



A USDOT NATIONAL
UNIVERSITY TRANSPORTATION CENTER

Carnegie Mellon University



Semi-Annual Progress Performance Report for University Transportation Centers

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Center for Improving Mobility of People and Goods

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Signature:

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

What are the major goals of the program?

The primary goal of Mobility21, a National University Transportation Center for Improving Mobility is to develop and deploy technologies, policies, incentives, and training programs for improving the mobility of people and goods in the 21st century efficiently and safely. We 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. We used the following metrics as a guideline to reach the Research Performance Measures.

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 Deployment Partner 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

- 30 research projects were active during this report period.

Additional accomplishments:

- *September 1, 2023 - UTC Researcher Named Director of Wilton E. Scott Institute for Energy Innovation at CMU* - Mobility21 UTC researcher Costa Samaras has been named the next director for the Wilton E. Scott Institute for Energy Innovation at Carnegie Mellon University
- *August 22, 2023 - TRB Highlights Mobility21 UTC Summit in Newsletter* - The Transportation Research Board highlighted the Mobility21 Fourth Annual National Mobility Summit held in Washington, DC in March 2023 in a recent newsletter, highlighting Equity in Transportation.
- *August 2, 2023 - SURCOM Program Director Highlights Mobility21 Research at APTatech* - Dr. Jill Hough, Program Director at Small Urban and Rural Center On Mobility (SURCOM) recently shared Mobility21 UTC research from Sarah Fox and Nik Martelaro at APTatech, highlighting transit technology research done by the University Transportation Center.
- *July 10, 2023 - Mobility21 UTC Researcher Named Amazon Scholar* - Mobility21 UTC researcher and Carnegie Mellon University Professor Mario Berges has been named an Amazon Scholar to work with Amazon's Devices and Services Organization.
- *June 23, 2023 - Cleantech Open Northeast 2023 Cohort Announced* - Cleantech Open, which runs the world's largest clean technology accelerator program, has announced the Northeast 2023 Cohort which includes Mobility21 UTC researcher Destenie Nock's spinout Peoples Energy Analytics and Venkat Viswanathan's spinout InceptEV
- *June 22, 2023 - Mobility21 Researcher Awarded CyLab Seed Funding* - CyLab at CMU has awarded \$450k in seed funding to projects based on intellectual merit, originality, potential impact, and fit towards the Security and Privacy Institute's priorities. Among those awarded was Mobility21 UTC research Fei Fang for her project "Towards Inclusive Security and Privacy: Design for Digital Security and Privacy for the Homeless Population."
- *June 16, 2023 - Traffic21 Director Awarded ASCE James Laurie Prize at the 2023 International Conference on Transportation & Development* - Traffic21 Director Chris Hendrickson attended the ASCE 2023 International Conference on Transportation and Development, where he participated in the panel "The Transportation-Energy Nexus: The March Toward Sustainable and Resilient Systems." During the conference he was also awarded the ASCE James Laurie Prize (an award given to a member of ASCE who has made a definitive contribution to the advancement of transportation engineering).
- *June 13, 2023 - Study Conducted by Mobility21 Researchers Highlighted in Information Systems Research* - Mobility21 UTC researcher Sean Qian and CMU Professor Beibei Li were recently featured in Information Systems Research with their study that found that ridesharing platforms significantly outperform taxi systems in coping with emergencies, largely due to the benefits of technology.
- *May 23, 2023 - Mobility21 UTC Research Featured in Autonomous Vehicle International Op-Ed* - Mobility21 UTC researcher Carlee Joe-Wong's work was recently featured in ADAS & Autonomous Vehicle International Magazine, which highlighted her UTC project, "Mixed-Autonomy Era of Transportation: Resilience & Autonomous Fleet Management."
- *April 26, 2023 - Mobility21 UTC Faculty Researcher Named University Professor* - Mobility21 UTC researcher Burcu Akinci, along with four other Carnegie Mellon University faculty members, has been elevated to the rank of University Professor, the highest distinction a faculty member can receive at Carnegie Mellon.

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 **196** deployment partners.

At Carnegie Mellon University Women in Transportation Fellows help lead, and the UTC supports, a university-wide graduate and undergraduate student transportation club. The UTC also actively engages student groups at its partner universities and colleges.

Highlighted Education Initiatives:

- *August 11, 2023 - Architecture and Design Thesis Explores AVs* - Mobility21 UTC researcher Stan Caldwell joined a master's thesis review panel for CMU Master of Science in Sustainable Design student Yi Zhao. Zhao's research applied innovative design applications to explore urban design and equity scenarios of shared autonomous transportation in a disadvantaged neighborhood in Pittsburgh.

- *July 27, 2023 - Dwight David Eisenhower Transportation Graduate Fellowship Awarded to CMU Ph.D. Student - Ph.D. candidate Sofia Martinez has been awarded the prestigious Dwight David Eisenhower Transportation Graduate Fellowship by the U.S. Department of Transportation's Federal Highway Administration. Co-advised by Mobility21 UTC researchers Costa Samaras and Corey Harper she is focused on the electrification of the U.S. public transportation sector to reduce carbon emissions.*
- *July 10, 2023 - Mobility21 UTC Faculty Discusses Challenges & Opportunities in Developing a Workforce for EVs - Mobility21 UTC faculty member, Bob Koch of the Community College of Allegheny County took part of Pittsburgh Region Clean Cities workshop on hybrid electric vehicles (EVs), which focused on maintenance and safety aspects of hybrid EVs.*
- *June 15, 2023 - Mobility21 Updates CMU Transportation-Related Coursework Listing - Mobility21 provides a comprehensive list of transportation-related courses offered by Carnegie Mellon University.*
- *May 27, 2023 - University of Pennsylvania Student Team Named Autonomous Karting Series 2023 Champions - Students from the University of Pennsylvania's Penn-Autoware Team, led by Mobility21 UTC researcher Rahul Mangharam, were crowned Autonomous Karting Series 2023 Champions for their wins in both categories of racing - reactive and open category for motion planning. They competed against teams from UC San Diego, Purdue, UC Berkeley, and several other universities.*
- *May 4, 2023 - Students of CMU Adjunct Professor Henry Posner Present Final Class Projects - Students presented their final projects as part of the CMU course, The American Railroad: Decline and Renaissance in the Age of Deregulations of the Original Business Network. The course is taught by Henry Posner, Carnegie Mellon University Adjunct Professor, and chairman of the Railroad Development Corporation (RDC).*
- *May 3, 2023 - Traffic21 Women in Transportation Fellow Presents Capstone for Pittsburgh Regional Transit - Traffic21 Women in Transportation Fellow Maggie Harger completed her fellowship by presenting her capstone project for Pittsburgh Regional Transit.*
- *April 15, 2023 - CMU Graduate Students Secure Second Place in Kellogg Design Challenge - Carnegie Mellon University graduate students from interdisciplinary courses joined forces to win second place in the Kellogg Design Challenge, the world's largest MBA design case competition. Assisted by Traffic21 Director Raj Rajkumar and Metro21 Executive Director Karen Lightman, they were able to explore autonomous vehicles and transportation policies to narrow down the problem space for their sponsor, Nissan.*
- *April 14, 2023 - Mobility21 Recognizes Students During National Student Appreciation Week - Mobility21 celebrates our student workers Sreya Vangala and Women in Transportation Fellow 2021-23 Maggie Harger for their hard work and contributions during National Student Appreciation Week at Carnegie Mellon University.*
- *April 13, 2023 - Project Olympus Show & Tell Highlights Transportation Projects - The Swartz Center for Entrepreneurship at Carnegie Mellon University hosted the Project Olympus Show & Tell, a popular venue for connecting CMU startups with the wider business and entrepreneurial community. Mobility21 UTC researcher Dr. Destenie Nock provided insight into her research, while Heinz College MISM student Adam Knapp provided information on his customer discovery kickstart, "Parkor," a program that helps customers find parking in real time.*

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 build a “community space” to bring together people interested in transportation on CMU’s campus. This was the impetus for Mobility21’s launching of the Smart Mobility Connections (SMC) seminar series. One of the UTC faculty is featured at each hour-long session; half of the time is reserved for questions and answers as well as networking. All Mobility21 SMC seminars are advertised on the DOT webinar website, UTC website and publicized through faculty, student and government and industry partner distribution lists. Recordings of each session are saved to our YouTube channel and links posted to the Mobility21 UTC website’s *What’s Happening* section. The information and links are also sent to our US DOT Grants Manager for posting on the US DOT website.

Below are the SMCs held during this reporting period.

Date	Speaker(s)	University	Title	Video Recording Link
9/29/2023	Swarun Kumar	CMU	Next-Generation Radars: Towards Smart Vehicles that See What the Eye Can't See	https://youtu.be/pYNXb357oAQ
4/21/2023	Yorie Nakahira	CMU	Safety of Intelligent Systems Operating in Uncertain and Interactive Environments	https://youtu.be/xtGwrTggXIU

Additional technology transfer activities:

- *July 12, 2023 - Dr. Corey Harper Attends EV Charging Symposium* - Mobility21 UTC researcher Dr. Corey Harper participated in the US DOT Electric Vehicle (EV) Charging Symposium, where participants engaged in roundtable discussions focused on generated momentum for the forthcoming nationwide expansion of EVs and EV charging infrastructure

Collaboration

At the core of our efforts, is collaboration. During this reporting period Stan Caldwell, Lisa Kay Schweyer, Karen Lightman, and Chandani Sharma 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:

- *August 11, 2023 - UTC Researchers Submit Public Comments on EPA Standards* - Mobility21 UTC researcher Jeremy Michalek submitted public comments on EPA's proposed light-duty vehicle GHG standards through the Vehicle Electrification Group.
- *July 27, 2023 - Mobility21 Director Participates in Autonomy Debate* - Mobility21 Director Raj Rajkumar participated in a debate, "Autonomy: Coasting or Crashing" which sought to answer whether or not AVs will be mainstream in the next 10 years. Alongside Prof. Rajkumar in the debate was Brad Templeton, founding faculty for Computing & Networks at Singularity University.
- *July 26, 2023 - PennDOT Secretary and FHWA Regional Administrator Lead STIC Meeting* - Stan Caldwell, Mobility21 Executive Director and founding member of the Pennsylvania State Transportation Innovation Council (STIC), participated in the meeting today to provide insight on how UTC researchers could support state transportation innovations. The quarterly STIC meeting was co-chaired by PennDOT Secretary Mike Carroll and FHWA Pennsylvania Division Administrator Alicia Nolan.
- *July 25, 2023 - Mobility21 Program Manager Participates in Panel Discussion* - Mobility21 UTC Program Manager Lisa Kay Schweyer participated as a panelist for the U.S. DOT/UTC panel discussion during the AASHTO RAC Summer Meeting's Collaboration, Coordination and Outreach Meeting alongside Tyson Rupnow from the Louisiana DOT and Tim Klein from the U.S. DOT.
- *July 24, 2023 - Allegheny County Hosts Meeting on Comprehensive Plan* - Mobility21 UTC Program Manager Lisa Kay Schweyer and Metro21 Executive Director Karen Lightman participated in Planning meetings for Allegheny Places, the Allegheny County comprehensive plan. This plan establishes an overall vision for the future for Allegheny County and how to get there.
- *July 5, 2023 - Mobility21 Director Named to Highly Automated Vehicle Advisory Committee* - Mobility21 Director Raj Rajkumar has been invited by Pennsylvania Governor Josh Shapiro to participate on the Highly Automated Vehicle (HAV) Advisory Committee through the Pennsylvania Department of Transportation. The HAV Committee is a partnership between public and private key stakeholders to ensure the safe integration of connected and automated vehicles on Pennsylvania's roads and enhance Pennsylvania's continued global leadership with this evolving technology.
- *July 1, 2023 - PennTec 2023 Hosts Collection Systems Smart Panel with Justin Starr* - Mobility21 UTC faculty member from the Community College of Allegheny County, Dr. Justin Starr participated on the Collection Systems Smart Panel at PennTec2023, which looks to advance Pennsylvania's water quality professionals through education and training, promoting sound sustainable water policies, and fostering public stewardship of water resources.
- *June 29, 2023 - WTS Hosts Tour of City of Pittsburgh Traffic Shop* - Mobility21 Program Manager and WTS member, Lisa Kay Schweyer joined "WTS Pittsburgh, CMAA Three Rivers & The City of Pittsburgh's Department of Mobility and Infrastructure (DOMI) for a tour of the DOMI Traffic Shop." She met DOMI staff and learned more about the signs, traffic signals, and line painting operations.

- *June 22, 2023 - Council of University Transportation Centers Holds Summer Meeting* - The Annual Council of University Transportation Center's summer meeting brings together the nation's leading transportation professionals from academia and industry, along with U.S. DOT and other transportation agency officials. Raj Rajkumar, Director, Stan Caldwell, Executive Director and Lisa Kay Schweyer, Program Manager of Mobility21 and Safety21 UTCs participated in the meeting. Stan and Lisa Kay presented an overview of the national summits hosted by Mobility21. And Lisa Kay led several sessions designed for the administrative professionals who work at UTCs.
- *June 15, 2023 - PennSTART Highlighted at SAE Meetup in Pittsburgh* - Stan Caldwell, Mobility21 Executive Director joined a panel with Mark Kopko from PennDOT, Joe Suter from the Pennsylvania Turnpike Commission, Tim White from RIDC and moderated by Nat Beuse from Aroura to discuss plans for the Pennsylvania Safety and Transportation Research Track (PennSTART). The panel was held in Pittsburgh for SAE Innovations in Mobility Meet-up Fueling Economic Growth in PA with PennSTART.
- *June 13, 2023 - White House Hosts Inaugural ARPA-I Summit* - Today, leaders from Congress, industry, nonprofits, academia and labor were in attendance for the launch of the Advanced Research Projects Agency for Infrastructure (ARPA-I). "Newly created by the President's Bipartisan Infrastructure Law, ARPA-I will fund high-reward next-generation physical and digital infrastructure technologies and systems that have the potential to modernize America's transportation." Mobility21 UTC researcher and Principal Assistant Director for Energy and The White House Office of Science and Technology Chief Advisor for Energy Policy Costa Samaras was on hand to welcome the group as the speakers laid out the vision of the future that the Advanced Research Projects Agency for Infrastructure (ARPA-I) is designed to deliver. Participating in the event was Mobility21 Director Raj Rajkumar and former Traffic21 Diversity Fellow Allanté Whitmore.
- *June 12, 2023 - Traffic21 at the Hitachi Rail Reception for APTA* - Hitachi Rail sponsored a reception for the APTA Rail Conference at the Heinz History Center in Pittsburgh. Traffic21 Director Chris Hendrickson was joined by Mobility21 Executive Director Stan Caldwell.
- *May 10, 2023 - Pittsburgh Emerging Tech Community Engagement Roundtable* - The City of Pittsburgh hosted a community engagement roundtable event in Hazelwood Green for thought-provoking discussion on the current state of Autonomous Vehicles in Pittsburgh and to uncover invaluable insights on how to effectively engage with emerging technologies, featuring Mobility21 Executive Director Stan Caldwell as a panelist.
- *May 5, 2023 - Mobility21 Program Manager Provides Public Comment* - Mobility21 Program Manager, Lisa Kay Schweyer provided public comment in response to: Increasing Public Access to the Results of USDOT-Funded Transportation Research, Agency/Docket Number: Docket No. DOT-OST-2023-0045. Her comments can be viewed [here](#).
- *May 4, 2023 - Mobility21 Tours East Broad Top Pop-Up Metro* - Members of the Mobility21 team toured the East Broad Top Railroad's Pop-Up Metro, a transit infrastructure alternative utilizing low-density freight lines and North America's only battery- propelled passenger cars.
- *April 25, 2023 - UTC Impacts Highlighted at ITSA Annual Meeting in Texas* - Mobility21 UTC Executive Director Stan Caldwell spoke on a panel titled "Reinventing the Rustbelt: Oxidation to Innovation" at the Intelligent Transportation Society of America's Annual Meeting. The panel was moderated by Jim Katsafanas of Michael Baker Corporation and also included Colin Castle from Michigan DOT, Preeti Choudhary from DriveOhio and Stephen Zubyk from Eastgate COG in Ohio.
- *April 17, 2023 - Mobility21 Program Manager Participates in Community Advisory Board Meeting at Cleveland Fed* - Lisa Kay Schweyer, Mobility21 Program Manager, attended the first meeting of her term on the Community Advisory Council for the Cleveland Federal Reserve Bank. She was able to share her experience working with employers and commuters and transportation to work.
- *April 12, 2023 - Metro21 Executive Director Joins Discussion on Smart Cities* - Karen Lightman, Executive Director of Metro21: Smart Cities Institute, recently joined University of Pittsburgh Law School Professor Michael Madison for a discussion on his new book, "Governing Smart Cities as Knowledge Commons" to explore data in smart city planning and practice.
- *April 7, 2023 - Dr. Justin Starr Works With Pittsburgh Water & Sewer Authority on Stormwater Pipe Assessment* - Mobility21 UTC partner and CCAC professor Dr. Justin Starr recently worked with the Pittsburgh Water & Sewer Authority at the 2023 Pennsylvania Water Environment Association's Stormwater Summit to provide a demo of a stormwater pipe assessment using a drone.
- *April 6, 2023 - Mobility21 UTC Researcher Joins Team for ARPA-E \$3.2M EV Award* - Mobility21 UTC researcher Venkat Viswanathan will partner with MIT and 24M for a \$3.2 million EVs4ALL award from the U.S. Department of Energy Advanced Research Project Agency-Energy (ARPA-E). The initiative will focus

on developing fast-charging and low-cost electric vehicle batteries.

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 4,485 subscribers**. The readership represents individuals in industry, government, academia, and community organizations **from 13 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. **561 articles were posted** in this reporting period.

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 released:

- *Modeling the impact of dynamic tolling in large-scale regional networks: A case study for Delaware Valley Regional Planning Commission (DVRPC)*, Sean Qian
- *Helping Transit Agencies Assess Opportunities to Improve Access and Equity with Automated Vehicles*, Costa Samaras
- *Developing Data Collection Systems to Support Community-Driven Integrated Mobility Services*, Patrick Carrington
- *Towards Data-Driven and Continuous Safety Inspection of Commercial Trucks and Trailers*, Pingbo Tang
- *Designing the Future of Transit Work*, Sarah Fox and Nik Martelaro

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

N/A as this is the final report for the Mobility21 UTC.

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 **196** deployment and equity partners.

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, <https://mobility21.cmu.edu/about/leadership/advisory-council>.

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

Publications, conference papers, and presentations

Title	Type	Citation	Date
<i>A Single View Perspective Prior for Efficient Detection</i>	Other	A. Ghosh, "A Single View Perspective Prior for Efficient Detection", Master's Thesis, Tech. Report, CMU-RI-TR-23-42, August, 2023	2023-08-15
<i>Detection and Tracking of Accessibility Challenges</i>	Other	Camden Cummings, Anurag Ghosh, and Christoph Mertz, "Detection and Tracking of Accessibility Challenges", RISS journal, 2023, to be published. https://riss.ri.cmu.edu/research_showcase/working-papers-journals/ .	2023-08-15
<i>Towards Explainability in Modular Autonomous System Software</i>	Peer Reviewed	H. Zheng, Z. Zang, S. Yang and R. Mangharam, "Towards Explainability in Modular Autonomous System Software," 2023 IEEE Intelligent Vehicles Symposium (IV), Anchorage, AK, USA, 2023, pp. 1-8, doi: 10.1109/IV55152.2023.10186720.	2023-07-27
<i>Learned Two-Plane Perspective Prior based Image Resampling for Efficient Object Detection</i>	Other	Anurag Ghosh, N. Dinesh Reddy, Christoph Mertz, and Srinivasa G. Narasimhan, "Learned Two-Plane Perspective Prior based Image Resampling for Efficient Object Detection", The IEEE/CVF Conference on Computer Vision and Pattern Recognition 2023, accepted for publication.	2023-06-18
<i>Domain Adaptation by Revisiting Static Objects with a Transit Bus</i>	Other	Philip Neugebauer, "Domain Adaptation by Revisiting Static Objects with a Transit Bus", Master's Thesis in Informatics, Technische Universität München, 2023..	2023-06-15
<i>Your Room is not Private: Gradient Inversion Attack for Deep Q-Learning</i>	Peer Reviewed	Li, Miao, Ding, Wenhao, and Zhao, Ding. "Your Room is not Private: Gradient Inversion Attack for Deep Q-Learning" 2023, Book	2023-04-13
<i>Drive Right: Autonomous Vehicle Education through an Integrated Simulation Platform</i>	Peer Reviewed	Qiao, Z., Loeb, H., Gurrla, V., Lebermann, M., Betz, J., & Mangharam, R. (2022). Drive Right: Autonomous Vehicle Education through an Integrated Simulation Platform. SAE International Journal of Connected and Automated Vehicles, 5(12-05-04-0028).	2023-04-04
<i>Ridesharing and Digital Resilience for Urban Anomalies: Evidence from the New York City Taxi Market</i>	Peer Reviewed	Zhang, Yingjie, Beibei Li, and Sean Qian. "Ridesharing and Digital Resilience for Urban Anomalies: Evidence from the New York City Taxi Market." Information Systems Research (2023).	2023-04-01
<i>How effective is reducing traffic speed for safer work zones? Methodology and a case study in Pennsylvania</i>	Peer Reviewed	Zhang, Zhuoran, Burcu Akinci, and Sean Qian. "How effective is reducing traffic speed for safer work zones? Methodology and a case study in Pennsylvania." Accident Analysis & Prevention 183 (2023): 106966.	2023-04-01

Other publications, conference papers, and presentations:

Title	Event	Type	Attended	Date
Evaluating the Use of Bus-based Video Imagery to Monitor VMT on an Urban Network	World Conference on Transport Research	Academic	25	2023-07-18
Bringing Connected Vehicle Communications (V2X) to Shared Spectrum	19th IEEE International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)	Professional	100	2023-06-23
Evaluating the Optimality of Dynamic Coupling Strategies in Interdependent Network Systems	IEEE International Conference on Communications (ICC 2023)	Professional	50	2023-06-01
Autonomous Vehicle Education Using a Virtual Reality Driving Simulator	Cyber-Physical Systems and Internet-of-Things Week	Professional	100	2023-05-09

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, which includes the archived previous UTC T-SET site	New Posts: 561
http://mobility21.cmu.edu/	The Carnegie Mellon University's Mobility21 National University Transportation Center website	New Posts: 561
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: 255
https://www.youtube.com/user/Traffic21_TSET	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: 113 Views: 782
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: 1,190 Following: 1,212

Technologies or techniques

- *July 26, 2023 - The Ohio State University Uses AI to Monitor Traffic* - Researchers at The Ohio State University, a Mobility21 UTC academic partner, have proposed using cameras installed on camera buses on campus to detect objects on the road and count vehicles in an effort to monitor traffic conditions.
- *July 6, 2023 - Ohio State University UTC Researchers Develop Software for Autonomous Vehicles* - Safety21 UTC researchers, Bilin Aksun-Guvenc and Levent Guvenc from The Ohio State University have developed new software to aid in the development, evaluation, and demonstration of safer autonomous vehicles called the Vehicle-in-Virtual-Environment (VVE) method.

Inventions, patent applications, and/or licenses

There is one new invention/patent application to report this period.

Docket	Title	Inventors
2023-221 *	Incepts Source Code	Matthew Guttenberg*; Venkatasubramanian Viswanathan; Alexius Wadell

* The provisional patent application was filed 05/15/23. The invention and patent have both been reported in iEdison (IRN 0247601-23-0025).

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

	Research Performance Measure	Annual Target	Previous Reporting Period	Current Reporting Period	Total
Output #1	Annual Number of Journal Publications	35	26	9	35
Output #2	Annual Number of Research Pilot Deployments	10	5	2	7

Please see “Section #3 Publications” for publications.

Some examples of the research pilot deployments include:

- **September 8, 2023 – Addressing School Transportation Challenges** – “As the 2023-24 school year begins, students, parents, and school staff all understandably have many things on their minds. One thing that has become a consistent worry, especially since the pandemic, is an ongoing crisis in the school transportation system, spurred mostly from a constant shortage of school bus drivers. The Pennsylvania School Bus Association recently reported that, across the state, transportation providers are 3,500 drivers short. Allies for Children continues to address school transportation challenges, making sure that all students who need transportation are able to get to school.”
- **May 9, 2023 – Artificial Intelligence, Part 3: OK, it’s bad. But it’s also good, right?** – “Stephen Smith is a research professor of robotics at Carnegie Mellon University. He worked on a team that developed an adaptive traffic signal network called Surtrac, which improves commutes during peak traffic times in Pittsburgh. AI systems collect real-time data on where cars are on the road to change the traffic light signals based on where traffic is the worst. The city partnered with his team after a pilot program showed it improved traffic flow and reduced average travel times by 25%. Not only does this reduce the number of headaches for commuters, but cars spend up to 40% less time idling, reducing that much more carbon emissions from the air.”

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

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

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

	Research Performance Measure	Annual Target	Previous Reporting Period	Current Reporting Period	Total
Outcome #1	Annual Number of Media Stories Referencing UTC Research, Faculty, or Spinoff	80	39	24	63
Outcome #2	Annual Number of Instances Providing Exposure to Transportation, Science and Technology for Practitioners, Teachers, Young people, or Other Members of the Public (<i>other publications, conference papers and presentations</i>)	50	73	31	104

Some examples of the Media Stories Referencing UTC Research, Faculty, or Spinoff:

- *September 19, 2023 – Pittsburgh’s top driverless carmakers are pivoting to trucks. What does that mean for driverless cars’ future?* – “The head of the public-private partnership that is shepherding Pennsylvania’s application for a potential hydrogen hub centered around the Pittsburgh region said success isn’t just about winning funding but a real pathway to decarbonization...Destenie Nock, assistant professor of civil and environmental engineering, said the focus should be on a wider scope of industrial development than a single plant to make the biggest impact and to provide a voice consistently throughout the process and not just at certain points.”
- *August 19, 2023 – San Francisco Launches Driverless Bus Service Following Robotaxi Expansion* – “San Francisco has launched an autonomous shuttle service – less than a week after California regulators approved the expansion of robotaxis despite traffic and safety concerns. ‘Trained operators are going to be required even as we increase automation,’ said Nikolas Martelaro, autonomous-vehicle researcher at Carnegie Mellon University. ‘So the question there may not be how worried should someone be about losing their job versus what should they be thinking about the potential training that’s required.’ Autonomous driving technology could make buses safer, but requiring drivers or attendants on-board could undermine one of their perceived advantages: reduced labor costs.”
- *August 15, 2023 – Fujitsu to take expanded presence at new Avenu Workspaces coworking set up in Oakland* – “Fujitsu, a publicly traded Japanese company with more than 120,000 employees worldwide, is working to ramp up its presence in Pittsburgh. The company has committed to being the first new tenant in a new Avenu Workspaces location at 115 Atwood St., - away in the heart of Oakland. The new space will be bigger for Fujitsu, but specific details on the amount of space the lease will be, were not provided in an announcement about the move by InnovatePGH, which operates the Avenu coworking spaces. According to the organization, Fujitsu has been collaborating with Carnegie Mellon University through its Mobility Data Analytics Center and Computational Behavior Lab. The company is involved with projects through the two labs to evaluate measures to control traffic flow as well as to model how pedestrians behave in urban environments.”
- *August 14, 2023 – How to Find the Cheapest Ride-Sharing Option* – “ ‘The best strategy today is to have access to many services and to use each one when it best fits your trip needs,’ says Stan Caldwell, executive director of Carnegie Mellon University’s Traffic21 Institute, which focuses on transportation issues. For example, he says savvy travelers should consider using Uber or Lyft to get from home to a transit hub. Or they should use the ride-hailing services late at night when mass transit isn’t running. On other trips, a Zipcar rental or even a bike share or scooter might be more appropriate.”
- *August 9, 2023 – Electric Vehicle Owners in Pittsburgh Find Creative Ways to Charge Up as the City Adjusts to Shifting Transportation Trends* – “Recently, a team that includes Corey Harper, an assistant civil and environmental engineering professor at the Carnegie Mellon University School of Information Systems and Public Policy, received a grant from the Department of Energy to do research on EV charging infrastructure. ‘We saw that, right now, in Pittsburgh, a lot of the charges are located in areas where there are either a lot of shops near the schools, or the Downtown area,’ he explains to City Paper, referring primarily to the neighborhoods surrounding CMU and the University of Pittsburgh. ‘So, you know, pretty well-off areas.’ Harper explains that his DoE-funded research looks at creating “optimization tools” for cities, in this case, Pittsburgh and Seattle, to best determine where EV chargers should be located based on a number of factors. Harper says that, while there’s a growing demand to adopt EV technology, Pittsburgh and other U.S. cities need to make the transition in an equitable way.”
- *August 9, 2023 – Study: Bridge tolling comes with questionable trade-offs* – “A case study of how traffic would change if a nominal toll were added to Girard Point Bridge in Philadelphia illustrates the trade-offs: PennDOT could raise significant revenue, but traffic time would increase — as would emissions. The study, done for the Delaware Valley Regional Planning Commission and funded with a grant from the U.S. Department of Transportation, estimated a \$1 toll on the bridge would bring in about \$30,500 per day and \$46,700 per day with a \$2 toll during morning peak hours. Annually, those tolls would be \$11.1 million and \$17 million, respectively. ‘We’re talking about how to make a good compromise among different stakeholders,’ Sean Qian, a civil and environmental engineering professor at Carnegie Mellon University and co-author of the study, said. ‘PennDOT, I do see their perspective because it’s important to have extra revenue to fix the infrastructure. Especially for Pennsylvania, it’s a big challenge.’ ”
- *August 8, 2023 – Can Self-Driving Go Mainstream Within 10 Years? Watch This Debate* – “Billions are being invested in self-driving technology each year, and some question why it isn’t further along today, whether it can be really made to work and whether it can be a business that scales and makes profits for the many companies in the game. To address these questions, I engaged this week in a formal debate. Taking the negative was Professor Raj Rajkumar from CMU. Raj was one of the team leaders when CMU won the DARPA Urban Challenge — the contest that really

- got the self-driving robocar world going.”
- **July 31, 2023 – Grocery Delivery is Less Sustainable Than Shopping in Store** – “Carnegie Mellon University College of Engineering researchers (CMU Research) released its latest findings looking at the impacts of grocery delivery on energy use, emissions, and traffic congestion — including whether there might be a better way to manage and optimize deliveries. What it found is that grocery delivery was less energy efficient than people shopping for products themselves. The research aims to provide a new set of insights for organizations to integrate into ecommerce and grocery delivery trends for long-range, and more sustainable transportation planning. The global pandemic created a surge of ecommerce purchases and online grocery delivery services out of necessity, and many of those fulfillment methods are still being used today. ‘Right now, most people go to the grocery store on their way home from work, or during off-peak hours,’ said Destenie Nock, an assistant professor of civil and environmental engineering and engineering and public policy.’ ”
 - **June 20, 2023 – A Leaked Tesla Report Shows The Cybertruck Had Basic Design Flaws** – “In May, the German newspaper Handelsblatt began reporting on the “Tesla Files”: thousands of internal documents provided to it by a whistleblower. Among those documents was an engineering report that might give some insight into why the vehicle has taken so long to come to market. The unique styling of the truck, with its angular plates and stainless steel alloy construction, mean it’s not only hard to manufacture, but will probably be hard to repair, experts say. Stainless steel is not easy to shape or mold, “Hence the look as if it’s the output of a student in an in-class ‘Pop Quiz Number 1’ for the course ‘Intro to Car Design,’” says Raj Rajkumar, a professor of electrical and computer engineering at Carnegie Mellon University. The material requires specialized welding techniques, and it doesn’t flex easily, which could be dangerous in a crash, when force usually absorbed by a “crumple zone” could be transferred to cabin occupants instead, Rajkumar says.”
 - **June 20, 2023 – CMU/Yale Study Suggests BEVs Could Be Majority Or Near-Majority Of Cars And SUVs By 2030 Given Technology Trends** – “To understand mainstream consumer demand for future EVs, the team of researchers conducted consumer experiments eight years apart to determine what has driven the growth of the EV market and what it would take to increase future adoption. They found that consumers’ preferences for vehicle attributes such as longer range and cheaper operation haven’t changed much, but that consumers are more willing to adopt EVs as technology improves. With expected range increases and price decreases, the team predicted that demand for electric cars and SUVs could be comparable to gasoline cars and SUVs by 2030. The team includes Jeremy Michalek, a professor of mechanical engineering and engineering and public policy; Kate Whitefoot, an associate professor mechanical engineering and engineering and public policy; their Ph.D. student Connor Forsythe, and Ken Gillingham, an economics professor at Yale.”
 - **June 14, 2023 – It’s The Features, Stupid: EV Market Share Is Growing Because The Vehicles Keep Getting Better** – “This finding, from a recent paper in Proceedings of the National Academy of Sciences, indicates that the growth in demand for EVs is largely due to the appeal of the models’ technology and features, not a deeper attachment to the idea of owning an EV than in the past. While some car buyers may indeed want an EV on principle—like many of the early adopters who helped the vehicles get their first couple of percentage points of market share—researchers report that the size of this group does not appear to have changed. Meanwhile, EVs made up 7.2 percent of the market for new cars and light trucks in the first quarter of this year, more than double the share from two years ago, according to the research arm of Cox Automotive. Or, as another co-author of the study, the Carnegie Mellon University engineering professor Jeremy Michalek, puts it: ‘Consumers haven’t changed. It’s technology that’s driving EV adoption.’ ”
 - **May 31, 2023 – How Self-Driving Cars And Human-Driven Cars Could Share The Road** – “Similar to when the first automobiles traveled alongside horses and buggies, autonomous vehicles (AVs) and human-driven vehicles (HVs) must someday share the same road. How to best manage this transition is the topic of a new Carnegie Mellon University policy brief, ‘Mixed- Autonomy Era of Transportation: Resilience & Autonomous Fleet Management.’ Carlee Joe-Wong, the Robert E. Doherty Career Development Professor of Electrical and Computer Engineering at CMU, shares her thoughts with AAVI on how this might play out. Technology development continues to make driving safer as the auto industry pushes us toward eliminating human drivers. Who knows if humans will ever be totally out of the equation, but what is inevitable is that cars with varying levels of autonomous driving capacity will be sharing the roads. It would behoove us to get in front of this issue and learn what benefits can be derived from mixed autonomy on our highways, so that we can develop policies and regulatory structures that will keep people traveling safely and efficiently regardless of whether a person is behind the steering wheel or not.”
 - **May 8, 2023 – Republicans Cry Foul On Grants Going To Electric School Buses** – “Republicans say they envisioned the \$5 billion in the infrastructure act for climate-friendlier school buses would replace older polluting diesel buses with a mix of ones that run on electricity, compressed natural gas or propane. But nearly all of the first batch of funding the Environmental Protection Agency has given out to school districts around the country has gone to help schools buy electric buses, according to the agency’s data. Experts and Democrats say districts are asking for electric buses in greater numbers because they cost less to operate than other kinds of buses and have a greater impact on the

environment. And as the cost of batteries goes down, that will add to the savings that electric buses bring, said Chris Hendrickson, faculty director of Carnegie Mellon University’s Traffic 21 transportation research institute. Additionally, Hendrickson said, while buses that run on compressed natural gas or propane pollute less than those on diesel, they still use internal combustion engines that send greenhouse emissions into the air.”

- *May 8, 2023 – **The Future Of Transportation: The Role Of Bike Lanes*** – “Bike lanes have a significant impact on traffic, both in terms of reducing congestion and improving safety. By providing a dedicated space for cyclists, bike lanes can help to reduce the number of cars on the road, which in turn can reduce traffic congestion. More protected lanes means more people leaving cars at home and opting to cycle, which is a win-win. ‘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 a key micromobility study. Additionally, they can improve safety by separating cyclists from motor vehicles, reducing the risk of accidents and injuries. Studies have shown that cities with well-designed bike networks have lower rates of traffic fatalities and injuries.”
- *May 8, 2023 – **New Electric Vehicle Tax Credit Rules Aim To Reduce Dependence On China, But Present New Obstacles*** – “The \$7,500 electric vehicle tax credit in the Inflation Reduction Act, which Biden signed in August, doesn’t limit the number of credits, but ruled out the full \$7,500 credit for new EVs assembled outside North America. In April, the Treasury Department, writing regulations for the law, narrowed the tax credit eligibility further. The regulations require that a certain percentage of the components and minerals in car batteries be sourced from the U.S. or in countries that are U.S. trade allies. Limiting the tax credit is meant to encourage EV component supply chains, which China now dominates, to shift toward the U.S. and its allies, said Jeremy Michalek, director of the Vehicle Electrification Group at Carnegie Mellon University in Pittsburgh. Michalek said he expects the new regulations to slow EV sales temporarily. Slowik and Brinley said they don’t expect the new tax credit regulations to slow EV sales, because the manufacturing increase will make more vehicles eligible for the credits and because demand for EVs remains high.”
- *April 28, 2023 – **Take Care In The Cone Zone*** – “Traffic slows in construction zones for a reason. Construction vehicles often pull onto and off highways, and here workers and heavy equipment operate sometimes just feet from the open lanes of travel. Drivers have to be alert when traveling through a work zone, and that means allowing enough distance between vehicles so a sudden stop can be made without a collision. That’s especially true in longer work zones — research conducted by the college of engineering at Carnegie Mellon University and the Pennsylvania Department of Transportation shows that work zones more than 1.8 miles long could increase crash risks. The study also showed that road work conducted during the night does not increase the risk of accidents.”
- *April 28, 2023 – **Tesla Wins Bellwether Trial Over Autopilot Car Crash*** – “A California state court jury on Friday handed Tesla Inc (TSLA.O) a sweeping win, finding the electric vehicle maker’s Autopilot feature did not fail in what appeared to be the first trial related to a crash involving the partially automated driving software. The main question in Autopilot cases was who is responsible for an accident while a car is in driver-assistant Autopilot mode – a human driver, the machine, or both? “When fatalities are involved, and they are on highways, jury perspectives can be different,” said Raj Rajkumar, professor of electrical and computer engineering at Carnegie Mellon University. “While Tesla won this battle, they may end up losing the war,” he said, with people realizing Tesla’s tech is “far from becoming fully autonomous” despite Musk’s repeated promises over years.”
- *April 17, 2023 – **The Case For Flying Cars As A Climate Solution*** – “Venkat Viswanathan thinks there’s a “straight shot” from today to the technologies needed to build that future, despite all the jokes about flying cars being fantasy. The professor at Carnegie Mellon University is obsessed with building the batteries that will power these zero-emission aircraft. Viswanathan has worked with next-generation battery companies such as QuantumScape Corp., 24M Technologies Inc., and Aionics Inc., and concluded that aviation is “the most important problem that batteries can address,” he told the Zero podcast. The problem is that it’s hard to beat jet fuel when it comes to the right combination of weight and power needed to lift a plane (with passengers and cargo) off the ground. To make a battery that is powerful but light enough to accomplish the same feat is bound to be extremely expensive. That’s why Viswanathan believes the first application will have to be in the luxury market.”
- *April 12, 2023 – **When Will Cars Be Fully Self-Driving?*** – “Around now, we should be relaxing in the driver’s seat of our autonomous cars, streaming a TV show or perhaps even taking a nap while the vehicles drive us safely to our destinations. That was the prediction several years ago by some auto-industry executives and technology experts. But after billions of dollars in research- and-development spending, autonomous-vehicle technology hasn’t advanced anywhere near the point where it can replace human drivers. The Wall Street Journal gathered three experts to discuss the future of autonomous vehicles: Alexandre M. Bayen, a professor of electrical engineering and computer science at the University of California, Berkeley; Raj Rajkumar, a professor in the electrical and computer engineering department at Carnegie Mellon University; and Juergen Reers, a senior managing director at consulting firm Accenture who is part of its mobility practice.”

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):

- *August 15, 2023 - Robotics in Rural Pennsylvania* - Mobility21 UTC researcher Rachel Burcin curated a day of robotics and AI educator workshops in Venango, PA, as a kickoff for the 2023 educator conversations led by Carnegie Mellon University's Robotics Scholars Program in partnership with the Institution for Innovation for Tomorrow and County Commissioner Chip Abramovic. The educator day was adjacent to the first Venango Rural STEM Summit, which was originally inspired by Dr. Jordi Albo's work in rural spaces across the world.
- *July 22, 2023 - Mobility21 Program Manager Interviewed at Vintage Grand Prix* - Mobility21 Program Manager Lisa Kay Schweyer was interviewed as part of the live video feed during the Pittsburgh Vintage Grand Prix. She discussed Traffic21, as well as the Mobility21 and Safety21 University Transportation Centers.
- *July 13, 2023 - Traffic21 Director Discusses Battery Electric vs. Internal Combustion Engine Vehicles* - Chris Hendrickson, Faculty Director of Traffic21 Institute and Mobility21 researcher, was interviewed by a high school student in Missouri participating in the MIT Introduction to Technology, Engineering and Science Program. The topic of the interview was the relative desirability of battery electric versus internal combustion engine vehicles.
- *June 4, 2023 - Professor Jon Peha Presents at IEEE Conference* - Mobility21 UTC researcher Jon Peha gave a presentation about how to meet the spectrum needs of connected and autonomous vehicles at the 19th IEEE International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob). He described a novel approach in which connected vehicles supplement their current spectrum allocation with spectrum that is shared with other kinds of devices. This was part of a session on vehicular networks for risk reduction and safety-related systems.
- *May 30, 2023 - Smart Belt Coalition Convenes in Ohio* - May 12, 2023 Mobility21 Executive Director Stan Caldwell joined Smart Belt Coalition members from Ohio, Michigan, Pennsylvania and New Jersey at the Transportation Research Center in East Liberty, OH. During this meeting, Stan presented updates on the design of the PennSTART test track and CMU's new Safety21 National UTC.
- *April 18, 2023 - New UTC and Pennsylvania Safety Transportation & Research Track Highlighted with the Pennsylvania Transportation Alliance* - Mobility21 Executive Director Stan Caldwell presented at the bi-monthly meeting of the Pennsylvania Transportation Alliance on the new Safety21 National UTC and the Pennsylvania State Transportation and Research Track. The alliance, organized by Pennsylvania Statewide Independent Living Council, discussed how these research efforts could support mobility for people of all abilities.
- *April 4, 2023 - Mobility21 Program Manager Leads Discussion Groups at THE Climate ACTION Summit* - During THE (Transportation Helping our Environment) Climate ACTION Summit, sponsored by the Association for Commuter Transportation, Lisa Kay Schweyer, Mobility21 Program Manager, led 3 discussion groups on Creating Equitable Transportation. The discussion groups talked about how equity has been and can be successfully baked into decision making and transportation options that have a positive impact on climate including free transit fares, electric vehicle charging stations, and guaranteed basic mobility.

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?

- *July 27, 2023 - Mobility21 Researchers Investigate Impacts of Online Grocery Delivery on Energy Use* - Mobility21 UTC and CMU researchers Destenie Nock, Corey Harper, Jeremy Michalek and CMU faculty affiliate Greg Lowry have been investigating the impacts of online grocery delivery on energy use, emissions and traffic congestion. Their work created a new tool to aid policy-making and planning sustainable, equitable transportation systems.

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?

- *June 20, 2023 - Michelin Group Explores Innovation Opportunities with Carnegie Mellon University* - Michelin Mobility Intelligence Pittsburgh team, which include Mobility21 UTC researcher Christoph Mertz, explored various opportunities offered by Carnegie Mellon University, including the Manufacturing Futures Institute at Mill19 and the National Robotics Engineering Center to learn about work being done and opportunities for their beyond road business segments.

- *April 17, 2023 - Miovision and Mobility21 Spin-Off Company Get Big Investment* - Miovision, which acquired Mobility21 Spin Off Company Rapid Flow Technologies and maintains an office in Pittsburgh, made the following announcement: Miovision, a leading provider of intelligent transportation solutions that enable cities to reduce traffic congestion and vehicle emissions while improving public safety, announced today it has raised \$260M in growth funding in a round co-led by TELUS Ventures, Maverix Private Equity and Export Development Canada (EDC). “This investment will enable Miovision to continue to develop our platform and quickly integrate new acquisitions, including our recent acquisition of Global Traffic Technologies (GTT), building on the momentum the company has achieved over the last 18 months with the acquisitions of Traffop, Rapid Flow and MicroTraffic,” said Miovision CEO Kurtis McBride. “These acquisitions are helping Miovision rapidly add new applications that we can deliver via our network of devices at the roadside and intersection, reducing the upfront cost of deploying data-driven solutions that can help cities make their transportation networks safer and cleaner while supporting broader urban planning objectives.

What is the impact on the body of scientific knowledge?

Outside of the previously listed peer-reviewed 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). Justin Starr and Bob Koch began developing an interdisciplinary curriculum for EV technicians that focuses on both automotive technicians and mechatronics students. Specifically, they have worked with colleagues in Germany to adapt high voltage training materials into our automotive technology and mechatronics curriculum, with an emphasis on safety practices and electrical troubleshooting. They have also demonstrated several curricular modules within the context of existing courses to gain feedback from current students. Justin Starr presented student work with Artificial Intelligence and Drones in Transportation at the Pennsylvania Water Environment Association, the Pennsylvania

Stormwater Summit, the Indiana Water Environment Association, and the Ohio Transportation Engineering Conference. Bob Koch engaged in several student outreach activities at local career and technology centers to promote advanced and alternative fuel vehicles.

CCAC’s student teams in the Student Spaceflight Experiments Conference worked to refine experimental designs and one team had their experiment loaded into Nanoracks for launch into space. Unfortunately, launch delays with NASA moved this experiment to November 2023. The next round of students has begun refining their designs for next year’s spaceflight.

Dr. Starr traveled to Germany to meet with several European colleagues on plans for advancing EV education. Specifically, he attended the Hannover Faire in April and met with Festo Didactic to collaborate on the design of EV training systems for integration into mechatronics curricula. Dr. Starr participated in several meetings at Festo’s Esslingen production facility and met with Volkswagen AG to discuss the availability of EV trainers that are made available to the Handwerkshammer and Berufskolleg system in Germany.

Justin Starr and Bob Koch continue to attend the ITS PCB working groups and are entering their second year of using the “lite” version of CAVe-in-a-Box in our classrooms. Student feedback has led to the development of several in-depth lesson plans that make use of the equipment in several settings, ranging from infrastructure technician to Ethernet systems troubleshooting.

August 2023

- CCAC met with Northern Pennsylvania Regional College in order to discuss ways in which the institutions could collaborate to serve students residing in rural Pennsylvania. A draft framework where CCAC would articulate industry credentials earned at NPRC was created and is in the process of being implemented by other institutions.
- Dr. Starr hosted representatives from St. Mary’s, PA who were looking to participate in CCAC’s existing mechatronics apprenticeship programs. CCAC provided portable trainers and offered to allow students to enroll in Zoom and hybrid courses, including those on the future of transportation.
- CCAC cut the ribbon at the Verizon Innovation Lab at their Homewood Brushton Center. Many of the courses developed by Mobility21 are typically offered at CCAC’s West Hills Center location. The Verizon Innovation

Lab provides another location for students to obtain this education, and is especially useful at serving students who are dependent on public transportation.

July 2023

- Dr. Starr supervised several apprentices in their “practical examinations” in which they applied concepts from ITS into on- the-job applications. In July, apprentices showcased their maintenance and logistics skills at Impact-Guard in Leetsdale, PA.
- Dr. Starr attended the Education 2.0 Conference, where he participated on a panel discussion covering the future of AI and technology in secondary and post-secondary education. Dr. Starr also was awarded the Outstanding Leadership in Education award.
- CCAC participated in an article by Pittsburgh Magazine discussing the impact of AI and autonomy on the college classroom. Dr. Starr was interviewed and gave several quotes about how the work of the Mobility21 project is addressing this issue.
- CCAC hosted approximately 150 students from the Verizon Innovative Learning program at the West Hills Center. Students were exposed to lab activities in mechatronics and automotive technologies.

June 2023

- Dr. Starr and Prof. Koch met with Rachel Mauer from the German American Chamber of Commerce, Pittsburgh Regional Clean Cities and the Greater Pittsburgh Automobile Dealers Association to discuss the formation of the first EV apprenticeship program in the United States. All stakeholders met to evaluate the learning outcomes and objectives of the German standard as a reference point.
- Dr. Starr presented on AI as a Skilled Trade and its applications in inspecting wastewater infrastructure at the PennTec Conference in Hershey, PA for the Pennsylvania Water Environment Association.
- Designed several labs using the CAVe-in-a-Box to troubleshoot packet loss over switched connections.
- CCAC attended the kickoff of the Safety21 National UTC at the USDOT in Washington, D.C.

May 2023

- CCAC met with representatives from Worley, an engineering firm working on several projects for Saudi Aramco to discuss ways in which community college technicians could enter the international workforce. Discussions focused on integrating green technology into curriculum, estimating the economic impacts of hiring entry-level workers with experience with advanced technology and other related topics.
- Dr. Starr and Dr. Bullock participated in an interview on KDKA-TV to discuss the students participating in the Student Spaceflight Experiments Program, and how space transportation and logistics are incorporated into programming at CCAC.
- Participated in ITS PCB Working Groups meetings.

April 2023

- Dr. Starr traveled to Germany to meet with Festo AG to plan the development of equipment that can be used to train mechatronics students in key EV concepts. Some discussions focused on automotive technician skills, but others focused on manufacturing, such as safety when assembling battery packs.
- Dr. Starr met with Volkswagen AG in Germany to discuss how training modules are provided to trade schools. Volkswagen provides bundles of vehicles and trainers for qualifying institutions that teach automotive technology. VW also allows organizations to accept vehicles on loan indefinitely for 10% of the MSRP.
- Dr. Starr met with Tesla at the IMPACT conference in San Francisco to discuss supply chain and logistics needs for technicians entering the industry.

	Research Performance Measure	Annual Target	Previous Reporting Period	Current Reporting Period	Total
Impact #1	Annual Number of Instances of Technology Adoption or Commercialization	3	4	1	5
Impact #2	Annual Number of Instances of Research Changing Behavior, Practices, Decision Making, Policies (Including Regulatory Policies), or Social Actions	3	2	2	4

6. CHANGES/PROBLEMS

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

7. SPECIAL REPORTING REQUIREMENTS

Submission of Final Research Reports: Twenty-three final research reports have been submitted to the repositories as required in the Grants Deliverables and Reporting Requirement.