularly arbitrary toll locations and costs in general.
- A new data set has been curated and documented, to reflect the transportation gap in low-income communities across the United States as part of the Demand learning and supply optimization for last-mile transportation in disadvantaged neighborhoods project. The data set, data description, and code related to the data publicly available through GitHub: https://github.com/peteryz/employment-od.

Inventions, patent applications, and/or licenses
Three intellectual property disclosures were filed:
- WALT: Watch and Learn Time-lapse dataset, Dinesh Reddy Narapureddy; Srinivasa Narasimhan; Robert Tamburo
- Control of multi-drone fleets with temporal logic objectives. US20200348696A1, Rahul Mangharam.

- "Video content retrieval system." U.S. Patent 11,023,523, Hauptmann, Alexander G., Lu Jiang, and Po-Yao Huang.

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	Current Reporting Period
Output #1	Annual Number of Journal Publications	35	24
Output #2	Annual Number of Research Pilot Deployments	10	4

Please see "Section #3 Publications" for publications.

Some examples of these research pilot deployments include:
- Researchers from Carnegie Mellon University's Robotics Institute, led by Kris Kitani, and involving UTC researcher Sebastian Scherer, are working with Shimizu Corp., a Tokyo-based construction and civil engineering company to enable automated systems to more accurately detect and monitor cracks in reinforced concrete.
- Two industry collaborators (CompuSpections and Clarience Technologies) are using preliminary findings from project, Towards Data-Driven and Continuous Safety Inspection of Commercial Trucks and Trailers, to improve their hardware and software platforms.

> **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	Current Reporting Period
Outcome #1	Annual Number of Media Stories Referencing UTC Research, Faculty, or Spinoff	**80**	45
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**	41

Some examples of the Media Stories Referencing UTC Research, Faculty, or Spinoff:
- *March 23, 2022* - **GM bets $3.5 billion more on self-driving tech unit as SoftBank exits** - "SoftBank Group Corp 's Vision Fund exited its bet on General Motors self-driving car subsidiary Cruise as the auto giant upped the ante, investing another $3.45 billion in the loss-making unit... The SoftBank exit comes as Cruise awaits a regulatory permit to allow it to charge riders for a driverless ride-hailing service launched in San Francisco. 'Based on the experience that we have seen from Alphabet 's Waymo in Arizona, the revenue that you will generate from that deployment will be very, very small,' said Raj Rajkumar, Director of Mobility21 and professor of electrical and computer engineering at Carnegie Mellon University." *Link to Article*
- *March 22, 2022* - **Tired of waiting for driverless vehicles? Head to a farm** - "Beginning this fall, green 14-ton tractors that can plow day or night with no one sitting in the cab, or even watching nearby, will come off the John Deere factory assembly line in Waterloo, Iowa, harkening the age of autonomous farming… "I'm glad to see they're coming out and will stimulate the other technologies," said Raj Rajkumar, a professor at Carnegie Mellon University and an expert in autonomous cars... But, Rajkumar notes, tractors have it easier because they don't need to contend with other vehicles, pedestrians or the complexities of an urban scene. Tractors can make use of consistent GPS data, unlike cars that can lose contact traveling through tunnels or amid tall buildings." *Link to Article*
- *March 14, 2022* - **Self-driving cars could transform the world in unexpected ways** - "Another consideration to make before self-driving cars are fully deployed – how can we make sure their use is equitable? "There are three key areas that we need to focus on: policy making, data sharing, and technology deployment," Dr. Corey Harper, an Assistant Professor of Civil & Environmental Engineering at Carnegie Mellon University… "We make a lot of decisions without considering some of these under-served populations," Harper said. "Moving forward, policy data in the technologies we're deploying is going to be very important for us to get towards that more sustainable, smart city that we all envision."" *Link to Article*

- *March 11, 2022* - **To Reduce Traffic Congestion, Increase Local Micromobility** - "The big takeaways are that micromobility could decrease congestion, especially on highly congested corridors. But you're going to need wide-scale bike lane deployment," said Corey Harper, assistant professor of civil and environmental engineering at Carnegie Mellon University and one of the authors of the study. It's estimated that about 50 percent of car trips in urban areas are three miles or less in length, making them a possible candidate for replacement with other modes." *Link to Article*

- *March 2, 2022* - **Peduto administration pushed modern private transportation, development that hurt public transit, study says** - "Pittsburgh has concentrated too much on innovative transportation options that benefit higher-income residents instead of meeting the needs of those who need public transit the most, a study released Thursday by Pittsburghers for Public Transit said... The 25-page study, "Mobility For Who? Rebuilding Bridges to Transportation Justice," was performed by Tech4Society, a student group at Carnegie Mellon University that supports civic organizations, and PPT. They hosted an hour-long panel discussion after its release." *Link to Article*

- *March 1, 2022* - **Transportation Secretary Pete Buttigieg Says Pittsburgh Will Play Role In Switch To Electric Vehicles** - "In his interview with Secretary Buttigieg, KDKA money editor Jon Delano noted three things that might encourage people to buy electric vehicles: more charging stations so you can travel anywhere, a much shorter time to charge or fill up with electricity and guaranteeing it's cheaper to drive an electric vehicle over a gas one... The Transportation Secretary sees Pittsburgh as playing a key role in the nation's changeover to electric vehicles. 'Everything from the kind of research jobs connected with Carnegie Mellon which is at the forefront of a lot of transformation and innovation to union electrical worker jobs installing these electric charging stations to jobs even in manufacturing them in the first place,' he says. 'A place with a proud industrial tradition as well as amazing educational and medical institutions, there is no question in my mind that Pittsburgh is positioned to be at the forefront of the electric vehicle revolution.'" *Link to Article*

- *February 18, 2022* - **Fujitsu to develop 'social digital twin'** - "Japanese technology company Fujitsu and researchers at Carnegie Mellon University are collaborating on the development of a 'social digital twin' that could be used to model traffic, economic activity, and climate and public health measures... A project through CMU's Mobility Data Analytics Center (MAC) will use real-world data, including input of traffic regulations and the movement of vehicles, to evaluate the effectiveness of measures designed to dynamically estimate and control traffic flow. " *Link to Article*

- *February 1, 2022* - **Rich Fitzgerald and Farnam Jahanian: Autonomous vehicle testing bill essential to regional economy** - "The Pennsylvania Senate Transportation Committee will soon consider Senate Bill 965 to set rules of the road for self-driving vehicles. This would cover basic topics like insurance, registration, inspection and meeting federal safety standards — just the same as you'd expect for a vehicle an individual would drive…In short, SB 965 aims to ensure the continued safe development of this homegrown industry that is already creating thousands of jobs in Pennsylvania. We applaud the work of SB 965's author, Sen. Wayne Langerholc, R-Cambria, for collaborating with PennDOT Secretary Yasmin Gramian to write a bill that is supported by many regional leaders including Sen. Jay Costa, D-Allegheny, Sen. Wayne Fontana, D-Allegheny, Sen. Pat Stefano, R-Somerset, Sen. Devlin Robinson, R-Allegheny/Washington, and Sen. Elder Vogel, R-Beaver." *Link to Article*

- *January 26, 2022* - **Why Pittsburgh's New Airport Will Be the Right Size for the Future** - "The New York Times called it the "airport of the future" — the 1.82 million-square-foot terminal complex at Pittsburgh International Airport that opened to great fanfare in 1992. With its landside and airside buildings, underground tram and novel, X-shaped gate courses, the terminal became a model for other airports around the world... The Allegheny County Airport Authority has a memorandum of understanding with Carnegie Mellon University to help identify innovations or new technology — which could include autonomous shuttles to extended parking lots — but nothing has been decided. " *Link to Article*

- *January 21, 2022* - **State legislation seeks to expand driverless cars on the road** - ""This legislation is critical from two different perspectives: One is a competitiveness angle, both internationally and domestically, and the other requires a particular nature where testing has to happen on public roads with real traffic," says Raj Rajkumar, the co-director of General Motors-Carnegie Mellon Vehicular Information Technology Collaborative Research Lab. Rajkumar says it's much easier to test and work with developers when they're all in the same state, so it would benefit Pennsylvania to create laws that are more friendly to autonomous vehicle testing. "If it is being permitted in 39 states, but not in the brain and heart of autonomous vehicle technology development, that doesn't make sense," says Rajkumar. He says as technology improves, it needs to be tested in real conditions. " *Link to Article*

- *January 14, 2022* - **There's no evidence electric vehicles fare worse than gas-powered cars in long traffic jams** - "Jeremy Michalek, co-founder of the Vehicle Electrification Group and an engineering professor at Carnegie Mellon University, said cold weather can cut an electric vehicle's range, in miles, by as much as half, citing a study he co-authored. But range is a function of a moving car. While idling, a gas-powered vehicle, assuming a full tank of 15 to 18 gallons, could take anywhere from about a day to up to a week to burn through that gas, Michalek said. A stationary Tesla Model 3, he said, could exhaust its battery in as little as eight hours or as much as a few days, depending on the wattage of the heater. So which would fare better stuck in a daylong traffic jam like the one in Virginia? It depends, Michalek said, on how comfortable someone needs to be, whether the car has a heat pump and other factors. " *Link to Article*

- *January 5, 2022* - **How Digital Twins Are Transforming Manufacturing, Medicine and More** - In Pittsburgh, Ding Zhao, an assistant professor of mechanical engineering at Carnegie Mellon, has been working with carmakers to use digital twins to improve the safety of self-driving vehicles. In his lab, he leverages vast quantities of data collected from real tests of self-driving cars to build complex digital-twin simulators…"Real-world testing is too expensive and

sometimes not even effective," Zhao says. Digital twins are also being used in other complex and potentially dangerous machines, from nuclear reactors in Idaho to wind turbines in Paris. *Link to Article*

- *January 3, 2022* - **Why autonomous vehicles won't be taking over Ontario's city streets in 2022** - " "We are way far from that level where a machine can drive like humans in any conditions, " said Amir Khajepour, a professor of mechanical and mechatronics engineering at the University of Waterloo. "Whether that will happen in my lifetime, I 'm not sure. " The biggest, according to Khajepour, is making machines that mirror brain functioning when we drive, and that is far from easy. Add in debates about insurance and ethics, and it's clear there's a lot more to the industry than just technology... A 2020 paper published by Carnegie Mellon University researchers found driverless cars use more energy than cars requiring drivers, which reduced driving range and required more charging. Researchers are now looking at how drivers feel about the decreased range." *Link to Article*

- *December 20, 2021* - **PennDOT will provide $1.4 million for Pittsburgh Pedestrian Wayfinding Project** - "City officials are moving forward on a project to help residents and visitors more easily navigate four business districts in Pittsburgh. The Pittsburgh Pedestrian Wayfinding project will set up 50 kiosks and 110 directional signs … On Tuesday, Mr. Peduto introduced a resolution to City Council to provide $1.4 million to the project. The resolution would authorize a reimbursement agreement with the Pennsylvania Department of Transportation, through the Southwest Pennsylvania Commission's Transportation Alternatives Set-Aside program. The initiative provides funding for programs and projects defined as "transportation alternatives," including things like off-road pedestrian and bicycle facilities, environmental mitigation and recreational trail projects." *Link to Article*

- *December 20, 2021* - **AI Is Helping to Stop Animal Poaching and Food Insecurity This professor is using game theory to tackle these problems** - "When Fei Fang was a graduate student she was introduced to game theory— mathematical models that describe strategic interactions among rational decision-makers.... She has combined the modelling technique with machine learning to thwart terrorist attacks and reduce animal poaching. For Fang's work in the field, she was named one of IEEE Intelligent Systems magazine's "AI's 10 to Watch in 2020." Fang, an assistant professor of computer science at Carnegie Mellon, is now working with 412 Food Rescue, a nonprofit in Pittsburgh, to improve its system for alerting volunteers when surplus food is available for pickup." *Link to Article*

- *December 17, 2021* - **Why The U.S. Infrastructure Crisis Will Get Worse In 2022 Before It Gets Better** - "Karen Lightman is the executive director of the Metro21 Smart Cities Institute at Carnegie Mellon University. She said that, "My hope is that the [recently approved federal funding] will also support more collaboration with private and non-profit sectors. The funding from the U.S. government is meant to be a catalyst for other private sector funding, whereby it reduces the risk and will encourage developers to make improvements on their properties, for companies to grow and expand. "I look for infrastructure investments that are mindful of sustainability goals such as focusing on electrification and the use of renewable sources of energy (wind, solar, etc.) and also is focused on enhancing digital infrastructure such as equitable deployment of broadband— at the last mile as well as the very-important middle-mile infrastructure needed," she recommended." *Link to Article*

- *December 8, 2021* - **Smart Bandages, Vehicle-Damage Trackers and More Data-Collecting Devices of the Future** - A team of researchers at Stanford University and the University of Michigan is developing sensors that, when placed on the floor, capture and analyze vibrations created by footsteps in a roughly 60-foot range and assign a signature to a person's unique footprint. The sensors can capture a range of nuanced data, such as the force applied by a foot to the ground, so they provide more detailed information about gait balance or other subtle features than wearables, says Hae Young Noh, who initially worked on the project as an associate professor of civil and environmental engineering at Carnegie Mellon and is now at Stanford. *Link to Article*

- *December 6, 2021* - **Level-Setting: Why Drivers Still Don't Understand Self-Driving** - American car and truck owners have shaky knowledge of what constitutes a fully autonomous vehicle (AV), says the 2021 J.D. Power Mobility Confidence Index (MCI), released November 30. In the survey, only 37% of respondents correctly identified Levels 4 and 5 (based on SAE definitions) as referring to fully automated self-driving. In fact, more than half (55%) pointed to descriptions that are actually aligned with more modest driver-assist technology… Raj Rajkumar, a Carnegie Mellon [Mobility21 Director], said he was "not surprised" by the numbers in the survey. "Since AVs are not being sold right now, it's not shocking that people don't know what the levels mean," he said. *Link to Article*

- *December 3, 2021* - **Could Roads Recharge Electric Cars? The Technology May Be Close.** - "To put this in context, inroad charging while driving is not likely to be a broad solution for all electric vehicles, but it could play an important role for some applications," said Jeremy J. Michalek, professor of engineering and public policy and director of the vehicle electrification group at Carnegie Mellon University. *Link to Article*

- *December 1, 2021* - **White House creates new energy division to help craft climate change policies** - The White House has launched a new energy division of its Office of Science and Technology Policy (OSTP) and appointed Sally Benson, a well-known energy expert at Stanford University, to a high-level position to contribute to climate change policy… In addition to Benson, the White House is bringing in another heavy hitter in climate policy circles: Costa Samaras has joined OSTP as the principal assistant director for energy. Samaras most recently served as an associate professor of civil and environmental engineering at Carnegie Mellon University, where he directed an effort to track the country's progress in deploying clean energy." *Link to Article*

- *November 26, 2021* - **EVs need to be lighter, profs urge** - Electric vehicles are too heavy, creating a greater risk for death in a collision, a trio of professors warned in a recent paper. Electric vehicles are growing in popularity with expectations of them making up half of all vehicles sold in the U.S. by 2035. Canada announced a sales ban on fuel-powered vehicles for 2035 as well. But, bulk batteries replacing internal combustion power means that the rest of the vehicle needs to be heavier to provide the needed structural support, say Blake Shaffer, an assistant professor in the department of economics and school of public policy at the University of Calgary, Maximilian Auffhammer, a professor at the University of California, Berkeley and at the National Bureau of Economic Research in Cambridge, Massachusetts, and Constantine Samaras, an associate professor in the department of civil and environmental engineering at Carnegie Mellon University in Pittsburgh. *Link to Article*

- *November 23, 2021* - **Southwestern Pennsylvania Commission plans regional approach to broadband improvements** - The Southwestern Pennsylvania Commission is teaming with Carnegie Mellon University, Allies for Children and others to take a regional approach to improving broadband service in the 10-county area in an effort to take best advantage of $65 billion in recently approved federal infrastructure funds… Through funding from the Hillman Family Foundations, the group has held a series of meetings throughout the region to hear from residents about broadband service and developed a series of maps showing the level of broadband service in each neighborhood. Carnegie Mellon's role will be to help develop the technical needs and craft proposed policies for using the federal funds, said Karen Lightman, executive director of the university's Metro 21: Smart Cities Institute. Funds are expected to pass through the state's Department of Community and Economic Development. *Link to Article*

- *November 22, 2021* - **Billions of dollars in infrastructure bill for charging could supercharge electric vehicle adoption** - Most estimates call for battery and plug-in hybrid EVs being between 30% and 50% of the U.S. fleet by 2030. EV charging is still an emerging business model, and no one yet knows which one is going to be the most successful. That's part of the significance of the $7.5 billion earmarked for EV charging, said Stan Caldwell, executive director of Traffic21 Institute and Mobility21 at Carnegie Mellon University. "This can start to fill the gaps where the market is not going to come quickly," he said. And not just in terms of urban, where market forces have concentrated the stations, vs. suburban and rural areas, he said. There are access equity issues at play as well, around EV owners who may not have access to private charging, Caldwell said. "This is where the money (in the bill) can be strategically placed … Technology is not the biggest hurdle, the business model is," he said. *Link to Article*

- *November 22, 2021* - **Can travel make you happy? Many Americans plan to find out as they plan trips for 2022** - These travel trends could affect your happiness in 2022. It'll be more unpredictable than ever. "I expect restrictions will continue to be very dynamic based on both local COVID vaccination and infection rates," predicts Stan Caldwell, executive director of Carnegie Mellon's Traffic21 Institute. If you like adventure, this may be your year. Prices will rise. As more people book trips, rates will increase. Fare analysts at the airfare app Hopper forecast that ticket prices to Europe will jump about 12% this fall and will average $750 round trip. Roland Rust, a professor at the University of Maryland's Robert H. Smith School of Business, sums up the outlook in a few words: "High prices and fewer options." So book now if you see a rate you can live with because it's not getting any cheaper. *Link to Article*

- *November 15, 2021* - **Flying cars: coming soon to your city?** - Companies creating flying electric taxis are attracting a lot of attention in Silicon Valley these days. But are their nascent lithium-ion powered aircraft actually viable, or are they simply the latest overhyped fad for techno-optimist venture capitalists to sink their copious cash into? A recent report from engineers at Carnegie Mellon University, published in the Proceedings of the National Academy of Sciences, finds that battery-powered urban aircraft are well within the bounds of technological reality and could appear in everyday life surprisingly soon. Co-authors Shashank Sripad and Venkatasubramanian Viswanathan are likely entranced by the notion of flying cars, along with many others excited for future science and technology. But, as scientists, they must temper their optimism with evidence-based skepticism. *Link to Article*

- *October 27, 2021* - **Why this Amazon-owned company is bringing its autonomous vehicles to Seattle** - Seattle residents can start keeping their eyes out for matte black Toyota Highlanders, clad with a wealth of sensors on their roofs, plying the streets of their drizzly city. These retrofitted SUVs belong to Zoox, a self-driving car company owned by Amazon that wants to one day operate autonomous taxi services—like Uber, but with no driver behind the wheel… The industry goal isn't solely to build robo-taxis: other sectors involve autonomous trucking, self-driving shuttles, and the also the kind of driver assistance features that are designed for regular cars, like GM's Super Cruise. Currently, the self-driving car industry has reached a type of "reality phase," says Raj Rajkumar, who directs the Metro21: Smart Cities Institute at Carnegie Mellon University. He noticed a "massive hype cycle" that peaked around 2018, and then industry "doldrums" in 2019. "I think it's beginning to bounce back," he says. "Right now, the hype is a lot more muted." *Link to Article*

- *October 27, 2021* - **Aviation Fans Are Excited About the New Airport Terminal Being Built in Pittsburgh** - Design-wise, the terminal aims to make experience for passengers more efficient, and—dare we say it?—even fun. Features include shorter walking distances for arriving and departing passengers that reduce the time it takes to get from the curb to the plane by 50%, pre- and post-security outdoor terraces adorned with plants, an abundance of greenery indoors, and art displays. Other significant elements include clean air technology and more efficient and faster baggage delivery because the baggage claim devices will be longer, and bags will need to travel less distance from the planes to passengers. And that's just for now. The airport is currently collaborating with Carnegie Mellon to test AI-enabled technologies such as self-driving cars, robots that clean, and autonomous baggage delivery. *Link to Article*

- *October 25, 2021 -* **7 Universities that are pushing the boundaries of autonomous driving** - Big companies and cutting-edge start-ups often dominate the driverless car headlines. But the rapid acceleration of the technology would not be possible without the passionate work of academics around the world. We bring you seven universities that stand out from the rest. …[including]CARNEGIE MELLON UNIVERSITY, PITTSBURGH, USA…*Link to Article*
- *October 22, 2021 -* **For Uber and Lyft, the Rideshare Bubble Bursts** - Piece by piece, the mythology around ridesharing is falling apart. Uber and Lyft promised ubiquitous self-driving cars as soon as this year. They promised an end to private car ownership. They promised to reduce congestion in the largest cities. They promised consistently affordable rides. They promised to boost public transit use. They promised profitable business models. They promised a surfeit of well-paying jobs. Heck, they even promised flying cars. Well, none of that has gone as promised (but more about that later). Now a new study is punching a hole in another of Uber and Lyft's promised benefits: curtailing pollution. *Link to Article*
- *October 19, 2021 -* **Make electric vehicles lighter to maximize climate and safety benefits** - With heavier vehicles on the road, safety becomes even more important. Some vehicles already use cameras, radar and other sensors to avoid collisions by monitoring blind spots and driver alertness. These devices keep vehicles in lanes, adjust speeds, control headlights and apply the brakes if there's a threat of a crash. Deploying such technologies across the entire US vehicle fleet could avoid thousands of fatalities, more than one million crashes and billions of dollars in social costs annually. Old ideas to improve street safety should still be encouraged — speed limits, traffic calming road designs and pedestrian-focused infrastructure. Paris, Brussels, Bilbao and other cities have limited speeds on most roads to 30 kilometres per hour. *Link to Article*
- *October 15, 2021 -* **One way to cut down air pollutants: call an Uber** - Vehicles used for ride sharing apps "can reduce cold-start emissions from internal combustion engines. Vehicles emit far more conventional air pollutants when started 'cold'," researchers wrote. … TNC car trips represent an about 50 percent decline in air pollutants including fine particulate matter mostly because there are less cold starts in between rides. But, there's a catch, says Jeremy Michalek, a professor of engineering and public policy at Carnegie Mellon University and an author of the study. Driving your own car may lower the amount of carbon emissions you emit, since carbon emissions directly correlate with how much fuel is burned. *Link to Article*
- *October 11, 2021 -* **Self-driving cars: The 21st-century trolley problem** - If the goal is to get autonomous driving assistance to the masses, Tesla is closer. If the goal is to have cars that safely drive themselves, Waymo is winning… But by selling its vehicles to the general public, Tesla is able to collect lots of real-world driving data that will be useful in helping solve autonomous driving challenges. Raj Rajkumar, a professor of electrical and computer engineering at Carnegie Mellon University and an autonomous vehicle pioneer, calls Tesla's data collection an "incredible advantage" but warns that data is "part of the answer, but it's not the entire answer." Still, he thinks Waymo ought to collect more of it from regular drivers in regular conditions. "We should be driving them whenever they can drive themselves and, when they do not, humans drive themselves," Rajkumar said. "And for a time we collect experience. We understand what works, what does not work, and we refine." *Link to Article*
- *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." Mr. de Blasio insisted that Vision Zero will eventually transform the city's unruly streets. "It is the right model," he told reporters. "It's changed the behavior of drivers and we need to do a lot more to build upon it." *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. "We've seen a dramatic uptick in commercial curb activity in recent years, and that has only increased more dramatically during the pandemic," said Erin Clark, a policy advisor with the department… With the help of two grants, Pittsburgh is piloting "smart loading zones," which use pole-mounted video cameras, machine learning, a short-term fee structure and an app to help drivers get in and out of loading zones more efficiently. *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):

- *March 17, 2022 - [Pennsylvania Holds Legislative Hearing on HAVs](#)* Mobility21 Executive Director Stan Caldwell attended a field hearing on pending highly automated vehicle legislation with the Pennsylvania House Transportation Committee. The hearing was held at the Westmoreland County Community College Advanced Technology Center at RIDC Westmoreland. Stan had the opportunity to meet with state legislators, as well as labor and industry officials to discuss his UTC research on emerging transportation technology policy.
- *February 16, 2022 - [US State and Commerce Department Delegation Visit on Energy and Smart Cities](#)* - Metro21 Executive Director Karen Lightman presented the work of Metro21, Traffic21, Mobility21 and the Mobility Data Analytics Center to the Bulgarian Deputy Prime Minister Vassilev, the U.S. Embassy of Bulgaria, Bulgaria's trade

delegation, and members of the Department of Energy's International Affairs to discuss smart city initiatives for economic competitiveness and sustainability.

- *January 20, 2022 - Mobility21 Researcher Presents "Managing AI in Transportation" to DVRPC* - Mobility21 researcher Stan Caldwell presented an overview of the Traffic21/Heinz College Executive Education Course "Managing AI in Transportation" to 35 participants from New Jersey and Pennsylvania at the quarterly meeting of the Delaware Valley Regional Planning Commission Transportation Operations Task Force Meeting.
- *January 5, 2022 - Traffic21 and CMU Host Senator Wayne Langerholc Jr. at Mill19* - Traffic21 and Carnegie Mellon University welcomed Senator Wayne Langerholc, Jr. at Mill 19 to unveil SB 965, legislation that would permit AV companies to test vehicles meeting autonomy levels 3, 4 or 5 of SAE International's J3016 parameters for automated driving systems. Also in attendance at the press conference were CMU President Farnam Jahanian, PennDOT Secretary Yassmin Gramian, Senator Jay Costa, Allegheny County Executive Rich Fitzgerald, and many others.
- *December 16, 2021 - Emerging Transportation Technology Trends Shared with High School Students and Teachers* - Stan Caldwell, Mobility21 UTC Executive Director & researcher, presented a session on his emerging transportation technology policy research to 62 high school students and faculty from suburban and rural school districts throughout western Pennsylvania. The event was sponsored by Bob Koch from UTC academic partner, Community College of Allegheny County and held at their West Hills Campus Automotive Technology Center.
- *December 13, 2021 - Honda Visits CMU and Learns about UTC Research* - A group from Honda R&D America visited CMU and met UTC researchers including Sean Qian, Stan Caldwell, Nik Martelaro and Mobility21 Director Raj Rajkumar.
- *December 2, 2021 - Professor Lee Branstetter Presents His Work at the Heinz Informal Lunch Seminar* - Mobility21 UTC researcher Lee Branstetter, Professor of Economics and Public Policy at Carnegie Mellon University's Heinz College, presented his ongoing work "Closing the Opportunity Gap Among Marginalized Students: Using Human-Computer Teaming For Motivational Mentoring and Content Tutoring" at the Heinz Informal Lunch Seminar.
- *December 2, 2021 - Congressman Higgins Discusses Transportation & Infrastructure with Mobility21* - Congressman Brian Higgins, member of the United States House of Representatives serving New York's 26th congressional district, spoke to Mobility21 Director Raj Rajkumar, Mobility21 Executive Director Stan Caldwell, Mobility21 UTC researcher Steve Smith, and Metro21 Executive Director Karen Lightman to discuss the broad array of federally supported intelligent transportation and infrastructure research at CMU.
- *November 3, 2021 - Mobility21 Director Tours AV Policy & Research with Pennsylvania Legislators* - Mobility21 Director Raj Rajkumar and researcher Ding Zhao met with Pennsylvania State Legislators including Representative Josh Kail, Senator Joe Pittman, Representative Natalie Mihalek, Senator Ryan Aument, and Senator Pat Stefano. Rajkumar provided a tour of his level 4 automated vehicle and discussed automated vehicle-related UTC policy and technology research. Ding Zhao was able to give a demonstration of an autonomous sidewalk delivery robot.

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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?

- *March 30, 2022 -* In 2022, Pittsburgh will break ground on a smart city plan over six years in the making - "When the challenge was announced in 2015, Pittsburgh officials were excited about the chance to use the prize money to shake the city's reputation as a post-industrial steel town, Stan Caldwell, executive director of Carnegie Mellon University's Traffic21 Institute, who worked on the city's proposal, told us... The idea for Smart Spines is rooted in an earlier—and still ongoing—project called Scalable Urban Traffic Control (Surtrac), an "intelligent traffic-control system" that began in 2012 and aims to speed up traffic flow and reduce vehicle idle time. The tech, which was developed at Carnegie Mellon University, has since been commercialized via a company called Rapid Flow Technologies. " *Link to Article*
- *December 21, 2021 -* New Policy Report on "How COVID-19 Affects Major Trends and Forces Shaping The Future of Transportation" - Stan Caldwell applied his UTC research on emerging transportation technology policy in support of a year-long advisory round-table exploring "How COVID-19 Affects Major Trends and Forces Shaping The Future of Transportation" for Pennsylvania Department of Transportation Secretary Yassmin Gramian. CMU Heinz College Master of Public Policy and Management student Erick Shiring served as research assistant throughout the project to PennDOT Senior Policy Advisor and report lead Roger Cohen. Mobility21 UTC research Professor Megan Ryerson from the University of Pennsylvania also served on this round-table advisory group and applied her UTC research.
- *October 15, 2021 -* Penn researchers identify transit weak spots for SEPTA's rebranding initiative - A team of researchers from Penn's Center for Safe Mobility is working with SEPTA on the transportation agency's $40 million effort to rebrand its transit network and improve its ease of use. Using data from eye-tracking glasses, Stuart Weitzman School of Design associate professor Megan Ryerson and her team of urban planners partnered with the transportation agency to determine which of the city's stations were most confusing to riders of different transit familiarity, native languages, and physical abilities. The Center's experimental study is part of SEPTA's broader "Wayfinding" initiative to create a more intuitive transit system in response to complaints from riders about the lack of consistent branding and route signage. The Penn

faculty and alumni involved in the study hope the rebranding changes the way Penn students think about SEPTA. *Link to Article*

- *October 1, 2021* - Traffic21 Releases Policy Brief on Driver Warning Technologies and Partial Vehicle Automation - Traffic21 researchers released their latest policy brief, "Driver Warning Technologies and Partial Vehicle Automation: Save Lives and Money, " authored by Stan Caldwell, Chris Hendrickson, Corey Harper and Costa Samaras.   The brief reviews empirical data on changes in crash frequency and severity with driver warning technologies and partial automation; provides estimates of benefits, costs and lives saved; and concludes with policy recommendations.

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?
- Mobility21 UTC researcher Venkat Viswanathan and others have launched their start-up company Chement, a zero emissions cement production company that will allow for cleaner and cheaper carbon capture.
- University of Pennsylvania UTC researcher Rahul Mangharam established the Autoware Center of Excellence for Autonomous Driving Pennovation Center in Philadelphia to serve as a physical laboratory for collaborative research and development of open-source autonomous vehicle software. The Autoware Foundation is a non-profit consortium of over 60 industry, academic and government members that develop autonomous driving software as a community.
- As part of the project, F1/10 Autonomous Racing Course and Competition, PhD student, Matthew O-Kelly, started a company https://trustworthy.ai which was acquired by Waymo/Google in 2021.
- The deployment partners working with UTC researchers on the Better Boulevard Analytics project, were awarded a Transportation Alternatives Set-Aside project to create sidewalks throughout Shaler and Allegheny Townships. This project is well aligned with the research project, because the cameras are installed, to date, at the key intersection for this sidewalk project and will be able to document before and after usage of the walkways.

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.

Dr. Starr directly leveraged his work with the Virtual Racing League and Mobility21 activity in his Engineering Unleashed Fellowship, awarded by the Kern Family Foundation. Dr. Starr's fellowship awards him the opportunity to integrate entrepreneurial-minded learning into the skilled trades, and topics such as advanced sensors, intelligent transportation systems and the basics of artificial intelligence have been ideal points to introduce topics such as Curiosity, Creating Value and more. Dr. Starr presented on his work at a virtual EU Fellows meeting, and intends to publish the work when the academic year is over.

CCAC has also made progress in building out the connected vehicle sensor lab. Radar reference kits, lidar sensors, ECU simulators, NVIDIA Jetson computers and camera systems were all ordered during this time period, and the college received the first Velodyne LIDAR sensors (VLP-16 pucks). Dr. Starr and R. Koch have both used these sensors in the classroom and at various outreach activities. Dr. Starr brought the VLP-16 to an outreach event at Fox Chapel High School, where he presented to 81 students on concepts related to the future of transportation, and R. Koch performed similar outreach at the Butler Area CTC. He also was able to demonstrate the sensor and visuals in CCAC's advanced electronics automotive class.

CCAC also began the student Capstone project to construct a Smart Mobility Scooter. CCAC adjunct faculty member, Christopher Quick, led a class of three students. C. Quick will continue his work with a follow on class this summer to complete the built out and testing of the scooter and a demonstration at the college's West Hills Center. The initial scooter will have basic object detection, braking and path planning functionality, and is equipped with a lidar sensor, computer vision system and several redundant safety features.

Dr. Starr and R. Koch continue to attend the ITS PCB working groups and recently gave feedback to the CAVe-in-a-Box design team on a light version of the device that will not require GPS signal or multiple components in order to function. CCAC worked closely with the DOT and Leidos to refine initial ideas and is slated to pilot the device this summer in an experimental course. CCAC will be the first institution to trial the light device and will provide feedback on our experience. In addition, during:

March:
- Completed computer vision trial with robotics class on AI, neural networks and other image processing technologies.
- Held a collaboration event between Mechatronics students and CFI Aviation students where mechatronics students received a free introductory flying lesson in the flight simulators at South Campus, and learned about the control mechanisms in avionics, as well as the standards required for repair and maintenance.

February:
- Dr. Starr attended the Water & Wastewater Equipment, Treatment & Transport Show in February and met with several engineering firms to discuss challenges in water and wastewater pipeline inspections and bridge / culvert inspections.
- Bob Koch and CCAC along with the Greater Pittsburgh Automotive Dealers Association hosted "Career Day at the Auto Show." They had over 300 students in attendance and discussed opportunities in automotive careers, and the high-tech that exists in all areas of transportation. They also had over 20 employers looking to hire some of these students. Working with Duquesne Light there was an electric drive demonstration at the auto show where attendees could ride in an electric.
- CCAC met with Futurum to discuss highlighting work on the Moblity21 project in outreach materials for other educators and teachers through a variety of publications.
- Shared feedback and exchanged ideas with faculty from Florida International University and the University of Memphis re: CAVe-in-a-Box improvements.

January:
- Completed second trial with students and connected vehicle sensors to validate troubleshooting and failure modes.
- Bob Koch attended the PRCC/EV meeting with Duquesne Light.

December:
- Attended ITS PCB Working Groups #2 & #3 meetings.
- Did first trial with students and connected vehicle sensors to validate learning from exposure to advanced sensors.

November:
- CCAC held the virtual skilled trades fair the week of Thanksgiving to present on automotive programs to more than 50 students in high schools and CTCs.
- Met with the CCAC Foundation at the Vision Pittsburgh Event to better understand Astrobotic's vision for space exploration activity in the region (commercially).
- CCAC delegation attended a planning meeting and walkthrough of the site of the future Moonshot Museum on the North Side.

October:
- CCAC held its annual Odyssey Day event. The college had over 100 attendees explore topics relating to alternative energy, clean natural gas, and the future of transportation.
- CCAC attended several partnership calls with the Astrobotic Moonshot Museum and the Keystone Space Conference to discuss ways CCAC and the museum can collaborate on outreach activities.
- Several planning meetings for the Pennsylvania Autonomous Vehicle Summit.
- Planned for the ITS PCB Curriculum Webpages Session with Volpe and Pima CC. Presented CCAC's approach using Workforce Development to accelerate development of innovative technologies.

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

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."

6. CHANGES/PROBLEMS

- *Changes in approach and reasons for change* - The Fourth Annual National Mobility Summit was scheduled for March 31, 2022. 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. Due to continuing COVID concerns, in consultation with our US DOT grants manager, the event was postponed to 2023.
- *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.

7. SPECIAL REPORTING REQUIREMENTS

Submission status of Final Research Reports: Four final research reports have been submitted to the repositories as required in the Grants Deliverables and Reporting Requirements.