Center for Teaching Old Models New Tricks (TOMNET)
A USDOT Tier 1 University Transportation Center
PROJECT PROPOSAL

Title: Emerging Approaches to Autonomous Vehicles in Transportation Policy and Planning

Principal Investigator: Thaddeus Miller, Assistant Professor, School for the Future of Innovation in Society, The Polytechnic School, Co-Director: Center for Smart Cities and Regions, Arizona State University
Co-Principal Investigator: Ram Pendyala, Professor, School of Sustainable Engineering and the Built Environment, Director: TOMNET University Transportation Center, Arizona State University
Co-Principal Investigator: John MacArthur, Research Professor, Transportation Research and Education Center, Portland State University

1. Introduction

As autonomous vehicles (AVs) emerge, cities must grapple with how to utilize and manage these new disruptive technologies to advance public policy goals and deliver urban services related to public health, equity, economic development, mobility, and sustainability. Yet, cities and their communities and governmental institutions remain largely reactive in how they manage and integrate emerging technologies into policies, regulations and existing socio-technical systems. Instead, urban governments and communities must learn how to anticipate the potential impacts of emerging technologies (Guston 2014) and manage them based on community needs and values. Transportation planning models, for example, form the basis for transportation infrastructure planning, investment and development. The models are typically updated every 5-10 years and based on one-day travel survey data. As a result, AVs are not currently easily captured in the models or in the transportation planning process. AVs offer an opportunity to re-think how people and goods move around. As such, AVs could be a catalyst for new mobility policy and planning. Yet, AVs might also further entrench car culture in automobile dominated cities, drawing people away from other modes, including biking and public transit, with significant implications on land use, equity and mobility access. If cities are to seize the wider opportunity presented by the emergence of AVs, now is the time to develop policy and infrastructure solutions. This study will explore how policy, planning and modeling approaches to AVs are emerging in metropolitan planning organizations in the US. The results will provide the most comprehensive assessment of AV policy and planning to date and offer an opportunity to reflect on the limitations of current approaches and possibilities for future efforts.

Unfortunately, a recent collision during testing of an AV in Tempe, Arizona – resulting in the tragic death of Elaine Herzberg – raises doubts as to whether governance practices are progressing apace with the technology itself. This collision brought to the fore issues that had been subsumed under industry hype and academic trolley debates. This event revealed that even safety performance standards for AVs have not been established and those standards that do exist lack transparency and may be insufficient. It is clear that substantial ground needs to be made up to bring modeling, policy and planning in line with the progress of AV tech development. What problems will the sharing of roads by human-operated and self-driving vehicles produce? What wider impacts will AVs have on society? What approaches to governance are emerging for this technology and which are most successful? How should transportation models handle questions of AV use and travel behavior at such an early stage in development? These are just some of the many questions planners are only just beginning to wrestle with as AV development rapidly advances.

Many researchers have explored modeling scenarios involving AVs, but these typically take the form of conceptual navigation models based on quantitative transportation behavior and aimed at predicting roadway safety or efficiency under different conditions — for example, human/autonomous mixture (Bagolee et al. 2016), game-theoretic scenarios in various novel physical environments (Millard-Ball 2018), or environmental impacts (Thomopoulos and Giovanni 2015). Fewer studies have attempted to model the second and third order impacts of AV technology (Bahamonde-Birke et al. 2016; Milakis et al. 2017) and recent attention has been paid to perceptions of AVs by non-drivers (Hulse et al. 2018). Anticipatory governance and regulatory strategies, however, continue to be under-analyzed (Fagnant and Kockelman 2015, Hanna and Kimmel 2017). Guerra (2016) found that AVs were mentioned in a surprisingly low number of Long Range Transportation

Plans (LRTPs) produced by some of the nation's largest metropolitan planning organizations (MPOs) – just one out of twenty-five, in fact. These plans, which are generally updated every three to five years, are official policy strategy documents containing a 20-year transportation planning horizon vision. Guerra's interviews with representatives of the MPOs revealed that planners were by no means ignorant of advancements in autonomous driving technology and that their lack of engagement with the topic had more to do with the many uncertainties surrounding AVs – as with any new, disruptive technologies. Specifically, uncertainty made it difficult to effectively plan for their implementation and the long-term nature of the issue was at odds with other more immediate policy and investment priorities. Our own initial research reveals that recently updated LRTPs are more likely to mention or even substantively discuss AV technology. For example, Portland's RTP has a detailed section on emerging technology strategies but the regional models have not been updated to include AV uptake. Further, the growing ecosystem of AV researching and testing initiatives being pursued by government, industry, and academic units across the country is evidence of the greater attention being paid to these issues by key stakeholders.

As cities attempt to develop coherent modeling and policy approaches for AVs, this is a critical moment to take stock. How are planners beginning to conceptualize and talk about AVs and their impact on society? Also, what approaches are beginning to emerge? What are the potential impacts to existing transit systems? How are planners collecting the data they use to model AVs? Which stakeholders are they engaging and where? How are they incorporating AVs into transportation models? What assumptions are modelers making and why? Previous studies have been unable to explore these questions in depth due to the lack of AV policy development and there are many unknowns about market penetration and type of business models which will be deployed. Through content analysis of LRTPs, interviews with policy-makers, planners and modelers, we begin to explore these questions at a time when AV policy and planning is rapidly emerging. This project will provide an analysis of the state-of-play in MPOs' approaches to AVs. In turn, it will improve our understanding of the system of relations and allow more robust modeling of this innovation.

2. Project Objectives

This study will examine the most recent LRTPs developed by MPOs to analyze how autonomous vehicles are being incorporated. More specifically, we will analyze how transportation planners are characterizing the risks and benefits of AVs, identify emerging regulatory frameworks, and analyze early modeling approaches to forecast traveler behavior under alternative AV scenarios. Following this, we will conduct interviews with management and staff from a sample of ten MPOs to explore in more depth efforts to model AVs, and identify emerging critical barriers and innovations to transportation policy and planning for AVs. Interviews will focus on modeling approaches to AVs and how they are incorporating human attitudes, values, and perceptions in the modeling and forecasting of future travel demand related to AVs. The researchers have strong relationships with the Association of Metropolitan Planning Organizations (AMPO) and will work with them on this project. The outcome of this study will be the most comprehensive analysis of AV policy, modeling and planning to date. This will enable greater reflection on the governance of AVs at this critical time. The research team will generate a peer-reviewed publications analyzing and comparing emerging modeling and policy approaches to AVs, and a white paper report accessible to practitioners. The team will also present findings to practitioner audiences. Finally, this research will serve as the first step to a larger proposal that will explore broader urban policy and planning approaches to AVs, including practitioner and community engagement.

3. Proposed Methodology and Data

<u>Background Literature Review</u>

The Research team has reviewed the most recent literature dealing with this issue, especially those articles that look specifically at strategies and perspectives of regional and local governments, but not excluding professional reports, academic literature, and mainstream media reporting. However, connected and autonomous vehicle technologies represent a fast-moving target and any attempt to capture it within the scope of any single study will inevitably fall short, as development – and thus, discourse – will have progressed in the

meantime. In an effort to mitigate the deleterious effect of studying a disruptive technology as it emerges, the review process will be ongoing and iterative throughout the course of the study.

Content Analysis of Governmental Documents

The LRTPs produced by regional MPOs, which are the key focus of our research, are periodically updated — generally every 3-5 years — and their content could change dramatically from one edition to the next. Given how much AV development has progressed in the last 3-5 years, we expect our content analysis of the most recent plans to reveal an increase in the amount of attention these technologies are given as well as the range and diversity of topics addressed. We have selected almost thirty LRTPs produced by the largest MPOs (in terms of population residing within their constituent regions) in the United States for our content analysis. It is possible, even probable, that LRTPs currently under development will contain richer discourse related to AVs. When an MPO has made drafts of not yet ratified plans publicly available, we will examine those in addition to the LRTP on record for that region. Further, we will aim to learn as much as possible about considerations related to AVs in LRTPs still under development through our MPO interviews (see below). Finally, the study will incorporate additional documents, such as advisory protocols, produced by AV pilots and initiatives in which these MPOs participate.

The documents will be analyzed and coded inductively by the team's graduate research assistant using qualitative analysis software, in consultation with the Principal Investigators. Analysis will focus on the following: modeling approaches; AV scenarios; identified modeling challenges; assumptions about travel behavior; assumptions about human values, attitudes and perceptions related to AVs; proposed regulatory frameworks; transportation infrastructure changes; discussions of risk; policy and planning goals for AVs; and proposed policy approaches.

Interviews with MPO Management and Staff

The production of LRTPs is a long process and unlikely to capture the full range of AV-related discourse among metropolitan planners. Therefore, we will supplement our document analysis with one-on-one interviews with key personnel from planning organizations — 2-3 from ten of the MPOs, for a total of 20-30 interviews. They are important not only to provide necessary insights into practices of MPO transportation planning, but also as a way to access myriad other pieces of information about governance related to AVs and emerging technologies in general, as well as how planners work in situations of high uncertainty. By pairing document analysis with interviews, we will gain a deeper sense of why certain approaches are favored over others, as well as what challenges are perceived and how they are confronted. Finally, interviews may reveal more nuanced perspectives by illuminating discourse from the MPO planning process that does not make it into the final LRTP and why.

Interviewees will include MPO modelers, planners, and managers selected based on their involvement in producing the LRTPs and other documents, as well as their familiarity with planning concerns specifically related to AVs. By interviewing both MPO managers, who work to incorporate a coherent overall transportation vision, and frontline planners, who deal more directly with specific details related to particular issues, we will develop a more complete understanding of the planning process. The interviews will adhere to a set of predetermined questions but opportunities to explore interesting lines of investigation will be pursued where they present themselves. We are particularly interested in questions about how decisions around transportation models and AVs are made, cross-sector collaboration, public engagement, perceived barriers to planning efforts, and potential risks of AV technology implementation. The interviews will be conducted by all members of the Research Team and conducted in person when possible, but, due to geographical distribution, many will have to be performed via Skype or telephone. We have already received IRB approval from ASU and PSU for the interviews. Interviews will be transcribed and coded using the same software as the LRTPs and focusing on the same objects of analysis.

Comparative Analysis

Each MPO presents a case study in emerging AV governance strategies, allowing the opportunity to approach this research as a cross-site comparative analysis. A comparative analysis allows for identification of where concrete policy choices differ, how and why such differences occur, and where common approaches (particularly related to modeling) are emerging. AVs are likely to manifest in urban landscapes in a diversity of ways with both positive and negative outcomes. This comparative analysis will enable an exploration of how different MPOs are approaching AVs that may ultimately drive outcomes.

4. Work Plan

Literature review

- The research team will conduct a thorough review of relevant literature related to this topic. Sources for this material will include mainstream media videos and articles, academic literature, professional reports, reports from research initiatives, government policy reports, and strategic documents produced by local and regional governments. This review, which has already begun, will be ongoing throughout the process to ensure the most current and up to date understanding of the issue.

LRTP document analysis

- The research team will conduct a detailed, inductive content analysis of LRTPs produced by ~30 MPOs. The research team will keep a codebook and a shared excel file with the analyzed data.

Related AV initiatives document analysis

- Beyond the LRTPs, the team will identify and analyse AV pilot programs and initiatives that involve MPOs. The project team will work with AMPO on the development of our pool of MPOs. These documents may provide a more in depth and up-to-date picture of AVs in metropolitan areas. The documents will utilize the same coding scheme discussed above.

Interviews with MPO staff and management

- Following the coding of documents, interviews will be conducted with members of the MPO teams that produced the LRTPs and are involved with AV pilots/initiatives. These interviews will be contacted over the phone or Skype. The team will conduct interviews with 2-3 staff from a selection of 10 MPOs, including those leading modeling efforts. Interviews will enable the research team to get the most current and detailed understanding of policy, planning and modeling approaches. Interviews will build on issues identified in the document analysis and further explore modeling approaches and barriers, potential policy approaches, infrastructure changes, etc.

Transcribing and analyzing interviews

- The research team will transcribe the recorded interviews for more detailed content analysis. This data will be combined with that from the document analysis to produce answers to the group's research questions. Coding of interviews will follow the scheme set out in the document analysis.

Peer-reviewed publication write up

- The research team will produce one article with the previously mentioned data during the funded period (additional articles may be written based on the data collected during the project funding). The purpose of the article will be to provide an overview of how MPOs are approaching AVs through LRTPs and other initiatives and develop a discussion about the current limitations and positive opportunities being developed by MPOs with a focus on modeling approaches and assumptions about travel demand and behavior, and human values, attitudes and perceptions regarding AVs.

White paper for practitioners

- The research team will develop a white paper oriented toward practitioners that will provide an overview of our findings with a focus on emerging modeling approaches. The team will work with AMPO on the white paper development and the dissemination of the final paper.

5. Project Schedule

August 2018	● begin LRTP content collection and analysis ● full day project planning workshop at ASU ● first bi-weekly team meeting
September 2018	● continue LRTP analysis ● two team meetings
October 2018	● finalize LRTP analysis ● full day virtual project workshop - discuss content analysis results ● begin MPO interviews ● two team meetings
November 2018	● continue MPO interviews ● two team meetings
December 2018	● finalize MPO interviews ● two team meetings
January 2019	● full day virtual project workshop - discuss initial interview results ● begin MPO interview transcription and analysis ● two team meetings
February 2019	● finalize interview analysis ● two team meetings
March 2019	● full day workshop at PSU - discuss final interview results; begin collaborative white paper ● two team meetings
April 2019	● continue collaborative work on white paper; complete draft ● two team meetings
May 2019	● finalize white paper ● begin collaboration on article for publication ● two team meetings
June 2019	● complete article draft ● white paper presentation with AMPO ● two team meetings
July 2019	● submit article for publication ● two team meetings
August 2019	● presentation for academic audience (summer 2019) ● two team meetings

6. Relevance to the Center Theme

TOMNET is concerned with the development of advanced behavioral approaches that would enable the more accurate forecasting of future travel demand under emerging policy and technology scenarios. With the advent of transformative technologies such as autonomous vehicles and ride-hailing services, forecasting future travel is becoming increasingly challenging, particularly in a long range transportation planning context. Given TOMNET's focus to help improve the state of the art in travel forecasting, particularly in the context of planning for emerging technologies, it would be helpful to take an inventory of methods, data, and assumptions that MPOs around the country are currently utilizing to address emerging technologies in their planning efforts. Based on such an inventory, it will be possible for TOMNET to identify gaps and limitations, and develop and execute a research agenda that addresses pressing modeling needs in MPOs. This project will provide a state-of-the-art understanding and analysis of how MPOs are developing modeling, policy and planning approaches to AVs. The results will advance understanding of how practitioners are developing travel behavior and mobility choice models adapted for emergence of AVs. They will also show the assumptions made by modelers as they attempt to incorporate human attitudes, perceptions and values. The comparative component of the project will enable the team to bring approaches from across MPOs into dialogue to better understand common barriers and potential social, institutional and technological innovations. Finally, the study will also disseminate results among practitioners via a white paper and presentations to support the ability of MPOs to share challenges and approaches.

7. Anticipated Outcomes and Deliverables

Project deliverables/products

- Peer-reviewed publication: Based on governmental documents and interviews, the paper will analyze and compare emerging modeling and policy approaches to AVs in MPOs.
- White paper for practitioner audience: The White Paper will collect and organize our findings for practitioners, highlighting emerging modeling approaches.
- Presentation for academic audience: We will present our findings at conferences and as guests at university speakers series.
- Presentation for practitioner audience: Similar to academic presentations, we will present an overview of our findings to a practitioner audience, but, like the White Paper, we will pay special attention to emerging modeling approaches.

Anticipated outcomes and benefits

- This project will provide a comprehensive analysis of how MPOs are approaching AV policies and modeling in their planning processes.
- As such, it will also enable reflection on the limitations of and possibilities for current approaches in both research and practice.

8. Research Team and Management Plan

Research Team

PI: Thad Miller, Assistant Professor, ASU. Miller's work explores how policy-makers and communities utilize science and technology to meet goals related to sustainability, equity and resilience. Miller has a successfully acquired funding and overseen research teams. He is co-PI on the NSF funded STIR Cities project. Under co-PI Miller the STIR Cities project is coordinating engagement studies with private industry partners, city governmental bureaus, and non-profit organizations in Portland, OR and Phoenix, AZ to assess the utility of collaborative socio-technical integration. The project has resulted in 2 publications to date with several other publication in preparation and planned. Miller is Senior Personnel and Executive Management Team member on the 5 year, $12 million NSF Urban Resilience to Extremes Sustainability Research Network. The Urban Resilience SRN has resulted in 15 publications across disciplinary boundaries to date. Miller leads several

interdisciplinary research projects as part of the network. Miller is also the co-director of the new Center for Smart Cities and Regions where he has established partnerships with municipalities to explore AV policy.

Co-PI: John MacArthur, Research Professor, Portland State University. MacArthur (co-PI) is based at PSU's Transportation Research and Education Center where he has done work on multi-modal integration, emerging technologies and community connectivity. He has collaborated with local and state transportation organizations in the Portland area for over 15 years. He has also co-lead the development of the Portland Regional Smart Cities Action Plan and is part of Metro's Emerging Technology Working Group.

Co-PI Ram Pendyala, Professor, ASU. Pendyala (co-PI) is a transportation systems modeler with a record of federal funding and collaboration with the Federal Highway Administration and the US DOT. He is an expert in activity-travel behavior analysis, and his recent research efforts have focused on reflecting behavioral impacts of transformative transportation technologies within large scale travel forecasting models. He has developed a number of integrated modeling tools to support metropolitan planning processes.

Graduate Research Associate: Adam Gabriele, PhD student, ASU. Gabriele recently received an MA in Sustainability and is beginning his first year in the School for the Future of Innovation in Society's doctoral program in Human and Social Dimensions of Science and Technology. He has assisted in planning and facilitating cross-sector workshops with private sector, government, and university partners and has worked as a writer and research assistant for SFIS for three years.

Team Management Plan

The project team has deep experience with funded work, collaborating successfully on interdisciplinary funded projects, and working with communities and practitioners. Miller (PI) will be responsible for project management and oversight. Miller, based at ASU, has a deep network of research and practitioner partners in both Portland and Phoenix. Miller will take primary responsibility for supervising the work of the GRA. Miller has significant experience in document analysis and interviews with governmental actors in transportation, sustainability, and resilience. MacArthur and Pendyala have deep connections with MPOs throughout the US, including with AMPO. Pendyala will provide expertise in reviewing the modeling tools used by MPOs in their long range planning processes. Based on his expertise in travel modeling, he will assess the ability of the modeling tools to reflect implications of new transportation technologies (such as AVs) and assess the extent to which model specifications are sensitive to variables (or systems attributes) that are likely to change under alternative future scenarios (characterized by varying degrees of technology penetration and adoption). MacArthur has more than a decade of experience working with MPOs and city governments on transportation and smart cities. MacArthur will assess policy approaches to AVs within the larger transportation systems context. He will also lead the development of the white paper in conversation with AMPO relationships.

The project team will meet for a one-day project planning workshop within the first month of the project. The entire team will meet bi-monthly (twice/month), in-person or virtually, to discuss research progress. All research team members will conduct interviews. Full day project workshops will also be scheduled for the third month to discuss results from the content analysis of the document and the sixth month to discuss initial results from interviews. Project meetings will continue throughout the publication process as well.

9. Technology Transfer Plan

- White paper for practitioner audience
    - The research team will work with AMPO and other MPO staff as they develop the white paper and disseminate results.
- Presentation to practitioners
    - Working with the AMPO, the research team will present at national meeting oriented toward practitioners and also present as needed in specific cities or regional meetings.

10. Workforce Development and Outreach Plan

The research team will include a Graduate Research Associate. Miller, Pendyala and MacArthur will train the GRA on content analysis, interviewing as well as in transportation policy and planning. The GRA will also be a member of the ASU Center for Smart Cities and Regions (Directed by Miller). As such, the GRA will attending biweekly meetings with CSCR students, postdoc, admin and faculty and will have an opportunity to present work, receive and give feedback as part of an active research community.

11. References

Guston D (2014) "Understanding 'anticipatory governance'" *Social Studies of Science* 44(2): 218-242

Bagolee S, Tavana M, Asadi M, Oliver T (2016) "Autonomous vehicles: challenges, opportunities, and future implications for transportation policies" *Journal of Modern Transportation* 24(4): 284-303

Millard-Ball A (2018) "Pedestrians, Autonomous Vehicles, and Cities" *Journal of Planning Education and Research* 38(1): 6-12

Thomopoulos N, Givoni M (2015) "The autonomous car – a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcomes" *European Journal of Futures Research* 3: 1-14

Bahamonde-Birke F, Kickhöfer B, Heinrichs D, Kuhnimhof T (2016) "A systemic view on autonomous vehicles: Policy aspects for a sustainable transportation planning" available at https://elib.dlr.de/108647/1/Paper_TR-A.pdf July, 13, 2018

Milakis D, van Arem B, van Wee B (2017) "Policy and society related implications of automated driving: A review of literature and directions for future research" *Journal of Intelligent Transportation Systems* 2(4): 324-348

Hulse L, Xie H, Galea E (2018) "Perceptions of autonomous vehicles: Relationships with road users, risk, gender and age" *Safety Science* 102: 1-13

Fagnant D, Kockelman K (2015) "Preparing a nation for autonomous vehicles: opportunities, barriers, and policy recommendations" *Transportation Research Part A* 77: 167-181

Hanna M, Kimmel S (2017) "Current US Federal Policy Framework for Self-Driving Vehicles: Opportunities and Challenges" *Computer* December: 32-40

Guerra E (2016) "Planning for Cars That Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans, and Autonomous Vehicles" *Journal of Planning Education and Research* 36(2): 210-224

12. Qualifications of Investigators

Please see CVs following Section 14

13. Budget (Including Non-Federal Matching Funds)

Institution: Arizona State University, School for the Future of Innovation in Society
Project Title: Emerging Approaches to Autonomous Vehicles in Transportation Policy and Planning
Principal Investigator: Dr. Thaddeus Miller

Budget Period: 8/1/2018 - 07/31/2019

CATEGORY	Budgeted Amount from Federal Share	Budgeted Amount from Matching Funds	Explanatory Notes; Identify Source of Matching Funds

Faculty Salaries		$15,985	0.716 Months-T. Miller; 0.37 Months R. Pendyala
Other Staff Salaries			
Student Salaries	$23,140		12 Months (@ 0.5 FTE) of a GRA
Fringe Benefits	$2,432	$4,462	ERE costs for Miller, Pendyala & GRA
Total Salaries & Benefits			
Student Tuition Remission	$17,757		Tuition Remission for GRA
Operating Services and Supplies			
Domestic Travel	$3,200		Four trips @ $800/ea
Other Direct Costs (specify)	$776		
Other Direct Costs (specify)			
Total Direct Costs	$47,305	$20,447	
F&A (Indirect) Costs	$16,695	$11,553	56.5% of MTDC (excludes tuition remission)
TOTAL COSTS	$64,000	$32,000	

14. Grant Deliverables and Reporting Requirements for UTC Grants (November 2016)

Exhibit F

UTC Project Information	
Project Title	Emerging Approaches to Autonomous Vehicles in Transportation Policy and Planning
University	Arizona State University (and Portland State University?)
Principal Investigator	Dr. Thaddeus Miller
PI Contact Information	thaddeus.miller@asu.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	TOMNET UTC (USDOT Funds): $64,000 ASU Cost-share: $32,000
Total Project Cost	$96,000

Agency ID or Contract Number	
Start and End Dates	8/1/2018 to 7/31/2019 (anticipated)
Brief Description of Research Project	This project involves a review of MPO planning processes and long-range transportation plans (LRTPs) to assess the extent to which MPOs are addressing emerging transportation technologies, such as autonomous vehicles, in their planning efforts. The study involves reviewing LRTPs and planning processes to document assumptions, methods, data, and models that are currently being used to incorporate or reflect the effects of AVs in transportation forecasts and plans. The research team will analyze MPO strategic documents and conduct interviews with MPO management and staff to understand emerging planning and modeling practices around autonomous vehicles.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	TBD
Impacts/Benefits of Implementation (actual, not anticipated)	It is anticipated that the results of the research effort will help MPOs learn from one another and advance their ability to account for autonomous vehicles in their transportation planning and forecasting processes.
Web Links ● Reports ● Project Website	TBD

CVs

THADDEUS R. MILLER
Assistant Professor, School for the Future of Innovation in Society, and The Polytechnic School
Senior Sustainability Scientist - Global Institute of Sustainability
Arizona State University, Tempe, AZ 85287 Email: thaddeus.miller@asu.edu

Education
PhD, Sustainability, Arizona State University, 2011.
MPA, Environmental Science and Policy, Columbia University, 2004.
BA, Economics and Environmental Studies, Bucknell University, 2003.

Employment and Professional Experience
Assistant Professor, School for the Future of Innovation in Society; The Polytechnic School, Ira. A Fulton Schools of Engineering, Arizona State University, 2016-present.
Assistant Professor, *Assistant Professor*, Nohad A. Toulan School of Urban Studies and Planning, College of Urban and Public Affairs, Portland State University, 2011-2016.
Senior Sustainability Scientist, Global Institute of Sustainability, ASU, 2016-present.
Co-Director, Center for Smart Cities and Regions, Arizona State University, 2018-present.

Relevant Publications
- Miller, Thaddeus R. *Under review*. Imaginaries of Sustainability: Science and Technology in the Smart City. *Science as Culture*.

- Levenda, Anthony, Jennifer Richter, Thaddeus R. Miller, Erik Fisher. 2018. Smart Energy Imaginaries and the Governance of Innovation. *Futures* doi.org/10.1016/j.futures.2018.03.001\
- Muñoz-Erickson, Tischa A., Clark Miller, Thaddeus R. Miller. 2017. How cities think: knowledge co-production for urban sustainability and resilience. *Forests* 8(6): 203-220.
- Grabowski, Zbigniew, Marissa Matsler, Cassie Thiel, Richard Hum, Anne Bradshaw, Lauren McPhillips, Thaddeus R. Miller, and Charles L. Redman. 2017. Infrastructures as socio-eco-technical systems: five considerations for interdisciplinary dialogue. *Journal of Infrastructure Systems* 23(4): 1-9.
- Miller, Thaddeus R., Arnim Wiek, Daniel Sarewitz, John Robinson, Lennart Olsson, David Kriebel, and Derk Loorbach. 2014. The Future of Sustainability Science: A Solutions-Oriented Agenda. *Sustainability Science* 9(2): 239-246.

Graduate Student Supervision/Advising

Graduated: 2 PhDs (includes 1 woman); Current Supervision: 2 PhDs

Synergistic Activities

- Member, Technology and Innovation Subcommittee on AVs, City of Tempe, 2018-present
- Executive Management Team. Urban Resilience to Extreme Events Sustainability Research Network (UREx SRN). National Science Foundation. $12,000.
- Co-Principal Investigator. STIR Cities: Engaging Expert Performances of Sociotechnical Imaginaries for the Smart Grid. National Science Foundation, $303,000, 2015-2018.

John MacArthur – Research Associate
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A. Professional Preparation.

Lehigh University, Bethlehem, PA, Civil Engineering B.S., 1992
The University of Michigan, Ann Arbor, MI, Environmental Health Sciences M.S., 1996

B. Appointments.

Transportation Research and Education Center (TREC) Portland State University, Sustainable Transportation Program Manager/Research Associate, January 2009-Present
HDR Inc., Context Sensitive and Sustainability Coordinator, 2006-2008
Weston Solutions, Inc., Senior Project Scientist, 2001-2006
IMC Global, Inc., Environmental & Health Specialist, 2000-2001
NSF International, EMS Program Assistant, 1997-1999

C. Publications

1. McNeil, N., J. Dill, J. MacArthur, J. Broach, and S. Howland. *Breaking Barriers to Bike Share: Insights from Residents of Traditionally Underserved Neighborhoods*. NITC-RR-884b. Portland, OR: Transportation Research and Education Center (TREC), 2017.
2. MacArthur, J., N. Kobel, J. Dill, and Z. Mumuni. *Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, OR*. NITC-RR-564B. Portland, OR: Transportation Research and Education Center (TREC), 2017.
3. McNeil, N., J. Dill, J. MacArthur, J. Broach, and S. Howland. *Breaking Barriers to Bike Share: Insights from Bike Share Users*. NITC-RR-884c. Portland, OR: Transportation Research and Education Center (TREC), 2018.
4. MacArthur, J., C. Cherry, M. Harpool and D. Scheppke. *A North American Survey of Electric Bicycle Owners*. NITC-RR-1041. Portland, OR: Transportation Research and Education Center (TREC), 2018.

5. Ling, Z., C. Cherry, J. MacArthur and J. Weinert. Differences of Cycling Experiences and Perceptions between E-Bike and Bicycle Users in the United States. *Sustainability*, 2017, Vol. 9, Issue 9 1662; doi:10.3390/su9091662
6. MacArthur, J., and Kobel, N. *Regulations of e-bikes in North America: A policy review* (NITC-RR-564). National Institute for Transportation and Communities (NITC). http://nitc.us/research/project/564/, 2014.
7. MacArthur, J., J. Dill and M. Person, "E-Bikes in North America: Results from an online survey," Transportation Research Record: Journal of the Transportation Research Board, TRR 2468 2015, pp. 123–130.
8. Howland, S., N. McNeil, J. Broach, K. Rankins, J. MacArthur, and J. Dill. Breaking Barriers to Bike Share: Insights on Equity from a Survey of Bike Share System Owners and Operators. NITC-RR-884a. Portland, OR: Transportation Research and Education Center (TREC), 2017.

D. Synergistic Activities.

- Co-director of LEVER Initiative - Founded and co-directing Light Electric Vehicle Education and Research Initiative (www.LEVresearch.com), 2014 – Present
- Co-lead of the Portland Regional Smart Cities Action Plan, 2017- Present
- Transportation Research Board Committee Member APO20: Standing Committee on Emerging and Innovative Public Transport and Technologies, 2016 – Present
- Transportation Research Board Committee Member ADD55T: Task Force on Arterials and Public Health, 2015-Present
- Board Member and Treasurer, Drive Oregon/Forth, 2010 – 2017

RAM M. PENDYALA
Professor, Sustainable Engineering and the Built Environment
Senior Sustainability Scientist - Global Institute of Sustainability
Arizona State University (ASU), Tempe, AZ 85287-3005 Email: pendyala@asu.edu

Education

Ph.D., Civil Engineering (Transportation), University of California-Davis, December 1992.
M.S., Civil Engineering (Transportation), University of California-Davis, June 1990.
B.Tech., Civil Engineering, Indian Institute of Technology-Madras, June 1988

Employment and Professional Experience (last 25 years)

Professor, Sustainable Engineering and the Built Environment, ASU, 2006-2014 & 2016-present.
Frederick R. Dickerson Chair Professor, School of Civil and Environmental Engineering, Georgia Institute of Technology, 2014-2016
Senior Sustainability Scientist - Global Institute of Sustainability, ASU, 2011-Present.
Asst/Assoc/Professor, Civil & Environmental Engineering, Univ of South Florida, 1994-2006.
Assistant Professor, Civil Engineering, University of Louisiana at Lafayette, 1992-1994.

Fields of Interest and Expertise

(1) Multimodal transportation systems planning; (2) Activity-travel behavior analysis; (3) Transportation demand modeling and forecasting; (4) Mobility analytics and visualization; (5) Statistical and econometric analysis of transportation data; (6) Dynamic mobility management; (7) Travel survey methods and data collection; (8) Built environment – transportation – energy connections

5 Recent Relevant Publications (from over 200)

1. Garikapati, V. M., Pendyala, R. M., Morris, E. A., Mokhtarian, P. L., and McDonald, N. (2016). Activity Patterns, Time Use, And Travel of Millennials: A Generation in Transition? *Transport Reviews*, 36(5), pp. 558-584.
2. Pinjari, A. R., Augustin, B., Sivaraman, V., Imani, A. F., Eluru, N., and Pendyala, R. M. (2016). Stochastic Frontier Estimation of Budgets for Kuhn–Tucker Demand Systems: Application to Activity Time-Use Analysis. *Transportation Research Part A*, 88, pp. 117-133.
3. Shin, J., Bhat, C. R., You, D., Garikapati, V. M., and Pendyala, R. M. (2015). Consumer Preferences and Willingness to Pay for Advanced Vehicle Technology Options and Fuel Types. *Transportation Research Part C*, 60, pp. 511-524.
4. Garikapati, V. M., You, D., Pendyala, R. M., Jeon, K., Livshits, V., and Vovsha, P. S. (2015). Tour Characterization Framework Incorporating Activity Stop–Sequencing Model System. *Transportation Research Record: Journal of the Transportation Research Board*, 2494, pp. 77-86.
5. Archer, M., Paleti, R., Konduri, K., Pendyala, R., & Bhat, C. (2013). Modeling the connection between activity-travel patterns and subjective well-being. *Transportation Research Record: Journal of the Transportation Research Board*, 2382, pp. 102-111.

Graduate Student Supervision/Advising

Graduated: 10 PhDs (includes 2 women), 50 Masters; **Current Supervision**: 4 PhDs

Recent Honors and Awards

Pyke Johnson Award for Best Paper in Planning and Environment, Transportation Research Board of the National Academies, 2011 and 2013

Invited Speaker, Distinguished Lecture Series, Department of Civil and Environmental Engineering, Florida International University, 2015

Invited Keynote Speaker at 5 International/National Conferences, 2014-2016