



# CUTR

CENTER for URBAN  
TRANSPORTATION  
RESEARCH

## How New Technologies and Autonomous Vehicles May Change Public Transportation

**PSTA Board Workshop**

Steven E. Polzin, PhD.

May 6, 2016

# CENTER FOR URBAN TRANSPORTATION RESEARCH

- Established 1988 by Florida Legislature
- Home of the *National Center for Transit Research*
- Applied research – Policy focus
- Technology transfer / training
- Education
- Multi-disciplinary (Anthropology to Zoology)
- “Real world” experience
- Housed in USF’s College of Engineering
- 180+ active research projects
- \$14 million in 2015
- over \$5 million federal
- 35 full-time research faculty
- 20-50+ student researchers



# Outline

- Introduction to technology changes
- The context
- Impacts of technology changes
  - Vehicle ownership
  - Location decisions
  - Sharing travel
- Transit's Response
- Discussion

# We are in Perhaps the Most Transformational Period in Transportation Since the Development of Personal Vehicles

Demographics

Economics

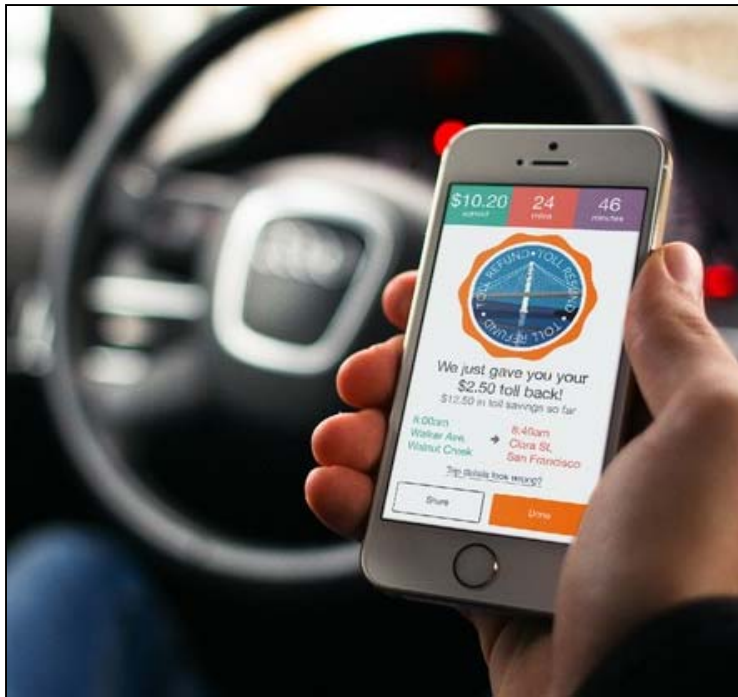
Technology

Governance

Culture/values



# Technology

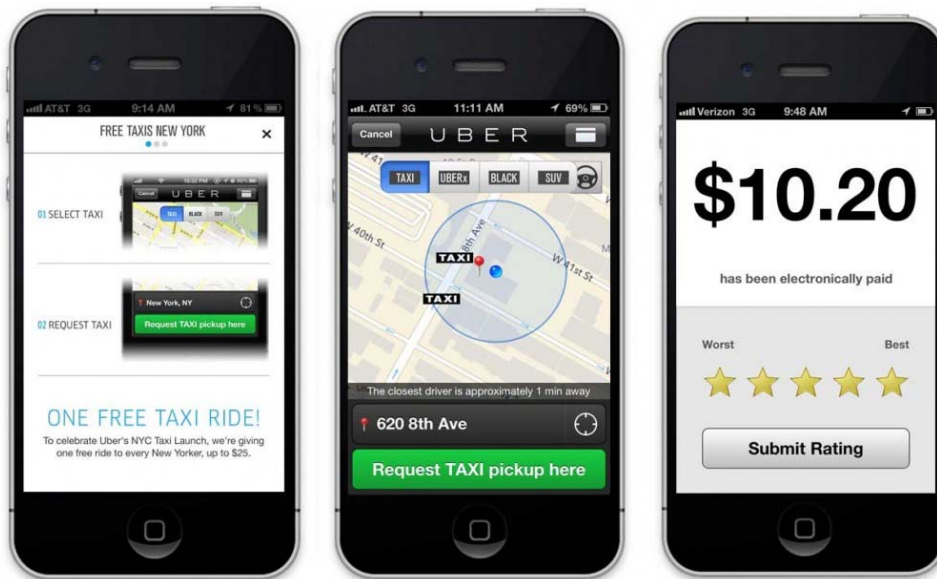


- Powerful global positioning satellites
- Ubiquitous wireless communication capability
- Powerful portable computing
- Powerful web computing capability for pathfinding and scheduling optimization
- Sophisticated sensors
- Artificial intelligence/ machine learning

Integrated with new materials, designs, propulsion systems, etc.

# Transportation Network Companies (TNC)

TNC – a company that leverages smart phone apps to hail livery services. Sometimes referred to as e-hailing or ridesourcing.  
Not Ridesharing



Offers real time information on arrival, electronic payment, electronic customer feedback. Perceived as cleaner, more convenient and safer than taxis. Generally lower cost and more quickly available than traditional taxis.

# Automated/ Connected Vehicles



# Automated Vehicles Relieve the Occupant of Driving

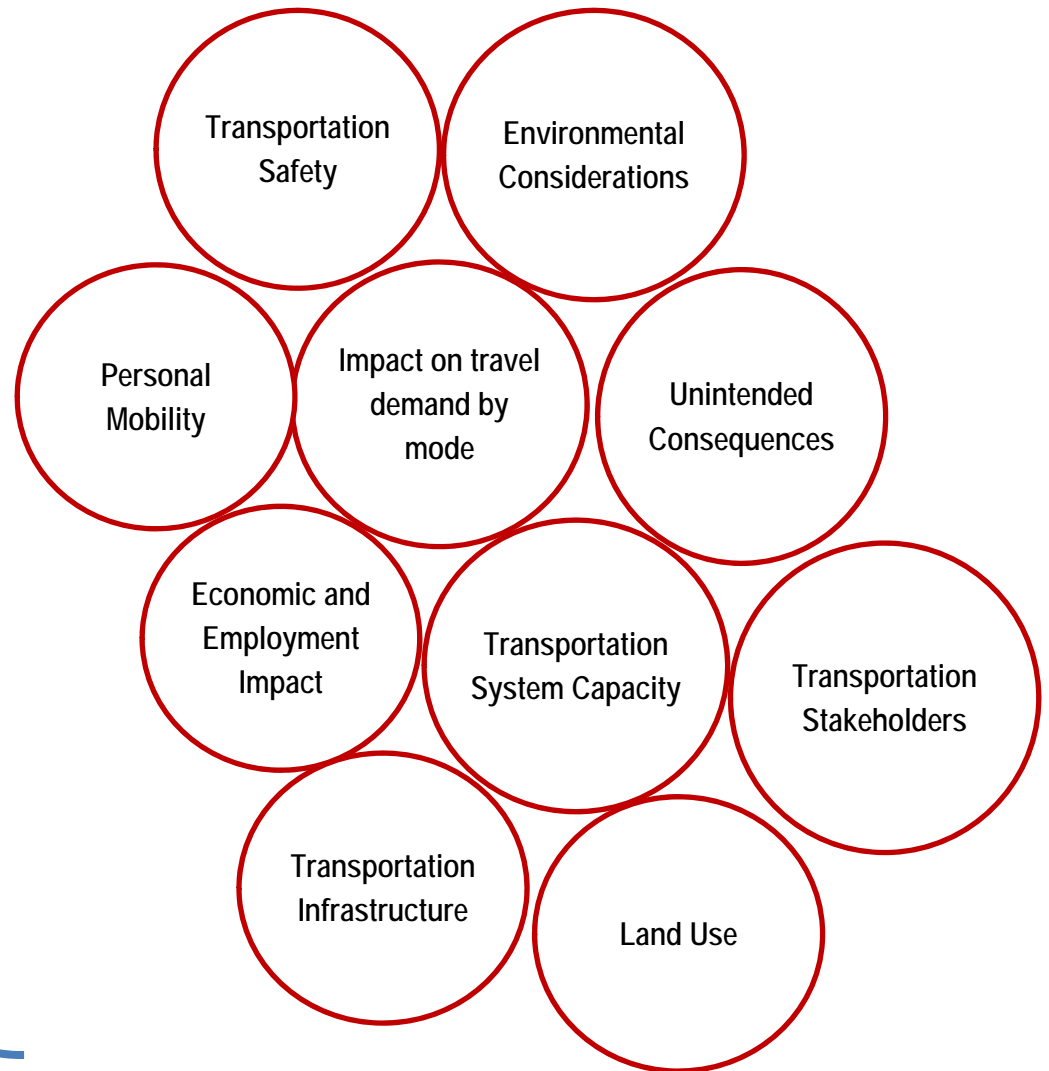




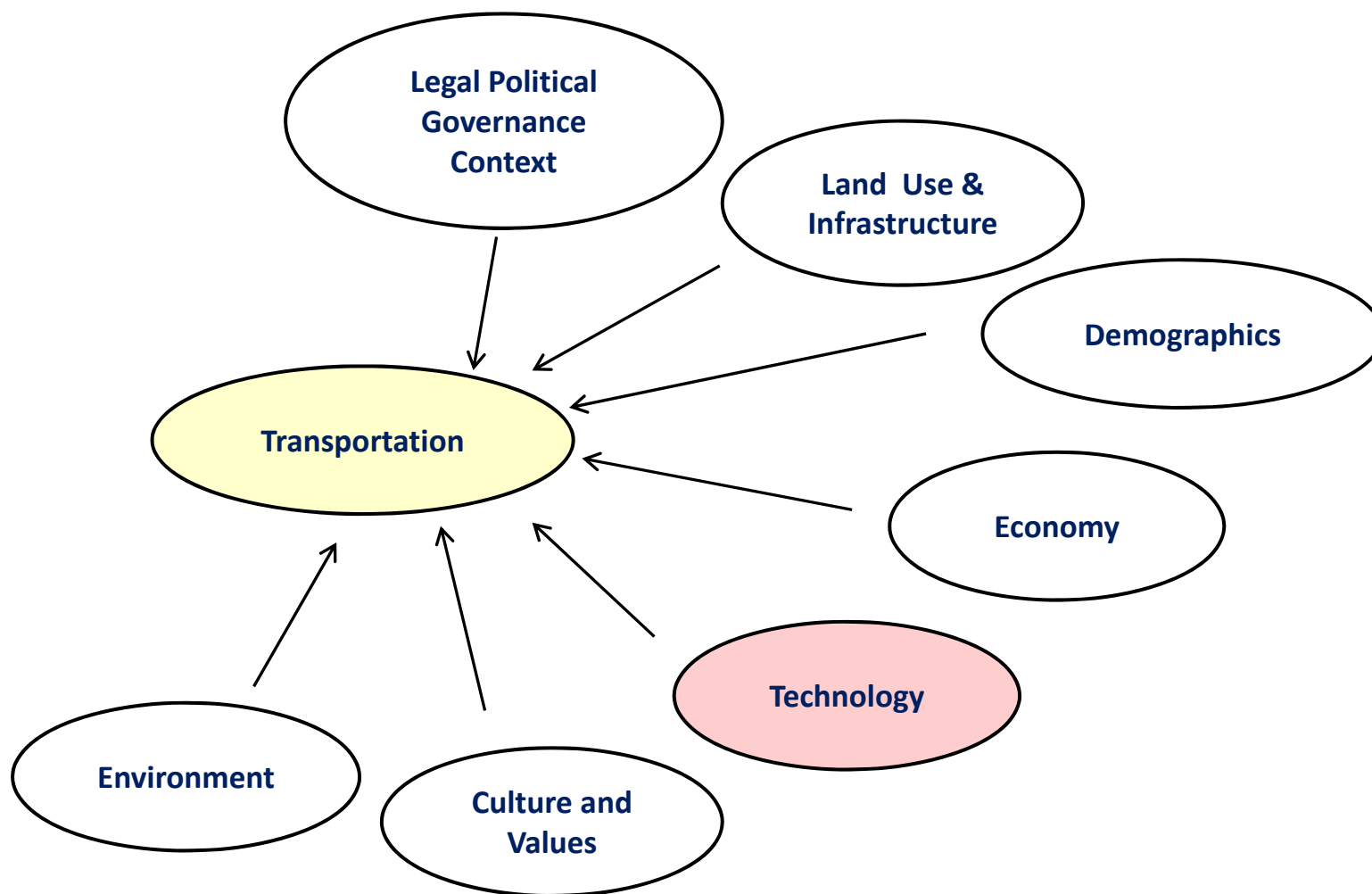


➔ **Travel Behavior**

## Consequences



# Everything Affects Transportation and Transportation Affects Everything



**Disclaimer:**

**“Prediction is very difficult,  
especially if it's about the  
future.”**

**Nils Bohr, Nobel laureate**



**Hey Watson, When did  
you say automated  
vehicles will be here?**

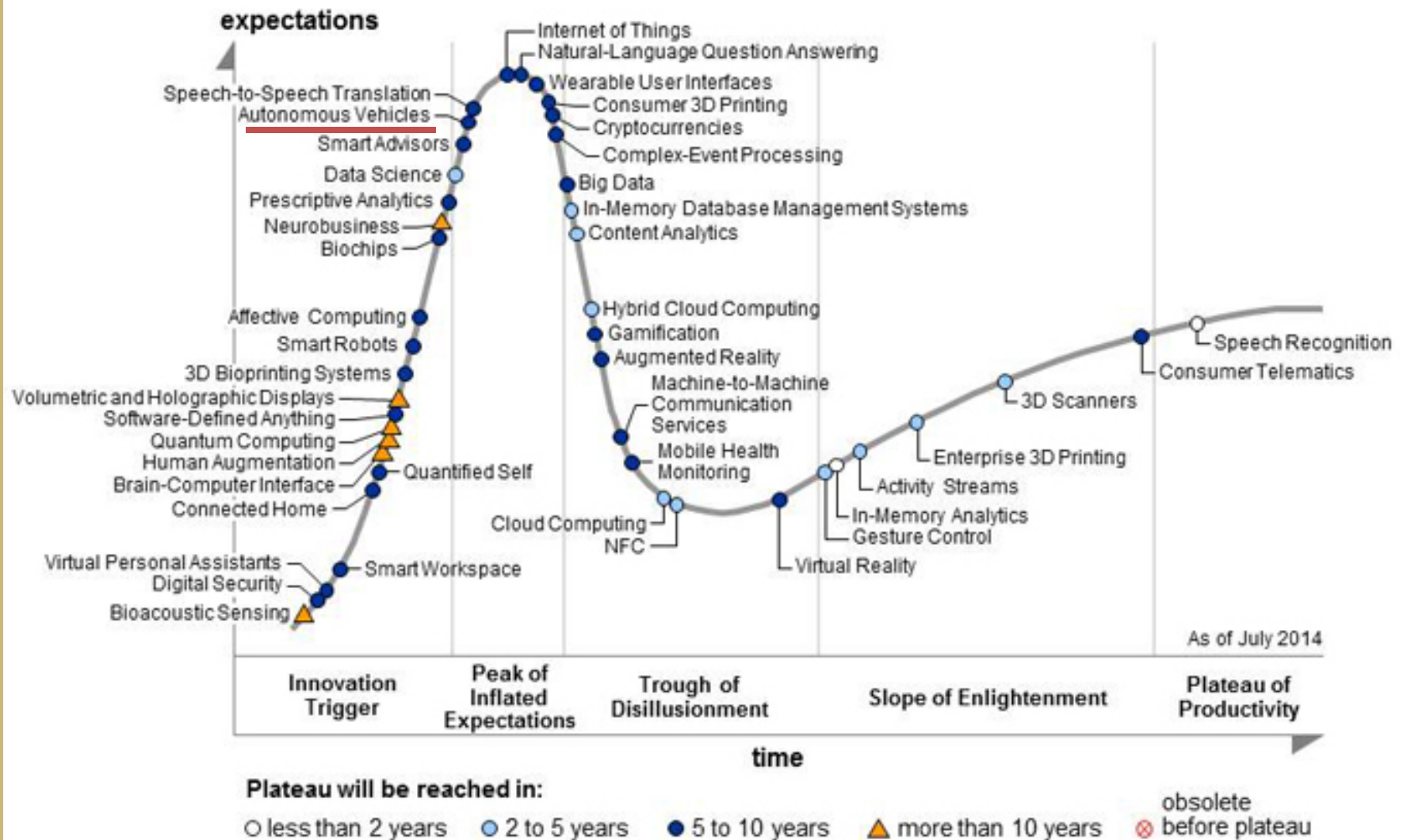
**And what will the  
impacts be?**



**Very smart people have very  
different opinions on the pace  
of implementation, market  
acceptance, and impacts of  
technology on transportation**



# Hype Cycle for Emerging Technologies



Source: Gartner (August 2014)

# The Public is Being Bombarded with Stories on Autonomous Vehicles



Chris Urmson, Director of the Google Self-Driving Car Program

**Cop pulls over Google self-driving car - going 24 in 35 mph zone**

CNN November 13, 2015



**Will your driverless car kill you so others may live?**

Los Angeles Times, 2015

# The Business World Is Being Rocked by Technology Deployed for Transportation

**Uber Valuation Put at \$62.5 Billion After a New Investment Round**

By [MIKE ISAAC](#) and [LESLIE PICKER](#), New York Times, DEC. 3, 2015  
12-11-2015

- GM \$53.6 B
- Ford \$54.09
- Tesla \$29.08

**GM is Investing \$500 Million in Lyft to Develop Self-Driving Cars**

January 2016

**Google, Ford in Talks on Self-Driving Car Partnership**

December 2015

**Toyota Chief Shifts to Self-Drive:** Akio Toyoda, once a skeptic, steers automaker into autonomous vehicle race.

WSJ, January 2016

**Transportation as a Service Envisioned as Massive Global Market Opportunity**

Uber  
Google  
Apple



Ford  
Chrysler  
GM



# Consensus? Thoughts

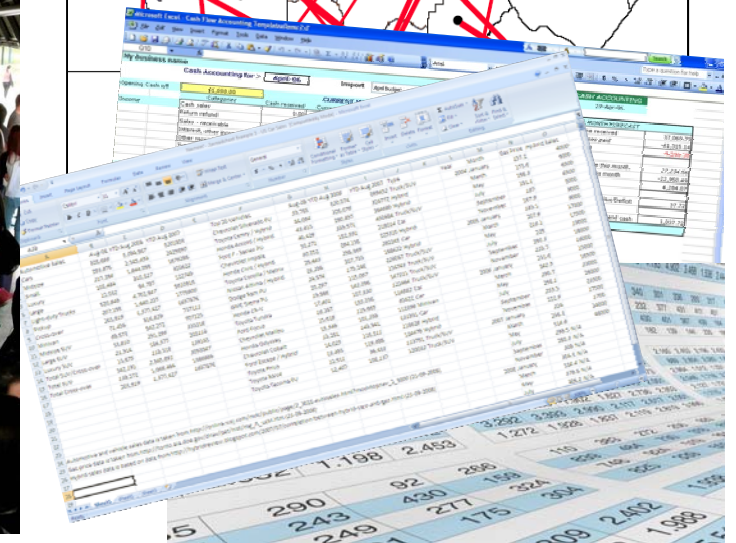
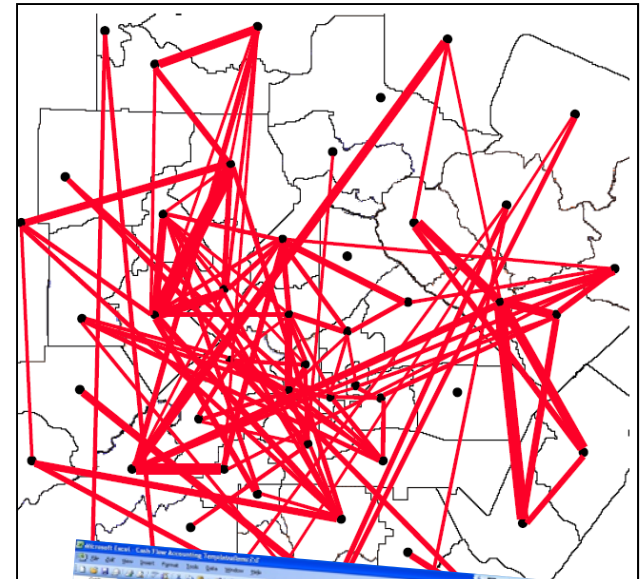
- Some safety benefits evident by mid 2020s
- Some capacity impacts (incident reductions benefits) by late 2020's
- Sufficient market penetration for some dedicated high capacity exclusive lanes in high volume corridors in 2040s



# Providing Transportation

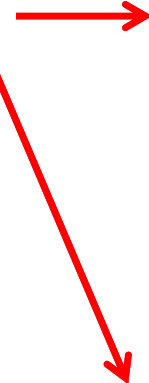
The transit industry  
(moving people, building places)


The technology and  
financial interests  
(logistics and dollars)



# Technology Implementation is Not Easy

August 13, 2015

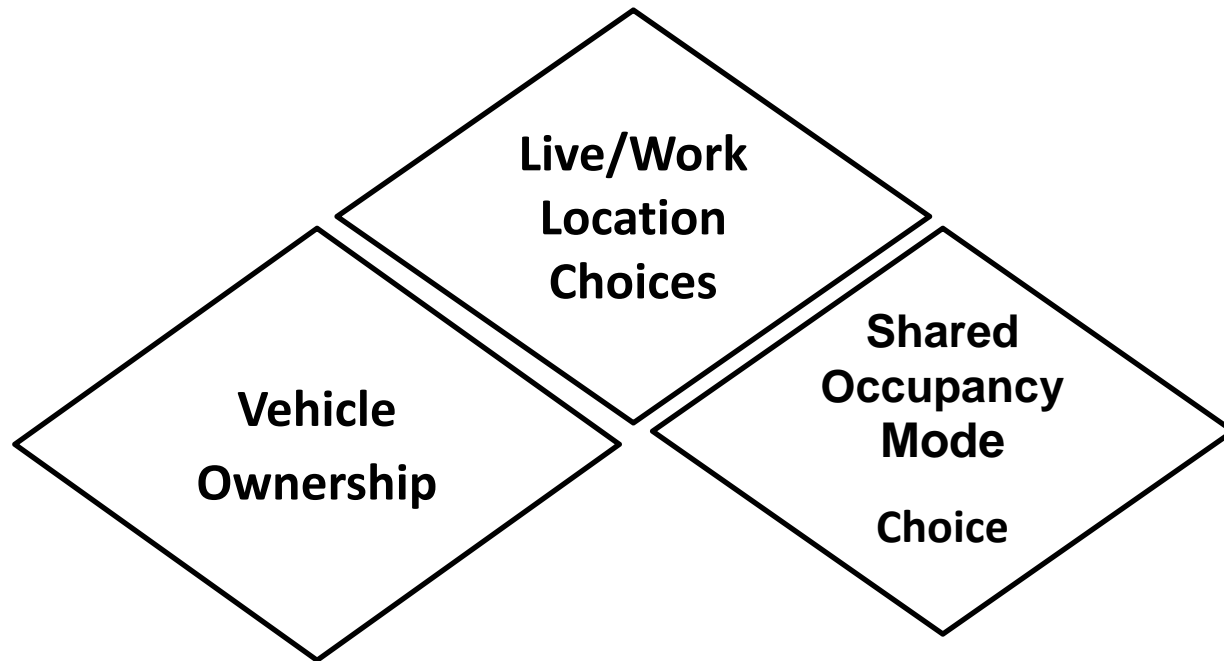


A photograph of two fishermen on a pier. The fisherman on the left is wearing a dark shirt and a cap, leaning over the railing. The fisherman on the right is wearing a light blue shirt and a hat, standing upright. Both have fishing rods. The background is a large body of water under a clear sky. Two thought bubbles are overlaid on the image, containing text in pink. The first bubble is connected to the fisherman on the left, and the second bubble is connected to the fisherman on the right.

**“I couldn’t get my autonomous car to back down the boat ramp.”**

**“I got dropped off by my TNC car service but they said I couldn’t carry any fish home in their vehicle.”**

# Impacts of Technology is Highly Dependent on Three Key Decisions





## The Vehicle Ownership Decision

- Average car driven about 10,000 to 12,000 miles per year
- About one hour per day at an average of 30 mph
- About 13+ million new vehicles purchased by households annually
- Households own about 215 million vehicles
- Avg. life of 17 years and 163,000 miles before scrapping
- Households responsible for about 2.25 trillion VMT annually
- U.S. vehicle fleet valued at over 2 trillion.

# Ownership Not Just a Mobility Decision



Functional  
transportation



Ego



Investment

Image



Hobby

Entertainment

Transportation  
plus?

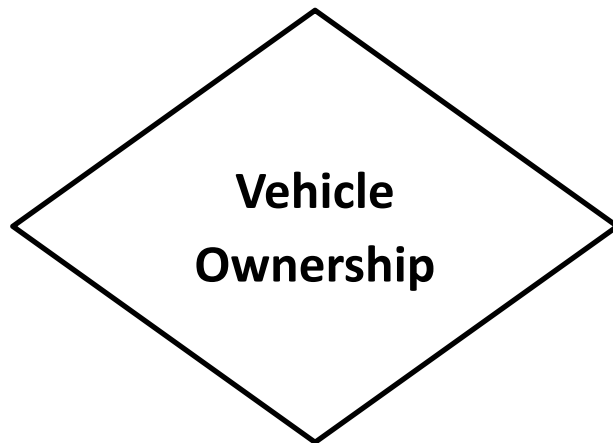
# Personal, Private Sector, or Government Ownership of Vehicles?

**Mobility Services Center**  
**Single Payment Plan – Bundled Mobility Services – Govt . Vouchers Accepted**

**Transit passes - Bikes - Motorcycles -  
Autonomous vehicles - TNC Vouchers, Amtrak HSR  
Tickets**  
**– One Low Monthly Fee**

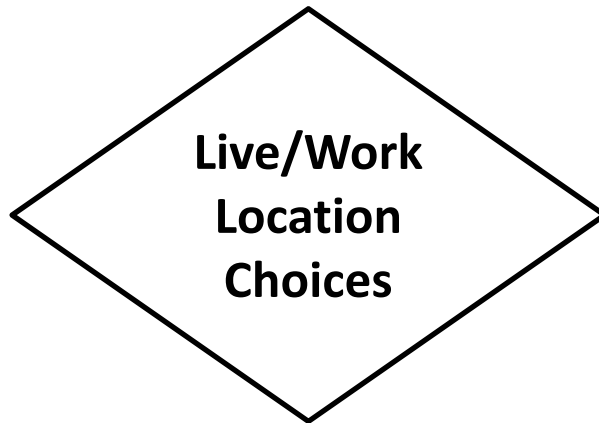


**It remains to be seen what share of households would be willing to relinquish one or more vehicles.**





# Key Decisions



# Land Use Impacts

**Drive till you qualify  
becomes nap till you  
qualify?**

**More house and less  
garage?**



# Land Use Impacts

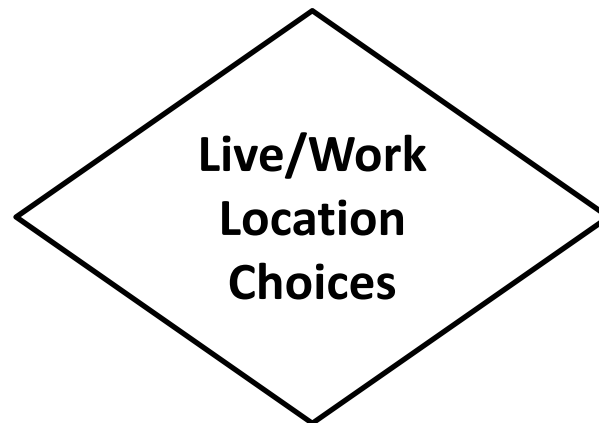
What will automated mobility enable?

Without having to own and park a car I can afford the urban lifestyle.



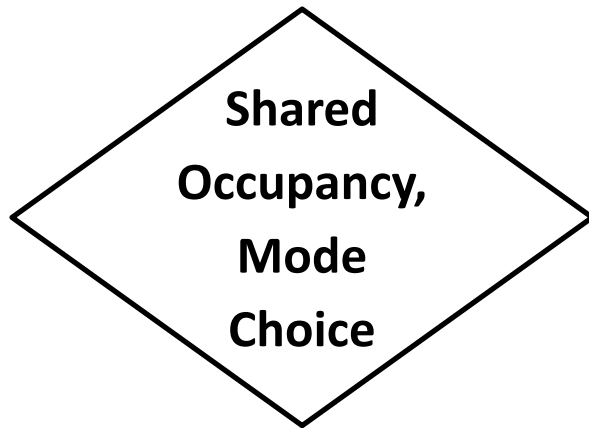
After a day at the office and a nap on the ride home I can enjoy the great outdoors.

It remains to be seen how travelers will react to the ability to be “passengers” during their vehicle travel.

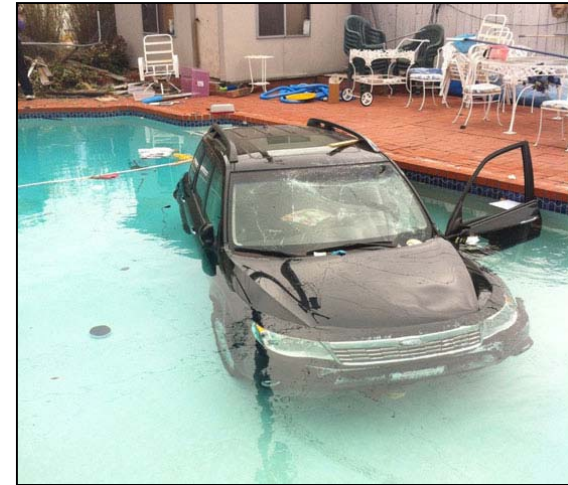


# Key Decisions

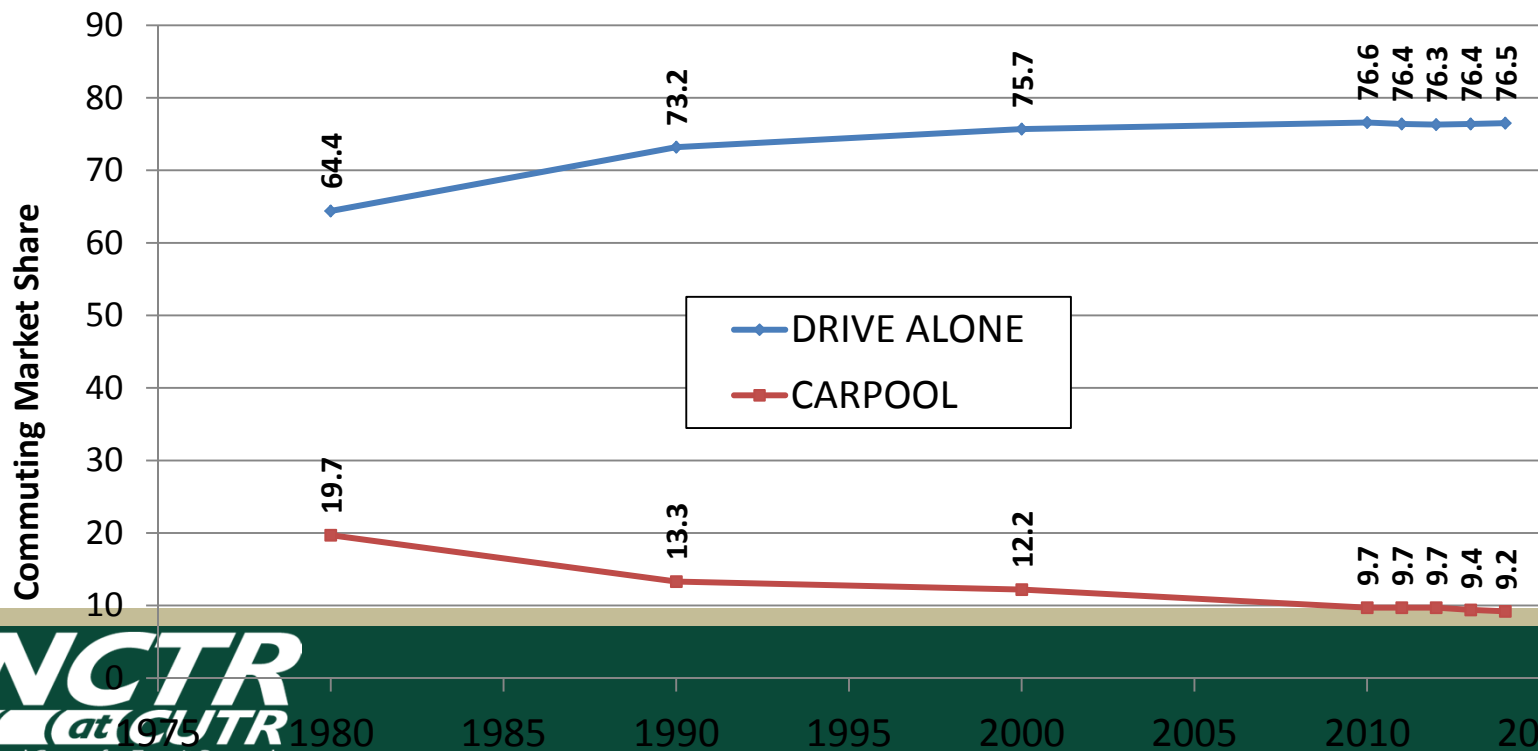
Sharing vehicles  
**sequentially**  
versus sharing  
vehicles  
**concurrently**



# Do Travelers Want to Share a Ride?



## The Demise of Carpooling?

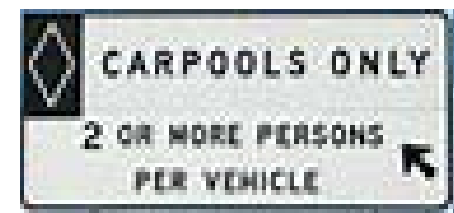
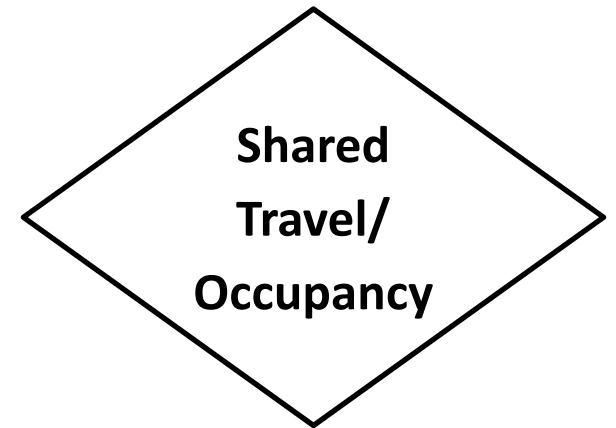


## Tidbits on Carpooling

- Work trip auto occupancy is approximately 1.13.
- Approximately half of the passengers riding with commuters are other work commuters and half are persons carrying out other activities (go to school, go to daycare, etc.)
- For every 100 vehicles commuting to work about six have a fellow commuter, approximately half are fampools.

*Will a generation, many of whom haven't shared bathrooms or bedrooms or phones or televisions or dorm rooms, share small vehicles with strangers?*

It remains to be seen how accommodating of vehicle sharing travelers will be and what the cost benefits and time penalties will be.






# So What Does this Mean for Transit?



# The Competition is Coming

LIMITED TIME ONLY

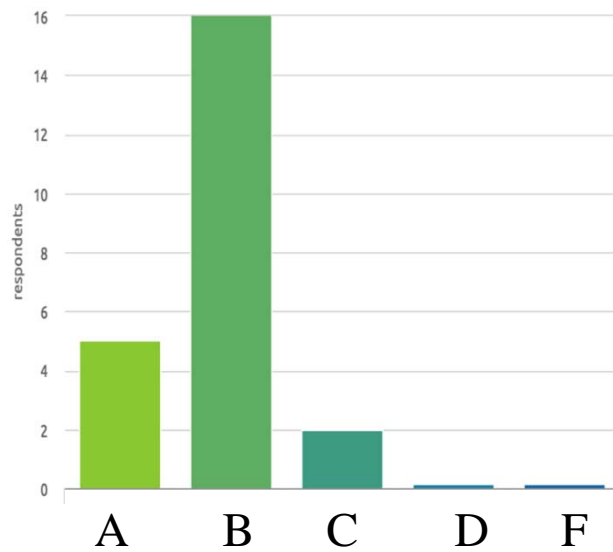
**\$2.25 Lyft Line Rides.  
That's Right.**



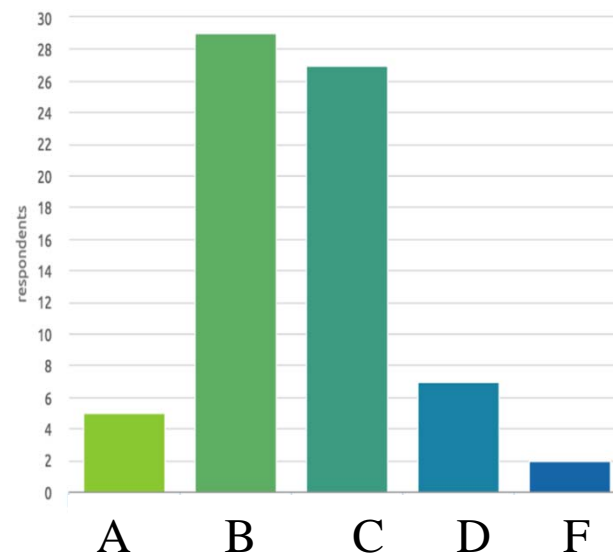
Lyft Line competing openly with SFMTA transit in San Francisco

Source: Charlie Youakim, *Passport*

# The Grades Are In In Chicago



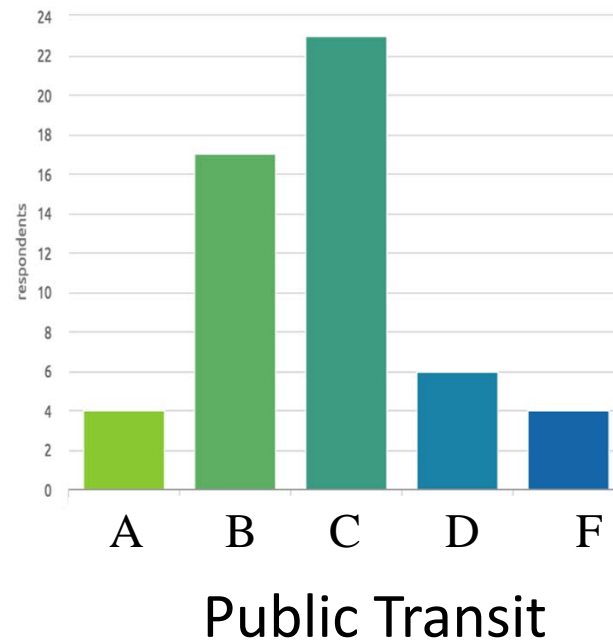
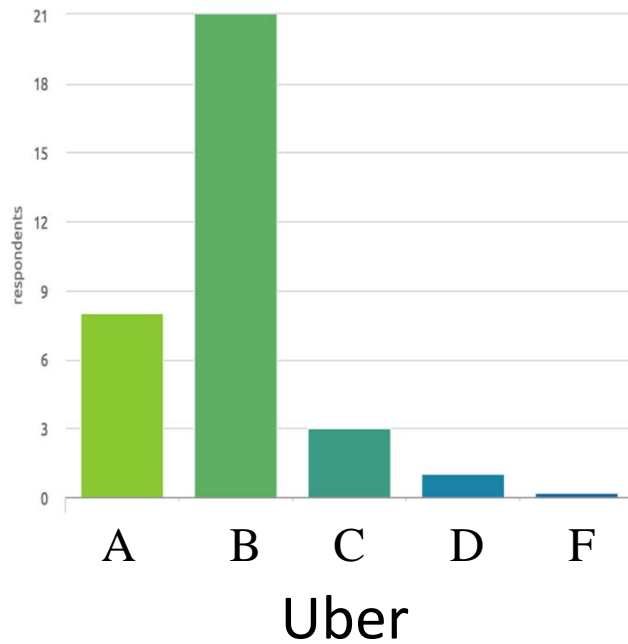
Uber



Public Transit

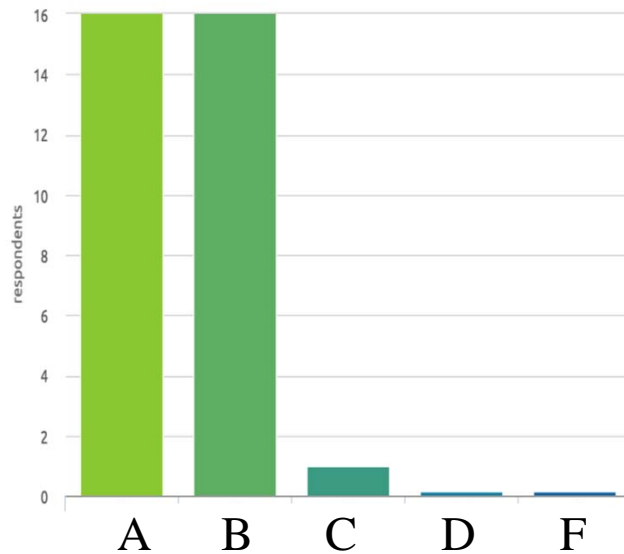
Source: Charlie Youakim, *Passport*

# The Grades Are In In Los Angeles

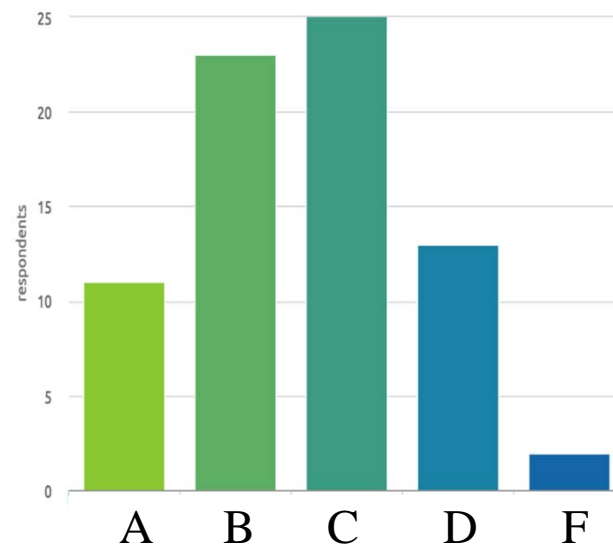


Source: Charlie Youakim, *Passport*

# The Grades Are In In New York City



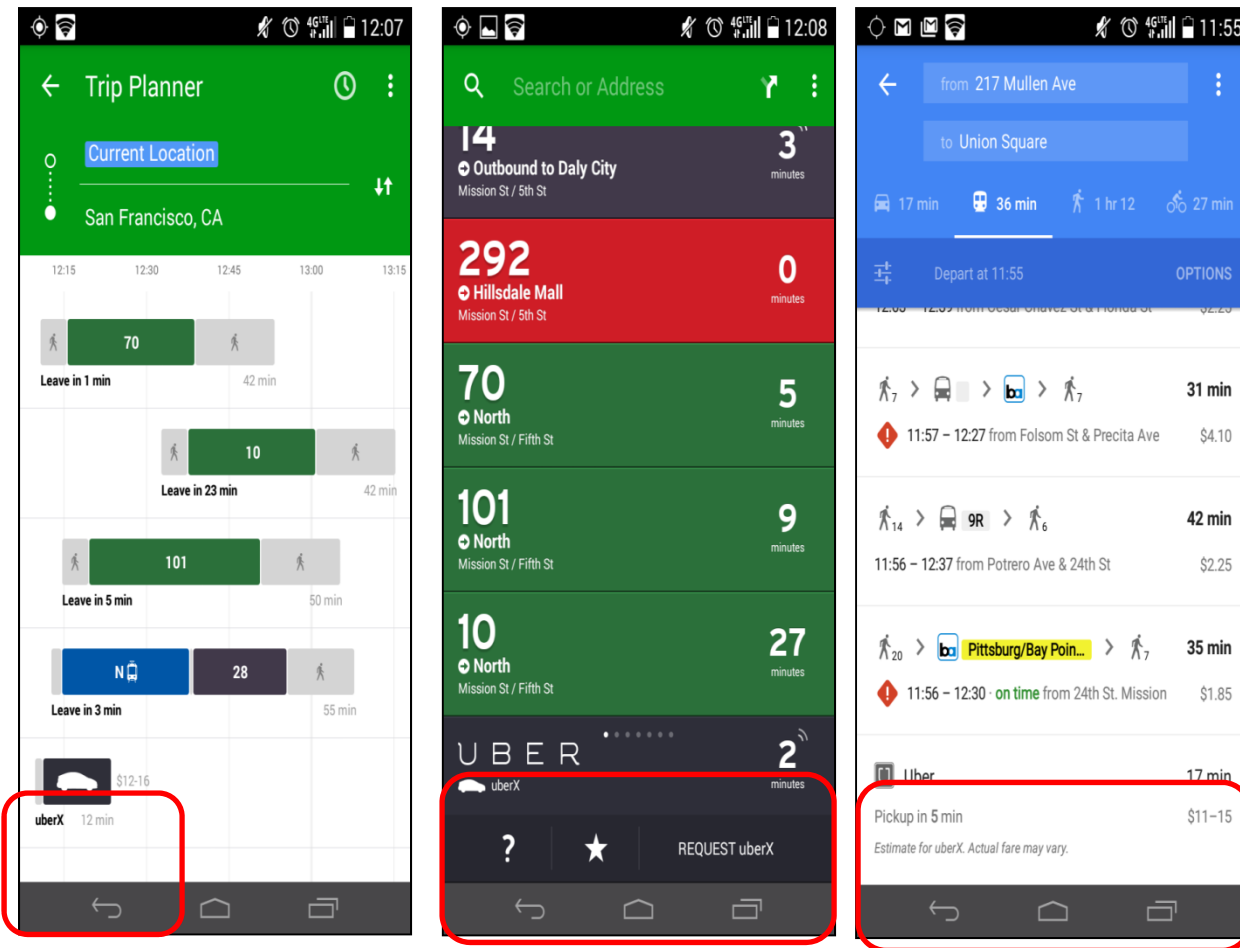
Uber



Public Transit

Source: Charlie Youakim, *Passport*

# The Competition is Coming



Source: Charlie Youakim, *Passport*

# The Rise of The Rideshares

Uber: >3m riders/day in North America<sup>1</sup>

NYC (MTA): 9m riders/day

Chicago (CTA): 1.6m riders/day

Boston (MBTA): 1.3m riders/day

San Francisco (SFMTA): 700k riders/day

DC (WMATA): 900k riders/day

<sup>1</sup> Based on internal Passport estimates. Uber reported 1m riders per day in Dec 2014.

Source: Charlie Youakim, *Passport*

# How Disruptive?

## Self-driving buses will be a big part of the transit puzzle

Roberto Baldwin , @strngwys  
January 2016

<http://www.engadget.com/2016/01/01/self-driving-buses-will-be-a-big-part-of-the-transit-puzzle/>

## What Will Happen to Public Transit in a World Full of Autonomous Cars?

From the Atlantic, CITYLAB

January 2014

<http://www.citylab.com/commute/2014/01/what-will-happen-public-transit-world-full-autonomous-cars/8131/>

## Driverless Cars: What Could Possibly Go Wrong?

by Robert Hutchinson  
Harvard Business Review

January 2016

[https://hbr.org/2016/01/driverless-cars-what-could-possibly-go-wrong?utm\\_source=feedburner&utm\\_medium=feed&utm\\_campaign=Feed%3A+harvardbusiness+%28HBR.org%29](https://hbr.org/2016/01/driverless-cars-what-could-possibly-go-wrong?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+harvardbusiness+%28HBR.org%29)

## Autonomous Vehicles' Disruptive Potential for Transit

Surface Transportation News #147  
January 2016

<http://reason.org/news/printer/surface-transportation-news-147>

## Urban Transit's Uncertain Future

NOVA NEXT

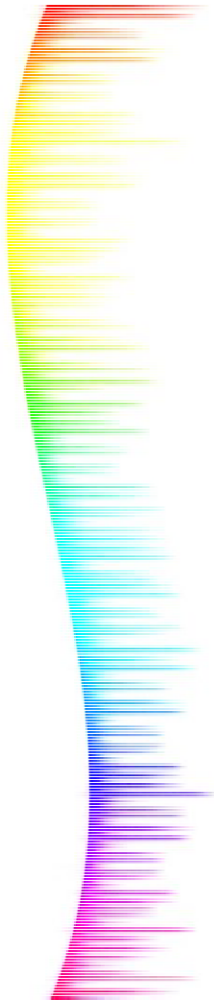
January 2016

<http://www.pbs.org/wgbh/nova/next/tech/urban-transits-uncertain-future/>





# Perceptions of the Impact on Public Transit are Emerging



- Insurance industry, labor, etc. won't let this happen.
- Emerging technologies will undermine auto ownership and complement transit in first-mile/last-mile services - supporting transit use.
- Transit will be reduced to very high volume fixed guideway operations.
- The public transit industry will morph into a mobility service provider.
- Shared rides in autonomous vehicles will become the new public transit.

# Transit's Strategic Response?

1. Strive to understand/monitor the impact of technology on travel behavior
2. Leverage the emerging modes/services to complement transit
3. Leverage the emerging technologies within transit operations
4. Be at the table in preparing for and adapting to new technologies
5. Advocate for transit's goals/strengths
6. Acknowledge the uncertainty and adapt long-range planning to mitigate risk



# 1. Strive to Understand/Monitor the Impact of Technology on Travel Behavior

- a) Auto ownership, cost and use trends
- b) Acceptance of evolving modes: bikeshare, carshare, TNCs, microtransit, etc.
- c) Impacts of new services on travel and transit

# Emerging Insights into Behavior Impacts

- Beware these business concepts and characteristics are changing rapidly.
- The early case study data is often limited to a few, not necessarily typical markets.
- Early findings reflect early adapter behaviors and may not apply to the broader market.

## 2. Leverage the Emerging Modes/Services to Complement Transit

- a) Paratransit services
- b) First-mile, last-mile
- c) Guaranteed ride home
- d) Co-branding/integrated marketing
- e) Integrated traveler information
- f) Etc.

# 3. Leverage the Emerging Technologies within Transit Operations

- Safety features/driver assist
- Productivity/capacity features  
platooning, preferential treatments
- Convenience/reliability features  
customer information, fare payment, wi-fi, etc.



# Automated or Piloted Vehicles

Challenges a fundamental cost factor (operator labor) in transit delivery

- Technologies could break the dependency on expensive infrastructure and exclusive right-of-way as prerequisites to allowing autonomous operation.
- Capture the benefits of congestion free operations while sharing the ROW/travel way investment.



# Automated or Piloted Vehicles

Removes the criticality of having large vehicles to amortize driver labor over

- Enables higher frequency smaller units of capacity
- Enables lower cost (smaller scale) infrastructure
- Enables greater flexibility in fitting infrastructure in built environments.





# Public Transit as a Technology Deployment Opportunity

- New technologies with unique features or special maintenance, safety, training, etc. often benefit from deployment in a professional/institutional environment (like a transit agency)
  - Policy/image motivation
  - Controlled professional environment
  - Economy of scale to amortize training, fixed capital, etc.
  - Vehicles have high use which enables rapid experience accumulation

*CNG, hybrid, electric*



## 4. Be at the Table in Preparing for and Adapting to New Technologies

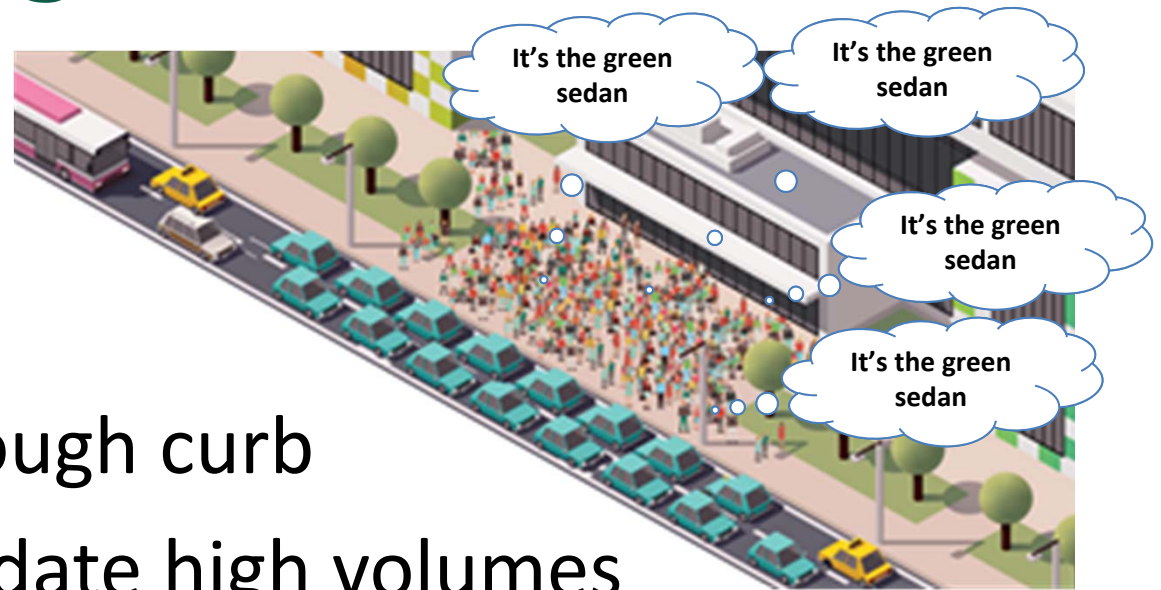
- a) Be at the table.
- b) Acknowledge the potential impacts and commit the industry to a constructive path forward.
- c) Education and training.

## 5. Advocate for Transit's Goals/Strengths

- a) Some markets will still need high capacity vehicles – transit's space efficiency



# 5. Advocate for Transit's Goals/Strengths



a) There is not enough curb space to accommodate high volumes with small vehicles (especially with shared ride coordination).

## 5. Advocate for Transit's Goals/Strengths

b) some users will need the mobility subsidy inherent in today's transit

- 70ish% operating subsidy

- 100% capital subsidy

=  $\approx$  80% non user subsidy of travel costs.

Mobility options priced over current user fare costs will impact many travelers.

# Cost of Mobility Options

<i>Source: IRS</i>	Auto Capital and Operating Cost (business)	\$0.54/mi., \$0.575 in 2015	
	Variable Cost (moving and medical)	\$0.19, \$0.23 in 2015	
	Out of Pocket (charitable, by statute)	\$0.14	Auto owners "feel" \$0.14 per mile costs in mode choice decision
	BLS Consumer Expenditure Survey	\$0.44/ vmt \$0.26/ pmt	
<b>Transit Fares</b>		<b>~ \$0.24/mi</b>	
<b>TNC (Uber, Lyft)</b>		<b>~\$0.65-2.00/mi</b>	
(sequentially shared vehicle, not concurrently shared ride)			
<b>Automated Vehicle (shared ride)</b>		<b>~&lt;\$0.20-????</b>	

## Ability of Transit Patrons to Procure Private Sector Mobility Services

- On average between 2009-2013 total expenditures (capital and operating) per passenger mile of transit service delivered equaled **\$1.04**. Fares covered **\$0.24**.
- Based on NHTS 2008 data **38.5%** of transit passengers had household incomes below **\$20,000**.
- Based on 2007 APTA onboard survey summaries, **34.9%** of transit passengers have household incomes below **\$25,000** (2004 \$).

# Access to Smart Phones and Banking Relationships

- Data indicates that 8% of the adult population does not have cell phones and 32% of adults do not own smartphones.  
(<http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/>)
- Onboard survey data suggests that 27% of St. Louis and LA Metro bus passengers do not have a smartphone as of 2013. While 33% of LA Metro rail passengers do not own a smartphone as of 2013.
- The Federal Reserve indicates that 7.7 percent of households in 2013 had no formal banking relationships (bank account). Alternative accommodations would be required for these patrons to utilize app enabled mobility services – these jeopardize the security benefit of not having anonymous travelers.



## 5. Advocate for Transit's Goals/Strengths

- c) Some travelers will still need door-to-door assistance.



# 6. Acknowledge the Uncertainty and Adapt Long-Range Planning to Mitigate Risk

## Low Risk Decision

- Near-term impacts/benefits
- Lower cost
- Reversible/redeployable
- Similar examples from which to gauge impacts

## High Risk Decision

- High cost
- Not reversible
- Dependent on longer-term impacts
- Original/rare situation

# Planning Challenges?

None of the MPOs most likely to be planning for self-driving cars have incorporated them into their most recent RTPs. 2 Of the twenty-five largest MPOs, only Philadelphia's Delaware Valley Regional Planning Commission mentions autonomous vehicles at all.

- There is a great deal of uncertainty about what technologies will prevail, how much and when they will penetrate the market, whether regulation will hinder or support deployment, what the direct impacts will be on capacity or safety, and how consumers will respond.
- Driverless cars and their potential impacts are too far removed from decisions about whether and how to invest in and maintain transportation infrastructure.
- Vehicle automation is just one of a number of radical changes that could influence regional transportation over the next 30 years. Staff also mentioned changes in federal transportation funding, 3D printers, improvements in telecommunications, and the impacts of and policies to address climate change as potential game-changers.

"Planning for Cars That Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans, and Autonomous Vehicles", Erick Guerra, *Journal of Planning Education and Research*, 2015



## Risk Averse Planning

- Focus on near term benefits
- Test option's robustness (ability to perform in various future scenarios)
- Use uncertainty or risk analysis
- Invest in adaptive infrastructure

## A Path Toward Success

Policy makers and industry professionals with input from the public should strive to find ways for the positive benefits of technology to be realized without ego, greed, self interest, lust for power, or incompetence denying the public the full benefits of new technologies.



# Contact Information



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