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UNIVERSITY TRANSPORTATION CENTER

Carnegie Mellon University



**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, PI <https://orcid.org/0000-0002-8564-220X>
Chris Hendrickson, Co-PI <https://orcid.org/0000-0002-9812-3580>

June 30, 2021

Final Research Report
Contract # 69A3551747111

Disclaimer

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Synthesis of Research Results and Technology Trends to Inform Federal, State, Regional and Local Policies for Smart Mobility of People and Goods: Phase 3

Mobility 21 UTC Project #326 - Final Research Report
June 30, 2020

Project Details:

Stan Caldwell, PI <https://orcid.org/0000-0002-8564-220X>
Chris Hendrickson, Co-PI <https://orcid.org/0000-0002-9812-3580>

Period of Performance July 1, 2020 through June 30, 2021

Federal Funding: \$90,000

Research Description

Carnegie Mellon and its University Transportation Center partner institutions (Community College of Allegheny County, the Ohio State University, and the University of Pennsylvania) have a variety of research projects underway or completed on a diverse set of topics. Individual researchers publish research results and transfer technology for their individual projects.

This research project is intended to track disruptive technologies impacting transportation, assess a variety of policy alternatives and to synthesize research results from the full range of CMU and partner research efforts along with tracking government and industry trends to inform smart mobility policy. It is also intended to identify new opportunities for smart mobility research. The research work is conducted through a variety of activities:

- Meetings with civic and business leaders and government policy makers to discuss transportation challenges and advise on applicable smart mobility policies. These meetings include southwestern Pennsylvania, state, regional, national and international industry leaders and policy makers. Leverage the Mobility21 Deployment Partner Consortium of over 170 members.
- Presentations and publications providing policy analyses of smart mobility alternatives, such as connected and automated vehicle policies or multi-modal operational policies.
- Active participation in policy-making groups such as the Pennsylvania Autonomous Vehicle Task Force, Smart Belt Coalition, and the Pittsburgh Mobility Collective.
- Interaction with researchers at Carnegie Mellon and elsewhere to identify new opportunities for research and transportation policy improvement. Included in this activity is participation in national organizations such as Transportation Research Board the Intelligent Transportation Society of America.
- Research national and international disruptive transportation technology trends and associated policies. Synthesize and disseminate this information through the

Traffic21/UTC blog, social media and industry recognized Smart Transportation Dispatch weekly email newsletter.

Personnel

The project involves effort by Stan Caldwell and Chris Hendrickson:

Stan Caldwell is an Adjunct Associate Professor for Transportation and Policy and serves as Executive Director of Carnegie Mellon's Traffic21 Institute which is housed in the Heinz College and Executive Director of the Mobility21 National University Transportation Centers (UTC) which is housed in the College of Engineering. Both Traffic21 and the UTC are co-housed and co-staffed, and Stan manages the day-to-day operations of the three research centers. These centers fund and coordinate faculty from across the University in interdisciplinary transportation research. The research centers maintain a primary focus on deploying transportation research and technology in the community and work with public and private partners to use Pittsburgh, Pennsylvania, and the region as a smart transportation test bed. Through the work of these centers Stan has taken a nationally active role in the emerging intelligent transportation industry and serves as the chair of the Emerging Technologies Standing Committee of the Intelligent Transportation Society of America and developed the industry recognized Traffic21 Blog. He is also a founding member of the Smart Belt Coalition, Pennsylvania Autonomous Vehicle Policy Tasks Force, State Transportation Innovation Council, Pennsylvania Unmanned Aerial Systems Task Force and CAT Coalition.

Chris Hendrickson is the Hamerschlag University Professor Emeritus, Director of the Traffic 21 Institute at Carnegie Mellon University, member of the National Academy of Engineering and Editor-in-Chief of the ASCE Journal of Transportation Engineering. His research, teaching and consulting are in the general area of engineering planning and management, including design for the environment, system performance, construction project management, finance and computer applications.

Expected Impacts

This project is intended to continue the influence transportation decision making and policies with regard to new technology implementation and the improvement in mobility of people and goods both in Pennsylvania and nationally. Progress is assessed from activities such as meetings, presentations and publications as well as policy changes, technology implementations and new research projects. The first two phase of the project have resulted in accomplishments such as written policy brief and impact such as policies adopted by partners such as the Pennsylvania Department of Transportation and the City of Pittsburgh as result of this research.

Budget

Salary for SC and CTH to equal regular project amount. Funding of a masters level graduate assistant.

Matching Funds

The Traffic21 sponsored Smart Mobility Challenge is a direct complement to this research activity and the Hillman Foundation funding for the challenge can be used as matching funds. Carnegie Mellon University's Traffic21 Institute and its affiliated US DOT National University Transportation Center, Mobility21, are sponsoring a challenge to demonstrate how innovative technology can improve mobility using southwestern Pennsylvania as a test bed.

This challenge is inspired by Traffic21's years of successful collaboration with the City of Pittsburgh to become a globally recognized smart city test bed and the desire to demonstrate how suburban and rural communities can also benefit from innovative transportation.

Data Management Plan

This project does not involve extensive data resources. The primary data involves text and presentation. These documents will be managed and updated in accordance with the overall Mobility21 center data management plan.

Problem

New disruptive technologies such as vehicle automation, connected vehicles, alternative fuels and data analytics are rapidly developing and impacting society in both positive and negative ways. Federal, state, regional and local officials along with community organizations are challenged by a lack of technical capacity and information to assess these disruptive technologies and develop policies to manage their deployment in communities. Effective public policies have the potential to apply new technology to improve safety and efficiency of transportation systems and these policies can also mitigate unintended consequences of disruptive technology.

Approach

Carnegie Mellon University's Traffic21 Institute and Mobility21 National University Transportation Center have developed a proven model of Research, Development and Deployment through community partnerships. Traffic21 and Mobility21 maintain a Deployment Partner Consortium of over 170 public, private and non-profit members who collaborate with researchers to identify real-world transportation needs.

Deployment Partner Consortium

Over the past ten years Traffic21 has developed a reputation as an objective third-party advisor to government agencies and community organizations for technology and policy issues related to new developments and trends in transportation. Traffic21 also funds and manages cutting edge research in new transportation technology and interfaces with corporate partners to transfer that technology through pilot deployments and commercialization.

This positioned Traffic21 well to synthesize research results and technology trends to inform policies for smart mobility of people and goods. As Director of Traffic21, Chris Hendrickson, and Executive Director of Traffic21, Stan Caldwell the approach of the researchers in this project was to leverage Traffic21 model and partnerships to advance this synthesis research.

[3M](#)
[412 Food Rescue](#)
[Access Transportation Systems](#)
[AECOM](#)
[Airport Corridor Transportation Association](#)
[ALCO Parking](#)
[Alcosan](#)
[Allegheny Conference on Community Development](#)
[Allegheny County](#)
[Allegheny County Airport Authority](#)
[Allegheny County Office of Children, Youth and Families](#)
[Allegheny General Hospital](#)
[Allies for Children](#)
[Ambulance Service Management Corporation](#)
[American Association of Retired Persons](#)
[American Association of State Highway and Transportation Officials](#)
[American Public Transportation Association](#)
[American Traffic Signals](#) (part of Verra Mobility)
[American Transportation Research Institute](#)
[ARGO AI](#)
[Association of American Railroads](#)
[Aurora Innovation](#)
[Automatic Labs](#)
(a SiriusXM company)
[Azuga](#)
[Babst Calland Law Firm](#)
[Benedum Foundation](#)
[Bentley Systems](#)
[Beth's Barricades](#) (part of Roadsafes)
[Bike Pittsburgh](#)
[Blind & Vision Rehabilitation Services of Pittsburgh](#)
[Boeing Horizon X/NeXt](#)
[Bombardier](#)
[Booz Allen Hamilton](#)
[Borough of Dormont](#)

[Bosch Research and Technology Center, North America](#)
[The Breathe Project](#)
[Carnegie Mellon University Campus Development and Facilities Design Department](#)
[Carnegie Mellon University Center for Air Particle Studies](#)
[Carnegie Mellon University Metro21 Smart Cities Institute](#)
[Caterpillar](#)
[Center for Hearing & Deaf Services](#)
[Children's Hospital of Philadelphia](#)
[Children's Hospital of Pittsburgh](#)
[Cisco](#)
[CITA – International Motor Vehicle Inspection Committee](#)
[City of Greensburg](#)
[City of Philadelphia](#)
[City of Pittsburgh](#)
[City of Seattle](#)
[Comcast](#)
[Common Caches LLC](#)
[Conference of Minority Transportation Officials](#)
[Cranberry Township](#)
[Crown Castle](#)
[Dalian University of Technology](#)
[Delaware Valley Regional Planning Commission](#)
[Dell Technologies](#)
[Drive Sally](#)
[Duquesne Light Company](#)
[East Liberty Development Group](#)
[Easter Seals](#)
[Economic Development South](#)
[Economy League of Greater Philadelphia](#)
[Econsult Corp.](#)
[Emovis](#)
[Ericsson](#)
[Federal Highway Administration](#)
[Ford Motor Company](#)
[Freedom Transit](#)
[GAI Consultants](#)
[Gannet Fleming](#)
[General Motors Global Research & Development](#)

[Green Building Alliance](#)
[Greater Pittsburgh Chamber of Commerce](#)
[Healthy Ride](#)
[Heinz Endowments](#)
[Heritage Community Initiatives](#)
[Hill District CDC](#)
[Hillman Family Foundations](#)
[Honda](#)
[IBM](#)
[Indiana University](#)
[iNetworks Advisors](#)
[Innovation Works](#)
[INRIX](#)
[Intel](#)
[Intelligent Transportation Society of America](#)
[International Council on Clean Transportation](#)
[Jackson/Clark Partners](#)
[JITSIK](#)
[Knight Bus](#)
[Lawrence County](#)
[League of American Bicyclists](#)
[Marshall Township](#)
[Masite](#)
[Meter Feeder](#)
[MetroLab Network](#)
[Mid-Ohio Regional Planning Commission](#)
[Mileage-Based User Fee Alliance](#)
[Millvale](#)
[Miovision](#)
[Municipality of Monroeville](#)
[Municipality of Penn Hills](#)
[National Aging and Disability Transportation Center](#)
[National Association of Area Agencies on Aging](#)
[Near Earth Autonomy](#)
[North Hills Community Outreach](#)
[North Huntingdon Township](#)
[Oakland Business Improvement District](#)
[Oakland Transportation Management Association](#)
[OSHER](#)
[Panasonic](#)
[Partner4Work](#)

<u>PathVu</u>	<u>Puget Sound Regional Council</u>	<u>The Heinz Endowments</u>
<u>Peloton Technologies</u>	<u>Quaker Valley Council of</u>	<u>Three Rivers Optical</u>
<u>PennDOT</u>	<u>Governments</u>	<u>Tiramisu Transit Inc</u>
<u>Pennsylvania Motor Truck</u>	<u>Qualcomm</u>	<u>TIRES</u>
<u>Association (PMTA)</u>	<u>Quality Counts LLC</u>	<u>TomTom</u>
<u>Pennsylvania Rural Robotics</u>	<u>Radium</u>	<u>Toyota</u>
<u>Initiative</u>	<u>Railroad Development</u>	<u>Travelers Aid</u>
<u>Pennsylvania Turnpike</u>	<u>Corporation Pittsburgh</u>	<u>Tsinghua University</u>
<u>Commission</u>	<u>Rapid Flow Technologies</u>	<u>Uber</u>
<u>Pi-Lit</u>	<u>Regional Industrial Development</u>	<u>University of Pittsburgh</u>
<u>PITT OHIO</u>	<u>Corporation</u>	<u>University of Pittsburgh Medical</u>
<u>Pittsburgh Community</u>	<u>Richard King Mellon Foundation</u>	<u>Center</u>
<u>Reinvestment Group</u>	<u>Roadbotics</u>	<u>Uptown Partners</u>
<u>Pittsburgh Downtown Partnership</u>	<u>Robotics Institute Summer</u>	<u>Urban Redevelopment Authority</u>
<u>Pittsburgh International Airport</u>	<u>Scholars</u>	<u>of Pittsburgh</u>
<u>Pittsburgh Parking Authority</u>	<u>RobotWits</u>	<u>Venango County</u>
<u>Pittsburgh Technology Council</u>	<u>RubyRide</u>	<u>Venium</u>
<u>Pittsburgh Transportation Group.</u>	<u>Salvo Strategies</u>	<u>Wabtec</u>
<u>Ztrip</u>	<u>Schweiger Consulting</u>	<u>Western Pennsylvania Regional</u>
<u>Port Authority of Allegheny</u>	<u>Southeastern Pennsylvania</u>	<u>Data Center</u>
<u>County</u>	<u>Transportation Authority</u>	<u>Western Pennsylvania School for</u>
<u>Port of Pittsburgh Commission</u>	<u>Southwestern Pennsylvania</u>	<u>Blind Children</u>
<u>Portfolio Associates</u>	<u>Commission</u>	<u>Westmoreland Transit</u>
<u>PPG Industries Inc.</u>	<u>Stanford University</u>	<u>Women's Transportation</u>
<u>Precision Neuroscopics LLC</u>	<u>Sustainable Pittsburgh</u>	<u>Seminar</u>
<u>Propel IT, Inc.</u>	<u>Technische Universität Clausthal</u>	<u>Zensors</u>

Methodology

The research work for this project was conducted through a variety of activities highlighted in the following page. Under each category are specific outputs by the researchers that include:

- Meetings with civic and business leaders and government policy makers to discuss transportation challenges and advise on applicable smart mobility policies. These meetings include southwestern Pennsylvania, state, regional, national and international corporate and civic leaders and policy makers.
- Presentations and publications providing policy analyses of smart mobility alternatives, such as connected and automated vehicle policies or multi-modal operational policies.
- Active participation in policy-making groups such as the Pennsylvania Autonomous Vehicle Policy, Task Force, Smart Belt Coalition, and the Oakland Transportation Management Association.
- Interaction with researchers at Carnegie Mellon and elsewhere to identify new opportunities for research and transportation policy improvement. Included in this activity is participation in national organization such as Transportation Research Board Executive Committee and Emerging Technologies Standing Committee of the Intelligent Transportation Society of America.

- Research national and international disruptive transportation technology trends and associated policies. Synthesize and disseminate this information through the Traffic21/UTC blog, social media and industry recognized Smart Transportation Dispatch weekly email newsletter. To enable the synthesis of technology trends related to improving mobility, Stan Caldwell curates an industry recognized blog and weekly email newsletter. The Smart Transportation Dispatch is a weekly synopsis of Caldwell's research on mobility technology and research trends. Key articles along with insightful excerpts are posted on a blog and a weekly email newsletter is sent to the over 4,000 subscribers. During the 12 months of this research project 1,027 news articles were researched, synthesized, blogged and shared in social media with 1,173 twitter followers along with the 4,000 email subscribers.

Research with PennDOT

A key component of this research project was working with Roger Cohen, Pennsylvania Department of Transportation Senior Policy Advisor to Secretary Yassmin Gramian. Stan Caldwell advised a group of four CMU graduate students on an independent study course to complete a study on rural transportation. **See detailed project description below.** Following that course one of the Heinz College students, Erick Shiring, was hired as research assistant on this grant to continue working with PennDOT drafting the final report to the Secretary and Governor's Office. Following that report Shiring continued working with PennDOT staffing a post-pandemic advisory committee which included Stan Caldwell and University of Pennsylvania Mobility21 UTC researcher Megan Ryerson. A final report on the finding of this post-pandemic study is still in development and will be reported on in Phase 4 of this research project.

Traffic21 Students Present Rural Mobility Policy Study to PennDOT Secretary

July 29, 2020

The CMU Student Team, Spring 2020



Blair Chen,
MSPPM '21



Ziyu Dai,
MSCEE '21



Marcus Robinson,
MSPPM '20



Erick Shiring,
MSPPM '21

Graduate students from Carnegie Mellon University recently met with Pennsylvania Department of Transportation (PennDOT) Secretary Yassmin Gramian and members of her executive team, to present a comprehensive policy study titled *"Mobility, Accessibility, and Connectivity: Assessments and Recommendations Concerning Rural Transportation Equity in Pennsylvania."* Included in the report was a review of key national findings, an analysis of rural equity as a systemic concern in Pennsylvania, strategies and practices from around the U.S., and the students' recommendations to implement a rural transportation council. As a first-of-its-kind rural transportation model, the council would identify research and information needs, as well as

recommend and advocate for policy and program initiatives to enhance the mobility, connectivity, and accessibility of Pennsylvania's rural communities and become a model for other states.

Roger Cohen, PennDOT's Senior Policy Advisor to the Secretary and the client for this project shared: *"At a time when new technologies are dramatically redefining transportation and citizens are demanding greater accountability and responsiveness on the part of government, the student team from Carnegie Mellon looked at rural transportation services and found that there are disparities that can begin to be addressed by giving rural Pennsylvanians a greater voice in shaping the future of their communities."*

Under the guidance of Traffic21's Executive Director and Heinz College Adjunct Associate Professor Stan Caldwell and Heinz College Distinguished Service Professor Rick Stafford, CMU graduate students Blair Chen, Erick Shiring, and Marcus Robinson of Heinz College and Ziyu Dai of the College of Engineering were able to apply their knowledge and experiences to inspire real world policy change for future progress.

Also involved in the project was former Traffic21 Women in Transportation Fellow Ngani Ndimbie, executive policy specialist for PennDOT. Ngani was able to advise the students from a policy standpoint, as well as provide guidance from her experience as a Heinz College graduate. This project was supported by the Mobility21 National University Transportation Center. For more information and detail, you can read the full report [here](#).

Other Research Accomplishments and Impacts

Below are listed specific activities of researchers Chris Hendrickson and Stan Caldwell related to this research project. Activities include research presentations and meetings with government, community and corporate partners where synthesized policy research was transferred.

Traffic21 Executive Education Course Highlighted at MASITE – Pittsburgh Chapter Meeting

June 23, 2021

Traffic21 Executive Director Stan Caldwell and Program Manager, Lisa Kay Schweyer, presented an overview of the recently completed inaugural session of the CMU Heinz College executive education session "[Managing Artificial Intelligence in Transportation](#)" at the [MASITE](#) Pittsburgh Chapter Meeting. The executive education session was sponsored and developed by the Traffic21 Institute in partnership with the Heinz College Executive Education program.

PennDOT Holds Inaugural UAS Task Force Meeting

June 21, 2021

The Unmanned Aerial Systems (UAS) Task Force was organized by the [Pennsylvania Department of Transportation](#) at the direction of the [Governor](#)'s office with the vision of "*The Safe and Strategic Integration of UAS Technologies Into Pennsylvania's Transportation*

System.” PennDOT [Secretary Yassmin Gramian](#) kick off the inaugural meeting and Mobility21 Executive Director Stan Caldwell contributed as a founding member of the task force.

Mobility21 Researcher Presents PSPE Continuing Education Course

June 9, 2021

Mobility21 Executive Director Stan Caldwell presented the continuing education course “*Technology and Trends in Vehicle Automation*” to the [Pennsylvania Society of Professional Engineers](#). The course explained AV technology and trends and highlighted infrastructure applications and AV policy in Pennsylvania, and ended with a robust discussion on AV technology and policy. View the full recording [here](#).

Mobility21 Executive Director Presents at ITSA Board Meeting

June 9, 2021

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

ASCE Conference on Transportation & Development Features Traffic21 Director

June 8, 2021

Chris Hendrickson, Director of Traffic21 and researcher with Mobility21, gave a plenary talk for the [American Society of Civil Engineers’ International Conference on Transportation and Development](#) entitled “*Accelerating Deep Decarbonization for US Transportation Modes.*”

Carnegie Mellon Visited by Pennsylvania Senate Transportation Committee

June 3, 2021

Stan Caldwell, Executive Director of the Mobility21 University Transportation Center co-hosted and participated in the 2-day visit from the [Pennsylvania Senate Transportation Committee](#) to Pittsburgh. Senators [Wayne Langerholc, Jr.](#) (Chairman), [Tim Kearney](#), [John Gordner](#) and [Pat Stefano](#) joined local elected official and corporate and civic leaders for a meeting and showcase of transportation technology being developed, tested and deployed in the Pittsburgh.

The group met at Carnegie Mellon University’s facility at [Mill 19](#) in Hazelwood Green (a transformed steel mill which is now home to AV companies) for a demonstration of electric and autonomous vehicles including buses, trucks, cars and scooters. Other companies participating in the technology showcase were Spin, Tesla and Locomotion. Here Professor Rajkumar provided rides to the senators in his latest level 4 automated vehicle.



From left to right, Senators Kearney, Langerholc (Chairman) and Stefano. Read the Pittsburgh Post-Gazette article about the committee's visit to Mill 19. See media story here: <https://www.post-gazette.com/news/transportation/2021/06/03/Hazelwood-Green-autonomous-vehicle-technology-Senate-Transportation-Committee-Pittsburgh/stories/202106030198>

Traffic21 Director Contributes to Publication, Later Cited in NY Times Op-Ed

OPINION
GUEST ESSAY

Your Next Car and Clothes Dryer Could Help Save Our Planet

June 8, 2021

June 8, 2021

Traffic21 Director and Mobility21 researcher, Chris Hendrickson, serves on The National Academies of Sciences, Engineering, and Medicine's [Committee on Accelerating Decarbonization in the United States: Technology, Policy, and Societal Dimensions](#). In February 2021, the committee contributed to the [Accelerating Decarbonization in the United States Technology Policy and Societal Dimensions | National Academies](#).

On June 8, this publication was cited in the NY Times op-ed, [Opinion | To Fight Climate Change, Replace Fossil Fuels at Home and Work – The New York Times \(nytimes.com\)](#).

TRB Highlights Accelerating Decarbonization of the U.S. Energy System

May 21, 2021

Traffic21 Director Chris Hendrickson provided his knowledge and expertise for the latest TRB Newsletter Consensus Report "*Accelerating Decarbonization of the U.S. Energy System*."

Caldwell Appointed to Greater Pittsburgh Chamber of Commerce Smart Transportation Working Group

May 20, 2021

Because of Mobility21 Director Stan Caldwell's research on emerging transportation technology and policy, he was appointed to the [Greater Pittsburgh Chamber of Commerce](#) Smart

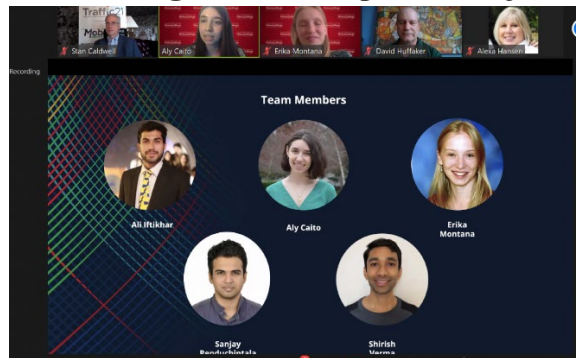
Transportation Working Group to study regional transportation technology needs. Caldwell, along with other members of the working group, presented findings and policy recommendations today at the Chamber Board of Director's meeting.

Traffic21 Executive Education Course Highlighted at PA Automated Vehicle Policy Task Force Meeting

May 12, 2021

Traffic21 Executive Director Stan Caldwell presented an overview of the recently completed inaugural session of the CMU Heinz College executive education session “[Managing Artificial Intelligence in Transportation](#)” at the quarterly meeting of the [Pennsylvania Automated Vehicle Policy Task Force](#). The executive education session was sponsored and developed by the Traffic21 Institute in partnership with the Heinz College Executive Education program.

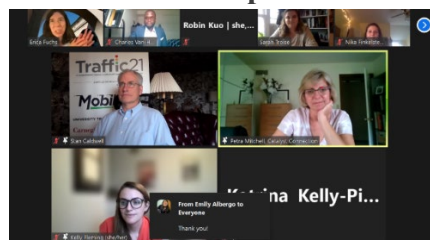
Heinz College Student Capstone Project Evaluates Transit Park and Ride Lots



May 5, 2021

Heinz College MPPM students Aly Caito, Ali Iftikhar, Erika Montana, Sanjay Renduchintala, and Shirish Verma, presented their Systems Synthesis class project “*Parking Management Scenario Planning for the Port Authority of Allegheny County.*” The course was advised by Professor Stan Caldwell and the client was Heinz College Alum [Amy Silbermann](#), Director of Planning and Service Development at the [Port Authority of Allegheny County](#). View the report [here](#).

CMU Student Capstone Course Focuses on Electric Vehicle Adoption



May 4, 2021

Stan Caldwell served on the advisory panel and provided feedback at the final presentation of the [Department of Engineering and Public Policy](#)'s undergraduate capstone project course on the local and national implications of vehicle electrification. The semester long project course was

taught by [Professor Erica Fuchs](#) and the question posed to the students was: *What are the implications of vehicle electrification for national security, geopolitical and other supply chain risks, economic prosperity (including jobs), and social welfare (including the environment and equity)?*

Traffic21 Director Chris Hendrickson Featured as Kent State Distinguished Speaker for 2021



April 22, 2021

Traffic21 Director Chris Hendrickson was featured as the Kent State Distinguished Speaker for 2021 presenting his project, "[Accelerating Decarbonization in the U.S. Transportation System.](#)"

Launch of the ITSA Urban Air Mobility Task Force

April 20, 2021

Stan Caldwell participated in the inaugural meeting of the Urban Air Mobility Task Force which is exploring education and policy initiatives around the electric vertical take-off and landing systems (eVTOLs). The task force chair is [Kristin White](#) from the Minnesota Department of Transportation and is supported by the [Intelligent Transportation Society of America Standing Committee on Emerging Technologies](#), chaired by Stan Caldwell along with [Andrew Liu](#) from AECOM.

Mobility21 Research Highlighted at Pennsylvania Transportation Alliance Meeting



April 20, 2021

Stan Caldwell provided an update to the Pennsylvania Transportation Alliance on research of Mobility21 faculty [Sarah Fox](#), [Patrick Carrington](#) and [Nik Martelaro](#) supported by the [US DOT Inclusive Design Challenge](#). The Challenge focuses on innovative design solutions to enable people with physical, sensory, and cognitive disabilities to use automated vehicles to access jobs, healthcare, and other critical destinations. Alliance members, including [Chairman John Tague](#), are community partners in this research.

Traffic21 Executive Director Stan Caldwell Reappointed to Pennsylvania STIC

April 7, 2021

Stan Caldwell participated in the quarterly meeting of the Pennsylvania Department of Transportation and the [Pennsylvania Division of the Federal Highway Administration State Transportation Innovation Council](#) where he was recognized with eight other members (including Penn State UTC Director [Eric Donnell](#)) and has been re-appointed to the board for another two-year term.

Managing AI in Transportation Webinar Provided Preview of Executive Education Course

March 26, 2021

Transportation industry leaders presented a preview of the upcoming executive education program from Heinz College and Traffic21, “[Managing Artificial Intelligence \(AI\) in Transportation](#).” Stan Caldwell, Executive Director of Traffic21/Mobility21 UTC, [Mark Kopko](#), Director of the Office of Transformational Technology for [PA Department of Transportation](#), [Summer Fowler](#), Chief Information Officer at [Argo AI](#) and [Allanté Whitmore](#), a Ph.D. candidate earning a joint Ph.D. in Civil Engineering and Engineering and Public Policy at Carnegie Mellon University discussed how AI is impacting all facets of transportation as well as the challenges and opportunities that private and public sector professionals face in managing this new technology. View the presentation [here](#).

CEDM Visiting Speaker Seminar Features Traffic21 Director



March 22, 2021

Traffic21 Director Chris Hendrickson was invited to present at a recent [Center for Climate and Energy Decision Making \(CEDM\)](#) seminar, where he presented his work with the [National Academies of Science, Engineering, and Medicine](#), “*Accelerating Decarbonization in the United States: Technology, Policy and Societal Dimensions*.”

Traffic21 and Metro21 Join Pittsburgh Region Broadband Study

March 18, 2021

Karen Lightman, [Metro21](#) Executive Director and Stan Caldwell, Traffic21 Executive Director participated in a kick off meeting for a regional broadband study led by the [Southwestern Pennsylvania Commission](#) in partnership with Carnegie Mellon and [Allies for Children](#). The [Hillman Foundation](#) provided funding for this project and [Michael Baker Corporation](#) has been contracted for support.

Stan Caldwell Presents at ITS America Board Meeting

March 18, 2021

As chair of the [ITS America Standing Committee on Emerging Technologies](#), Mobility21 Executive Director Stan Caldwell was joined by Vice-Chair [Andrew Liu](#) from [AECOM](#) in participating in the ITS America Board of Directors Meeting to present the first report of their committee activity on programing and policy. Stan's current Mobility21 research on transportation technology and policy supports this committee activity. Also presenting at the board meeting was [US DOT](#) Senior Advisor [Carlos Monje](#).

Mobility21 Engages with Pennsylvania Clean Transportation Table

March 15, 2021

As a member of the [Pennsylvania Clean Transportation Table](#), Mobility21 Executive Director Stan Caldwell participated in the March 2021 meeting, where participants discussed clean transportation technology and policy initiatives including electric those for electric vehicles.

Mobility21 UTC Activity Highlighted in Congressional Briefings

March 15, 2021

Stan Caldwell joined fellow University Transportation Center members of the [Research, Education and Training Reauthorization Coalition](#) (RETRC) in virtual congressional staff briefings on UTC accomplishments and impacts. Caldwell made presentations on Mobility21 National UTC research, education and technology transfer activity to staff from the following offices in a separate meeting:

- *[Senator James Inhofe](#)*
- *[Senator Joni Ernst](#)*
- *[Congressman Sean Patrick Maloney](#)*
- *[Congressman John Katko](#)*

ITSA Broadband Deployment Task Force Holds Inaugural Meeting

March 5, 2021

Mobility21 Executive Director Stan Caldwell was appointed to serve on the [ITSA Broadband Deployment Task Force](#), which held their inaugural meeting.

The ITS American Broadband Deployment Task Force is developing broadband policy for FAST Act reauthorization to support the 21st century connected, automated, shared, on-demand, and electrified transportation system. The task force's programmatic activities focus on ITS and edge device data to aid in the increase of safety and mobility and be the infrastructure pillar to bridge the rural and urban digital divide and advance public safety efforts.

Stan Caldwell Moderates Pennsylvania AV Summit Session

March 4, 2021

As a member of the 2021 [PA AV Planning Committee](#), Mobility21 Executive Director Stan Caldwell moderated a webinar on automated vehicle safety and validation with the following panelists:

- *Nat Beuse, Aurora*
- *Maureen Brown, Munich Re*
- *Amy Chu, Automated Vehicle Safety Consortium*
- *Jackie Erickson, Edge Case Research*

Mobility21 Joins Great Lakes Chamber on Congressional Briefing



March 3, 2021

Through Mobility21 Executive Director Stan Caldwell's UTC work on emerging transportation technology with the [Greater Pittsburgh Chamber of Commerce](#), he participated in a meeting with Wisconsin [Congressman Mike Gallagher](#) and a small group hosted by the [Great Lakes Metro Chambers Coalition](#) for a discussion on “*Designing Infrastructure Policies for the 21st Century*.”

Mobility21 Discusses Transportation Policy Research with Senator Langerholc



February 25, 2021

Stan Caldwell provided a private briefing on emerging transportation technologies and the Mobility21 National UTC to Pennsylvania State Senator [Wayne Langerholc](#), Chairman of the Senate Transportation Committee and discussed transportation policy research.

IPMI Summit Features Stan Caldwell

February 25, 2021

Stan Caldwell presented his Mobility21 research on emerging transportation technology trends on a panel in the closing session of the International Parking and Mobility Institute (IPMI) [Mobility and Innovation Summit](#) which was attended by two hundred transportation professionals.

Traffic21 Director Chris Hendrickson Provides Insights for GAO Report



February 16, 2021

The US Government Accountability Office recently released their report “[*Ensuring a Skilled Workforce in the USDOT*](#)“, which includes insights from Traffic21 Director Chris Hendrickson. The report highlights steps that should be taken to ensure the workforce has the skills necessary to oversee safety.

ITS America Emerging Technologies Standing Committee Welcomes Mobility21 Executive Director as Chair



February 9, 2021

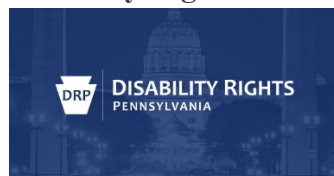
Stan Caldwell has been appointed chair of the [Emerging Technologies Standing Committee](#) of the Intelligent Transportation Society of America and was joined by Vice Chair Andrew Liu from [AECOM](#) in hosting the inaugural committee meeting. Committee members will participate in task forces for program and policy development of emerging ITS technologies.

PA Automated Vehicle Policy Task Force Quarterly Meeting

January 27, 2021

Mobility21 UTC Director, Raj Rajkumar and Executive Director, Stan Caldwell participated in the Pennsylvania Department of Transportation [Automated Vehicle Policy Task Force](#) Meeting where public and private stakeholders discussed automated vehicle initiatives in Pennsylvania and issues related to the safe adoption of automated vehicle technology. Rajkumar and Caldwell are founding members of the task force.

Disability Rights PA Hosts Transportation Alliance Meeting



December 15, 2020

Stan Caldwell presented at the Pennsylvania Transportation Alliance meeting hosted by Disability Rights PA. He provided an overview of Mobility21 UTC research related to improving mobility for people with disabilities.

Transportation Engineering & Safety Conference Highlights the Future of Shared Mobility

December 10-11, 2020

Stan Caldwell, Executive Director, and Lisa Kay Schweyer, Program Manager, Traffic21 Institute, and Mobility21 National



**TRANSPORTATION ENGINEERING
AND SAFETY CONFERENCE**

University Transportation Center organized and moderated 2 conference sessions during the Transportation Engineering and Safety conference on changes in transportation/mobility operation due to COVID-19 and the future of shared mobility.

UITP Research in Mobility Committee Meeting Discusses ‘Technology’

December 11, 2020

Mobility21 Executive Director Stan Caldwell provided his insight while speaking at the recent UITP Research in Mobility Committee meeting, led by Ms. Jill Hough of North Dakota State University. The topic of the session revolved around “*Role of Technology to Support Innovation and Shape the Future of Urban Mobility Post-COVID.*”

Traffic21 Director Chris Hendrickson’s Article on “Technology Revolutions” Featured in TR News

December 1, 2020

Traffic21 Director Chris Hendrickson’s paper, “*Technology Revolutions: Bringing Tomorrow Here Today*,” co-authored by Johanna Zmud, was published by TR News.* Read the article [here](#).



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TRB Special Projects and Policy Committee Meeting

November 12, 2020

Chris Hendrickson, Faculty Director of Traffic21 and researcher in Mobility21, attended the Transportation Research Board’s Special Projects and Policy Committee. A wide range of issues were discussed, including strategic plans, the critical issues documents and future policy studies.

Pittsburgh Bus Rapid Transit Holds Review for Final Design

November 9, 2020

Stan Caldwell participated in the Stakeholder Panel review of the Pittsburgh Bus Rapid Transit Final Design. Port Authority of Allegheny County’s Downtown-Uptown-Oakland-East End BRT service plan calls for a “core” route that runs east-west between downtown and Oakland with three branches that go to Greenfield, Highland Park and through several Mon Valley communities.

Traffic21 Director Receives Torrens Best Editor Award for 2020

November 7, 2020

Chris Hendrickson, Director of Traffic21, attended the virtual American Society of Civil Engineers Editors Workshop. During the workshop, he received the Torrens Best Editor Award for 2020. The workshop was an opportunity to discuss new technology and both administrative and ethical issues in organizing peer reviews for thousands of ASCE submission.

Review of Federal Railroad Administration Research & Development Program Published

November 3, 2020

Traffic21 Director Chris Hendrickson recently helped review the Federal Railroad Administration Research & Development Program. The Transportation Research Board (TRB) formed the Committee for a Review of the Federal Railroad Administration's (FRA's) R&D Program at the request of FRA's Office of Research, Development, and Technology (RD&T) for strategic feedback on the program. Access the full report [here](#).

NCHRP ADS Framework Summit

October 26, 2020

Stan Caldwell was one of a select group of industry stakeholders recruited to provide feedback on the *NCHRP Report 17-91 Assessing the Impacts of Automated Driving Systems (ADS) on the Future of Transportation Safety through a series of three virtual summit sessions*.

“Are We There Yet?” – UIC Urban Forum Panel Discussion

October 21, 2020

Stan Caldwell presented findings from his automated vehicle policy white paper “*Are We There Yet? Deployment of Connected and Automated Vehicles in the U.S.*” co-authored by Chris Hendrickson at an UIC Urban Forum Panel Discussion. Caldwell was joined by Austin Lannes Brown Executive Director of the Policy Center for Energy, Environment and the Economy at UC Davis and moderated by P.S. Sriraj Director, Urban Transportation Center, University of Illinois at Chicago. A recording of the webinar can be found at this link. <https://urbanforum.uic.edu/forum-white-papers/white-paper-presentation-webinar/>

Inaugural Bus Technology Summit Includes Presentation by Mobility21 Executive Director

September 22, 2020

Mobility21 Executive Director Stan Caldwell discussed his UTC research on disruptive transportation technology trends at the inaugural [Bus Technology Summit](#) in a session titled, “*Embracing Technology Disruptions with Cautious Optimism in the COVID Era.*” This summit was presented by School Transportation News.

Automated Vehicle Industry Trends Discussed at TMACC Meeting

September 17, 2020

This morning, Stan Caldwell presented his Mobility21 research on automated vehicle industry trends along with PennDOT Director of Transformational Technology to industry and community transportation professionals at a webinar hosted by the [Transportation Management Association of Chester County](#).



Hendrickson Updates Transportation Research Board Executive Committee

August 19, 2020

Chris Hendrickson, Faculty Director of the Traffic21 Institute and a Mobility21 UTC researcher, attended the Transportation Research Board's Executive Committee Meeting August 17-19, 2020. Hendrickson made a presentation as Chair of the TRB Division Committee, reporting on committee activities and statistics on diversity of TRB volunteers.

Stan Caldwell Presents at Pittsburgh Chapter of Women's Transportation Seminar

August 13, 2020

Mobility21 Executive Director Stan Caldwell presented "*Autonomous Vehicles: Why Now and Why Pittsburgh*" at a webinar hosted by the Pittsburgh Chapter of the [Women's Transportation Seminar](#). This presentation on Caldwell's University Transportation Center funded research highlighted industry and technology trends and public policies aimed put in place to enable innovation and mitigate risk.



2020 TIDC Annual Conference Features Stan Caldwell as Keynote Speaker

August 12, 2020

The Region 1 UTC, [Transportation Infrastructure Durability Center at the University of Maine](#), featured Stan Caldwell from Carnegie Mellon University's Mobility21 National UTC as keynote speaker on disruptive transportation technologies and infrastructure durability.

The purpose of the annual conference is to educate, engage, and work with varied stakeholders (academics, industry professionals, state DOTs, and other government agencies) to solve transportation challenges facing the New England Region and beyond. The conference is an opportunity to inform stakeholders on TIDC's research and technology transfer activities. This includes showcasing contributions TIDC researchers have made to a wide-range of transportation fields, including: structures, concrete materials, monitoring and assessment, and future efficient manufacturing techniques in transportation (i.e. 3D printing molds).



PA Rural Robotics Impact on Workforce Development



July 20, 2020

Mobility21 Executive Director Stan Caldwell met with Brad Moore, District Director for Congressmen Glenn Thompson PA-15, Venango County Commissioner Chip Abramovic, and Tim Heffernan, founder of the PA Rural Robotics Initiative to discuss the STEM activity between Mobility21 and PA Rural Robotics and its impact on Pennsylvania rural workforce development.

Media Citations for Caldwell and Hendrickson

4/26/21

Are user fees a middle-class tax hike or a fairer way to pay for infrastructure in Pittsburgh region?

“We have a grasp of what this stuff costs, but we don’t have a grasp on long-term financing of it,” said Stan Caldwell, adjunct associate professor of transportation and public policy at Carnegie Mellon University.

As the Highway Trust Fund has eroded over time, project fixes have been kicked down the road, and user fees have become more disconnected from the people who pay them, transportation experts said.

Drivers who use the Pennsylvania Turnpike complain their tolls fund urban public transit projects in Pittsburgh and Philadelphia, and public transit advocates complain federal transit spending remains too low. Pennsylvania Gov. Tom Wolf, a Democrat, created a task force last month to look at alternatives to the gasoline tax.

“The federal government is not addressing this, and so therefore the states have to keep doing it on their own and keep coming up with their own plans to fill in the gaps,” Mr. Caldwell said. “The system we have now, it can be argued, is a result of a lack of addressing this at the core.”

[More>>](#)

3/5/21

The world’s first driverless water taxi has been built in Tennessee

“Autonomous ship applications have advanced rapidly because vessels on waterways have less potential conflicts to navigate than vehicles on roadways, especially city streets,” says Stan Caldwell, adjunct associate professor of transportation and public policy at Carnegie Mellon, and executive director of the university’s Traffic21 Institute.

Automated cars and trucks need to contend with each other and with pedestrians, so a waterway is definitely more flexible than roadways. This doesn’t mean water paths don’t have their own challenges though. “Potential conflicts would be debris in the water, shallow water, and other

vessels, but even these are more limited than what you might encounter on a roadway,” says Caldwell. Docking and crossing are also good applications of marine self-driving robots. “Automation can enable precision docking with use of sensors as we have seen applied with automated buses,” Caldwell says.

[More>>](#)

5/17/21

Who Will Pay To Help Solve America’s Worsening Infrastructure Crisis

Rather than looking for ways to pay for the crisis, it can make more sense to include the cost of maintenance with the fees that are associated with using various aspects of the infrastructure.

Stan Caldwell, executive director of the Traffic21 Institute at Carnegie Mellon University, said, “Traditionally, transportation has been funded in the United States with user fees such as tolls, fuel tax and vehicle registrations. User fees seem fair, as the more you use the system the more you pay, but [they are] actually considered a regressive tax since a lower income individual pays a disproportionately high portion of their income.

“Companies who are dependent on shipping, such as retail and manufacturers, do fund transportation through user fees such as tolls, fuel tax and vehicle registration, but a corporate income tax would also generate revenue from companies in the service and finance sectors,” he said. [More>>](#)

2/26/21

Roads, transit and tech: How Buttigieg plans to localize the federal transportation agenda

He has pledged new federal automotive fuel economy standards to reduce greenhouse gas emissions and install 500,000 electric vehicle charging stations nationwide by 2030. He wants to move forward on long-awaited federal rules governing autonomous vehicles.

Touting his expansion of bike lanes in South Bend, he will seek to double the funding for the Transportation Alternatives Program, which funds biking and walking mobility. And he has floated funding the Federal Transit Administration at \$150 billion, an almost 13-fold increase from its current budget of \$12 billion.

“He’s going in the same direction as we are,” said Stan Caldwell, adjunct associate professor of transportation and public policy at Carnegie Mellon University.

“He understands the impact of transportation not just as the movement of people and goods but as community and economic development for a city, and how important it is to a city and a region,” Mr. Caldwell said. [More>>](#)

1/13/21

The pandemic cost public transit dearly. Will Pittsburgh-area riders return in 2021?

Stan Caldwell, executive director of the Traffic21 Institute at Carnegie Mellon University, noted that many people still don't feel safe enough to use transit.

"In my opinion, both locally and nationally, it's a clear reluctance for people to be in close proximity to other people in an enclosed environment," Caldwell said. "So we are seeing people taking other modes of transportation, and we are seeing vehicle miles traveled going back up to pre-pandemic levels here in the state of Pennsylvania and nationally."...

As COVID-19 cases rose, Pennsylvania again mandated telework, unless impossible. And it's not hard to imagine some companies will use more telework even after the pandemic.

"There was a lot of fear of loss of productivity if that would happen, but I think companies have seen the opposite, have seen increased productivity. So yes, that's a big concern," Caldwell said. "And if a system has been reliant on the revenues of that, it changes their revenue models significantly." [More>>](#)

10/5/20

What Insurance Do I Need For Micro-Mobility?

For anyone using a micro-mobility device like a skateboard, e-bike or scooter, health insurance will generally cover your injuries if you crash. If someone else crashes into you, you can potentially sue them (and get a payout from their liability insurance) for injuries and damage to your micro-mobile.

Buying additional coverage for your small transportation probably isn't worth it. "The product quality isn't at a good enough level yet," says Strobel. "Most of the e-scooters you see around in the city have a surprisingly low lifespan."

The insurance question for micro-mobility devices is largely unresolved. A scooter rental company like Lime, for example, deals with the liability issue by requiring customers to sign an agreement that limits its liability.

"Micro-mobility presents operators, and their fellow sidewalk and road users, with new risks," says Stan Caldwell, executive director of the Traffic21 Institute at Carnegie Mellon University. "And wherever there is risk, insurance will find a market." [More>>](#)

Findings

This synthesis of research trends impacting the mobility of people and goods has informed policy on the local, regional, state and federal levels. Activities associated with this research have brought together academics, government officials, industry leaders and community organizations to better understand and engage in discourse on policies related to disruptive transportation technology. Results of this

research have been disseminated to legislators and transportation agency officials as well as civic leaders, academics, industry professionals, advocacy organizations and the general public through the activity outlined in this report.

Research from this project has identified the current industry and technology trends of disruptive transportation technologies and related policy implications:

With the recent decision of the Federal Communications Commission to open the 5.9 GHz band, it appears that Dedicated Short Range Communications is being eclipsed by cellular vehicle to everything (CV2X) which is expected to be further enabled with 5G cellular infrastructure. Policy issues around CV2X include state and local investments in communications and ITS infrastructure, equity of 5G and other broadband communications access, private ownership, and deployment of small cells and other infrastructure along public roadways.

Advanced communications and information technologies has enabled data analytics applications such as ride hailing, bike and scooter share, real-time transit information and multi-modal navigation applications. These data driven applications pose policy issues of their equitable distribution and use, privacy and competition with public transit.

Level 2 automation is currently in production vehicles and data is showing increased safety and cost savings from these early automation features. Policy issues exist in marketing and consumer understanding of the limitations of these technologies as well as the affordability of vehicles equipped with this technology. There are various level 4 automated vehicle pilot deployments with, and without, drivers in various locations operating under a patchwork of state and local regulation. Industry investment in automated tractor-trailer truck technology have recently dominated the robo-taxi business model but pilots and deployments in both models are continuing. Many policy issues exist with level 4 testing and deployments including safety, privacy, security, emissions, equity, and worker displacement.

There has been legislation in many states enabling Personal Delivery Devices (PDDs) that have no operator on board and can weigh up to 500 pounds empty, travel in up to 25mph and operate on sidewalks and roadways. Policy issues include conflicts with pedestrians, especially disabled, on the sidewalks, and cyclist and other vehicles on the roadways, in cities where they are deployed. This technology also highlights the policy issues around cities monetizing the curb which also impacts ride hailing and goods delivery services.

Significantly more consumer adoption of battery electric passenger vehicles is expected as range of battery electric vehicles is rapidly increasing along with OEMs and new EV companies aggressively rolling out new battery electric vehicle models. Policy issues around this trend include addressing climate change with EV adoption, electric grid resilience, public charging infrastructure (including inductive charging), and equity issues of charging in low income communities without off street parking.

Smaller battery electric trucks and vans for local deliver and transit vehicles are also being commercially deployed. There are pilot demonstrations of various tractor-trailer truck battery electric trucks but range and efficiency are still issues. Policy issues include the emissions reduction for freight movement.

Electric vertical take-off and landing systems (eVTOLs) for both freight and people movement is rapidly evolving and includes hundreds of startup companies along with traditional logistics companies such as Fedex, UPS and Walmart. These eVTOLs have exposed policy issues among the FAA, NASA and city and state governments in areas of placement of vertiports, privacy, safety, noise and sight pollution, interference with low altitude aircraft, and impacts on ground transportation.

The pandemic era has exacerbated digital divide and highlighted the need for all communities to have adequate and affordable broadband access as communications emerges as a new mode of transportation of goods, services and people. Investments in broadband communications and planning for post pandemic mobility patterns require continued research of disruptive transportation technologies trends and associated policy recommendations. Policy issues include equitable deployment of affordable service in disadvantaged urban and rural communities, local government preemption, resilience and security, and infrastructure ownership models including cooperatives.

Conclusion and Recommendations

The past year of research has shown a significant industry shift in emerging technologies driven by rapid advances, significant industry investment, and commercialization in all types battery electric vehicles including cars, trucks, drones, planes, bikes, scooters, motorcycles and off road vehicles.

This EV advancement continues in parallel with connected, automated and shared vehicle technologies and local, regional, state and federal policy makers recognize the need for further research to guide them in taking advantages of the opportunities and mitigating threats.

The past year of research has also demonstrated the interest of policy makers, industry leaders and the general public in addressing equity in all modes of transportation. Transportation infrastructure, operation and planning need to incorporate a deliberate effort to ensure transportation technology and investments are innovating mobility for all.

In future research we recommend a focus on the equitable deployment of emerging mobility technologies and the impact on climate change, particularly with rapid advances in electric vehicle technology for micro-mobility devices, drones, passenger and freight vehicles. Just as with broadband infrastructure, vehicle charging infrastructure will be critical to the equitable deployment of this technology. We also recommend the continued parallel tracking and synthesizing of all disruptive transportation technologies including automated, connected, shared, electric and novel.