THE BLACK AND YELLOW BRICK ROAD:
Navigating New Mobility In Pittsburgh
Carnegie Mellon University

A private, global research university, Carnegie Mellon stands among the world’s most renowned educational institutions, and sets its own course.

With cutting-edge brain science, path-breaking performances, innovative start-ups, driver less cars, big data, big ambitions, Nobel and Turing prizes, hands-on learning, and a whole lot of robots, CMU doesn’t imagine the future, we create it.
CMU’s main campus is located in the Oakland neighborhood of the City of Pittsburgh, PA
Carnegie Mellon University by the numbers

2017 – 2018 | Total Students

Enrollment: 13,961
Undergrad: 6,100
Graduate: 7,861
THE BLACK AND YELLOW BRICK ROAD:
Navigating New Mobility In Pittsburgh
How Traffic21 began
A “Real World” Person Identified a “Real World” Problem
Opportunity to Develop & Grow Pittsburgh as a Test Bed
Continue Pittsburgh’s Role as a Leader in Intelligent Transportation Systems, Launching New Companies & Technologies
Living in a Revolutionary Time in Transportation Through “Disruptive” Technology
Connectivity

Novel Modes, Drones, Hyperloop, etc.
Shared Use
Traffic21
RESEARCH APPROACH

R D & D:
Research
Development
Deployment through partnerships
Traffic21

OUR STRATEGIES

Strong emphasis on Technology Transfer through public and private partners for real-world deployments

Cross-Sector collaboration
  - Partner Consortium
  - Advisory Council
  - Interdisciplinary Research Teams

Education & Workforce development

Diversity enhancement
TECHNOLOGY TRANSFER

- National Mobility Summit
- Smart Mobility Connection
- Webinars
- Publications
- Conference Presentations
- Spin-off Companies
EDUCATION & WORKFORCE

Cross-sector Research Collaboration
Carnegie Mellon University

College of Engineering
College of Fine Arts
Dietrich College of Humanities & Social Sciences
Heinz College of Information Systems and Public Policy
Mellon College of Science
School of Computer Science
Tepper School of Business
DIVERSITY

Women in Transportation Fellowship at the Heinz College

Diversity in Transportation Fellowship in the College of Engineering

Challenge Activity for Transportation You DC Program for High-School Girls

Co-founded the Women in Transportation Seminar Pittsburgh Chapter
MOBILITY21
UNIVERSITY TRANSPORTATION CENTER
2016-2022

Partnered with University of Pennsylvania, The Ohio State University, and the Community College of Allegheny County
MOBILITY21 UTC
SAMPLE OF FUNDED PROJECTS

Can Ridesharing Help the Disadvantaged Get Moving?

Regional Highway Corridor Benefit Research Study

Personalized Trip Planner for Seniors (PTPS)

Incentivizing Participation in Peer-to-Peer Ride-Sharing Platform

Improving rush hour traffic flow by computer-vision-based parking detection and regulations

Connected Vehicle Infrastructure for a Smart City

Latest Generation Data Portal for the Intelligent Mobility Meter

Mesoscopic car-truck flow modeling and simulation: theory and applications
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Mobility In Pittsburgh
Her choices were:
Motivation

Transportation systems in many U.S. cities are car-centric

When the transit-dependent population disproportionately overlaps with low-income and minority populations equity issues are amplified

Public transit agencies incorporate ride-sharing or demand response transit service, but costs significant

Understanding transit access for the transit-dependent population will allow for better decision-making for transportation planning
Background - Alternative Transit

**Electric & Autonomous Shuttles**

- Built similar to low-floor mini-buses with <20 passenger capacity
- 100+ demonstrations and pilots globally

**Transportation Network Companies (TNCs)**

- Digital network connecting a rider to a driver for a prearranged ride.
- Pooled services offer lower costs
10% of Allegheny County is transit-dependent
Research Question:

How much would it cost for autonomous shuttles or pooled TNC vehicles to take travelers in transit-dependent blocks to the nearest bus stop that goes to Downtown Pittsburgh?
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Should Jane choose to make her trip by:

- An automated vehicle
- An electric vehicle
- In a taxi or other shared ride vehicle
Example:
6 ride-hailing trips from 7:00 – 7:30 AM

What type of car should the fleet dispatch to serve each trip request?

Which connections between routes reduce empty vehicle miles?

When should electric vehicles go out of service to charge?
What powertrain mix minimizes the costs of ride-hailing?

1. Optimization Objective

Minimize vehicle purchase costs...
gasoline / battery charging costs...
and fuel / power grid emissions.

\[
\sum_{k \in \mathcal{K}} p_{ijk} c_{ijk} + \sum_{i \in \mathcal{L}} \sum_{j \in \mathcal{L}} \sum_{k \in \mathcal{K}} a_{ijk} f_{ijk} + \sum_{i \in \mathcal{L}} \sum_{j \in \mathcal{L}} \sum_{k \in \mathcal{K}} a_{ijk} g_{ijk}
\]

across all vehicles that can be purchased, and all route segments

2. Inputs

Trip requests
- Fare
- Origin/Destination
- Highway vs. City

Gasoline Vehicles
- Cost & Efficiency
- Fuel Price

Electric vehicles
- Cost & Efficiency
- Range & Charge Speed
- Power Price & Emissions

3. Outputs

Optimal fleet size and mix

Pairing of vehicles to trips

Policy Outcomes

- Emissions
- Congestion
- Cost of service
- Fleet Profits
- % Empty VMT
1. Optimization Objective

Minimize vehicle purchase costs...

\[ \sum_{k \in K} p_{ijk} c_{ijk} \]

+ \[ \sum_{i \in I} \sum_{j \in J} \sum_{k \in K} a_{ijk} f_{ijk} \]

+ \[ \sum_{i \in I} \sum_{j \in J} \sum_{k \in K} a_{ijk} e_{ijk} \]

across all vehicles that can be purchased, and all route segments

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She wondered what new concepts were being explored to provide service:

- Could autonomous shuttles help meet a latent transit demand?
- How might ride hailing services evolve?
- How might people with disabilities access transportation services?
Indoor Navigation Assistance for People with Visual Impairment through Robotics

Addressing the final mile navigation problem from transit drop-off point (ACCESS drop-off location, bus stop, building entrance, etc) to final destination.
Transportation Network Companies (TNCs) move people differently

More trips and “empty miles” could drive up energy use and emissions...

...but newer, more efficient TNC vehicles (running hot) could consume less fuel and emit less.
Vehicle ownership and VOC emissions decline

Change in outcome

Legend:
- Average effect
- Effect in urban state
- Effect in middle state
- Effect in rural state
- Effect not passing robustness checks

Error bands show 95% confidence interval
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Breaking in Smart Transportation:
eepurl.com/ch4Nb

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twitter.com/Traffic21_TSET
Questions?

Traffic21 Institute
traffic21.heinz.cmu.edu

Mobility21 UTC
mobility21.cmu.edu
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