MOBILITY DATA AND MODELS INFORMING SMART CITIES

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U.S. Department of Energy
Vehicle Technologies Office
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Project ID# EEMS007

This presentation does not contain any proprietary, confidential, or otherwise restricted information.
OVERVIEW

Timeline
- Project start date: 10/1/2017
- Project end date: 6/30/2020
- Percent complete: 99%

Budget
- Total project funding
  - DOE share: $500k
- Funding for FY 2018: 150k
- Funding for FY 2019 - FY 2020: 350k (with an additional 200k for urban typology)

Barriers
- Local-to-regional data gaps, outdated literature and/or lack of alignment with planning and decision-making
- Urban travel behavior data and metrics: shift from vehicle travel to human centered metrics
- Ever-increasing mobility options and responses to system disruptions, that lack data-driven evaluation

Partners
- DOE SMART Mobility Lab Consortium
- U.S. Dept. of Transportation Smart City Finalists
- Leading Cities for Urban Mobility
- University Researchers
- Metropolitan Planning Organizations
- Transit Agencies and Utilities
- State DOTs/Energy Offices
- Mobility-as-a-Service Providers; Entrepreneurs; and other Mobility Industry Leaders
- Mobility Data Integrators, Analysts, and Modelers
EARLY PROJECT FOUNDATIONS

Cross-Scale Actors & Institutions
Agile Data Inventorying
Performance Metrics
Data, Models, & Integration
City-Based Literature, New Pilots & Plans

From engaging/elicitating data in cities, travel surveys, filling gaps, to informing future mobility, with focus on:

- Mobility as a Service [MaaS] data (e.g. transportation network company [TNC], shared electric vehicles [EV] as bikes, scooters, automated shuttles) to mobility, energy, affordability **typology**

- Accessibility: Focus on two major trip generators where emerging(workforce) mobility is having impacts:
  - Future airports - gateways to / informing cities
  - Future commuting - job hubs / large employers

**TRAVELTIME BUDGETS AND MOBILITY IN URBAN AREAS**

MAY 1974
FINAL REPORT

**TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE** 47, 75-88 (1994)

Anthropological Invariants in Travel Behavior
C. Marchetti

**ABSTRACT**

Personal travel appears to be much more under the control of basic instincts than of economic drive. This may be the reason for the consistent linkage between the results of cost benefit analysis and the actual behavior of travelers.

In this paper we put together a list of the basic instincts that drive and control travelers’ behavior, showing how they work with technological progress and economic constraints.
RELEVANCE: TASK OBJECTIVES

*Insights: mobility, accessibility, affordability

What are TNC/AV impacts on less parking, access, energy, to affordable housing (H) & living?

Overall Goal:
• Quantify impacts on emerging mobility, access and infrastructure associated with new mobility choices and services in urban areas

Objectives Include:
• Acquire, review, analyze mobility and key destination accessibility data & models
• Advance data and models
• Explore potential impact

Housing & Transport, % of income:
LA Co.: 57%
Cook Co.: 48%
Harris Co.: 47%
Alameda Co.: 46%
Denver Co: 42%
New York Co: 38%
(CNT, 2020)

Outliers: Miami: 60%; Queens: 71%
"A rush to single occupancy vehicles (SOVs) may result in large travel time increases in transit heavy communities"
MILESTONES AND APPROACH

TRB 2020: "Ground Transportation at Airports: Ride-Hailing Uptake and Travel Shifts to Test Mode-Choice Modeling Assumptions"

• Q3 – Generalized city-airport and transport network company mode-choice model and impacts
  o Reviewed literature; collected/analyzed TNC open data, revenue data, transit data for modeling
  o Published 2020 TRB paper, poster, book chapter; advised/informed an additional ATHENA TRB paper

Contributions and Key Study Questions:
• TNC Use in Cities: Where are They Going, and What are Long-Term Impacts?
  • Highest TNC use concentrated in core areas and at airports (Henao & Sperling, 2018; Wenzel; 2019; Murphy, 2020)
MILESTONES AND APPROACH

Q4 – Refine bounded workforce mobility study
- Accepted 2020 TRB, ITS Papers, BECC submissions
- Focus on two cities initially; expansion to 6 city airports
- Longitudinal employer-household dynamics (LEHD) survey dataset processed for observing trends on employee commute length, feasibility of alternate city/airport commute choices, and job access
WHAT ARE EMPLOYER-PROVIDED WORKFORCE MOBILITY BENEFITS?

Basic mobility
- Micromobility
  - Flex schedule
- Transit Pass
- Work from home

Luxury and convenience
- Vanpool
- Parking Cash-Out
- Private bus
APPROACH: PARKING, MOBILITY, AND ENERGY

Why Important? Space Efficiency?

- Analyzed associations of parking & energy use data for 50 US counties, parking & mobility energy productivity for four cities
- Do types of associations vary? (typology)
  - On-demand mobility: less parking, higher curb demand? New utilization metrics?
- Two million cars, two billion parking spots?
  - Space Efficiency Metric: 14% of urban land area to cars
  - Cars today cruising for parking downtown can contribute 5 more daily miles traveled per curb space per day
  - what impacts if/when parking storage/transit is designed (or not) for automated vehicles?

**URBAN SCIENCE APPROACH:**

ENSURING **USEFUL / RELEVANT**

Mobility Energy Productivity and Typology Transfer for Agile Insights

- New York to > 10 State Typology; MEP Transfer (of city-scale results), BEAM / Polaris model outputs and new data
- ‘All Size’ City Relevance
TECHNICAL ACCOMPLISHMENTS: A 2017–2020 PUBLICATIONS TRAJECTORY

16 Total Pubs: 5 Transportation Research Board (TRB) Papers, 4 Intelligent Transportation Systems (ITS) Papers, 4 Journal Articles, 2 Reports, 1 Book Chapter [In FY 2017/2018: 4; 2019/2020: 12+ (to date)]

Progress in Energy:

"Of Actors, Cities and Energy Systems: Analyzing the Transformative Potential of Urban Electrification"

"Choice is an important element of accessibility: more choices in both destinations and modes of travel” - Handy, 2003

Workforce Mobility: role of employers in mode choices for job access?

Urban Micro-Urban Types/Typology: How choice outcomes vary socio-spatially?

Quantifying Change in Behaviors (e.g. new services and/or post-COVID)

Mobility Energy Productivity Metric as Time, Cost, Energy-Efficient Access to Opportunities
TECHNICAL ACCOMPLISHMENTS

Milestones and Corresponding Progress on Outputs

- Q3: Generalized Airport Mode-Choice Model (TRB 2020 Annual Meeting)
- Q4: Refined Regional Workforce Mobility Analysis Tool (ITS WC and *Transport Findings*)
- Shifting Urban Mobility Behavior report as part of Urban Science Final Capstone
TECHNICAL ACCOMPLISHMENTS

TRB 2020: "Ground Transportation at Airports: Ride-Hailing Uptake and Travel Shifts to Test Mode-Choice Modeling Assumptions"

Key Findings: ~30% of trips replaced transit, ~35% of trips replace parking at airport per 100 new TNC transactions (for Denver & Seattle). Future post-COVID impacts for TNCs?

- 12 to 36 months after TNC market entry at an airport, parking revenue peaked and then declined on a per-passenger basis.

Developed new data collection techniques and capabilities to understand & identify key TNC / MaaS levers to improve the energy productivity of future integrated mobility systems.

- Identified & advanced early stage R&D to inform innovative MaaS that enables (or inhibits) energy efficient mobility systems.

- Shared research insights, coordinated and collaborated with stakeholders to support and inform energy efficient local / regional transportation systems.
TECHNICAL ACCOMPLISHMENT: WORKFORCE MOBILITY

City-Airport Analyses

Commuting energy impacts and variations:
>> Airport median commutes longer than city commutes; city variations: Dallas vs. New York
  - 81% vs. 22% for Drive Alone
  - 10% vs. 5% for Carpool
  - 2% vs. 57% for Transit

*** Energy impacts tool developed for > 200,000 commuter travel origin and destination (O-D) pairs

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TECHNICAL ACCOMPLISHMENTS


Key Findings:
Annual Estimated Savings:

Denver:
Up to 20 million gallons of gasoline

Los Angeles:
Up to 78 million gallons of gasoline

- Q4 – Refine bounded workforce mobility study
  - Accepted 2020 TRB, ITS Papers, BECC submissions
  - Focus on two cities initially; expansion to 6 city airports

Developed workforce mobility tool, analysis / visualization techniques, & capabilities to understand & identify key job access levers to improve energy productivity of future integrated urban mobility systems.

Figure 1. Denver Downtown and Denver International Airport employee residence location by census block, 2017.
ACCOMPLISHMENTS
Exploring Key Levers & New Metrics

Socio-spatial variability across cities / communities:
- Alternative commuting
- Vehicles per household
- Fuel Economy
- EV adoption

Design goals for high utilization of metered parking at 80 to 90% (Millard-Ball et al., 2014; Shoup, 2018) vs. new decision processes with MaaS and COVID-19

Brief Characterization of Each MU-Type

- **P: Wealthy**, very high-income, HTA index, education, home and car ownership, low density, low hazard risk (18%)
- **V: Yuppy**, Middle-income, high education, low home, very low HTA index and car ownership, very high density and hazard risk (5%)
- **A: Very low-income**, HTA index and education, very low home and car ownership, very high density, high hazard risk (10%)
- **T: Blue-collar**, low-income and education, HTA index and home, high car ownership, high density, medium hazard risk (32%)
- **L: Exurban**, middle-income, education and HTA index, low home and high car ownership, very low-density, very low hazard risk (35%)
RESPONSE TO PREVIOUS YEAR’S REVIEWERS’ COMMENTS

Looking back, looking forward:

- “Enabled a nice collaborative effort between DOE and the US Department of Transportation, with the help and contributions of smart city partners” ✓
- Multiple collaborators are sharing data; and access to unique data for cities, transit, airports ✓ ✓
- Further inclusion of socio-demographics ✓ ✓ ✓

Moving people forward:

- Assessing importance of occupancy data for asset utilization, space efficiency, energy productivity ✓
- Urban Nexus Science requires new data focused on affordably/efficiently moving people, not vehicles ✓
- How and why of future integrated mobility choices?

Approach Strengths (thanks!)

+ Solid approach, significant progress
+ Well thought out and organized
+ Interesting results

Weaknesses/Suggestions:

- Access to MaaS data hard to come by (overcame with public records requests)
- Perhaps shift from “analyze what we have” to “what we need”
- Many new modes and as time goes on, analysis frameworks need to change (* mode choice frameworks increasingly important over time!)
- Perhaps more time to case studies (e.g. NY) & collecting / analyzing real-world data (surveys)
REMAINING CHALLENGES BARRIERS
Large (n) & (t) studies with human-scale data, pre and post COVID-19

- Humans-in-the-Loop & Behaviors
- Spatio- temporal (t) dynamics and outcomes that vary across key urban systems / contexts:
  - Socio-demographic
  - Economic
  - Technology / Infrastructure
  - Environment
  - Governance (e.g. operations)

Bogota, Colombia Study: examining mode choice before COVID-19 and predictive mode choice post quarantine:
PROPOSED FUTURE RESEARCH
Research Questions and Concepts for SMART 2.0

Areas of Interest *(Data Available)*:
- Future SOVs or more emphasis on moving people? *(Census 2020)*
- Telework & Active Travel *(FHWA)*
- Workforce Micro-Mobility *(NACTO)*
- Inter-city Travel: less by air? *(FAA)*
- Post-COVID: Changing Travel Times & Contact *(INRIX, Wejo, Apple, Google)*
- Value of Travel Time and Productivity *(BLS American Time Use Survey)*
- Induced Demand *(Cell+Video Data)*
- Post-COVID Travel Behaviors re Jobs, Health & Co-Benefits? *(Surveys)*

Aspirations: Models-Data Informing Cities:
- Urban Nexus Science as an Agile Incubator
- MEP & COVID19-Optimized Transit
- Integrated Public-Private Micromobility with Transit & MaaS
- Future of Smart Curbs and Parking
- Intercity/Long-Distance Travel and the Future of Airports

Any proposed future work is subject to change based on funding levels.
COLLABORATIONS: INL / Columbus / Smart Cities, LBNL on TNCs; Airport data from DEN, DFW, SFO; City Parking/mobility data from Pittsburgh; Portland, Denver…

SUMMARY

A Focus on COLLABORATIONS and Opportunity: Insights Within and Across Populations and Cities

Direct Impacts: for this project we conducted a process that:
(1.) Articulated and addressed EEMS-relevant research issues/barriers: new TNC/mobility data / metrics; workforce mobility, parking, socio-spatial variation in urban dynamics;
(2.) Identified/obtained relevant data and defined new metrics (e.g. public records, open data, surveys, integrated indicators and defined MEP, utilization, & efficiency metrics);
(3.) Integrated, visualized, analyzed data/model outputs to address knowledge gaps and key questions:
• What are new mobility impacts on urban parking, access, energy, travel behavior outcomes?
• Which factors of mobility, accessibility, land and housing in cities shape more affordable housing (H) & living?
• What metrics matter? Exploring of MEP, space efficiency, space utilization, travel time budgets, & productivity
• Who has what level of access, ability to adopt new mobility choices (and where)?

Model outputs only as good as inputs: access, adoption by whom?
• A need to build on fresh, locally collected mobility choices data
• Agile integration/development: interoperability of data, tools, models, methods, new metrics
• Harnessing and integrating new mobility, energy, productivity, affordability, & accessibility data
• MEP / occupancy data for moving people and access to key destinations for whom – eg age, income, downtown, airports, jobs, healthcare, grocery, digital service

...to mobility providers – participation in workshops ...
... THANK YOU !!!
MOBILITY FOR OPPORTUNITY

FOR MORE INFORMATION
Joshua Sperling
Joshua.Sperling@nrel.gov
* More recent focus on COVID19 impacts

* Urban data science & new technology-informed solutions:

  E.G. A DOE ICORPS award: HeadCount; contact tracing, etc
SMART WORKFLOW MODELING PROCESS

For whom? And where?

To access what?

MEP, typology, workforce mobility, TNC-airports, integrated mobility and urban science pillar efforts (broadly) help capture key city priorities, data inputs and model outputs, as relevant to understanding of technology, infrastructure, land-use, housing affordability patterns & impacts on accessibility, adoption, travel time, costs, energy to efficiently moving people with choices.
NEW BASELINE DATA FOR PRE AND POST-COVID OCCUPANCY ANALYSES:
Growing a Robust Evidence Base for Future Urban Mobility Systems
PUBLICATIONS AND PRESENTATIONS

In addition to 3 AMR oral presentations + poster presentation: 15+ Pubs, with new rich, curated datasets and analyses emerging

TRB Papers and Presentations:


• ITS-America and World Congress Papers and Presentations:


– Hoehne, C, Sperling, J et al. 2020 Parking as a lens to the urban soul: exploring associations of parking, mobility, & energy. ITS.
• Journal Articles:

• Reports:

• Book Chapter:
CRITICAL ASSUMPTIONS AND ISSUES

- Integrating Mobility-Accessibility-Energy-Travel Behavior Data, Theory, Methods is Complex and Challenging: Interdisciplinary Teams are Needed
- Lack of data and metrics for challenging-to-measure rapid transportation changes is a critical issue: e.g. what are impacts of private mobility choices? Who has access to new services? Critical to start with literature: what was, is, & could be?
- Our project addressed this by finding creative ways to fill data gaps
  - By ‘following the money/transactions’ for new mobility services
  - Defining new methods (e.g. data integration for MEP and typology),
  - New Metrics (e.g. MEP, asset utilization, space efficiency, accessibility),
  - Combining engineering-social sciences
  - Identifying stakeholder-relevant questions & co-design of analytical insights