

# Driving Change – Autonomous Vehicles’ Big Impact

National Economic Education Delegation

Jon Haveman, Ph.D.

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## National Economic Education Delegation

- **Vision**

- One day, the public discussion of policy issues will be grounded in an accurate perception of the underlying economic principles and data.

- **Mission**

- NEED unites the skills and knowledge of a vast network of professional economists to promote understanding of the economics of policy issues in the United States.

- **NEED Presentations**

- Are **nonpartisan** and intended to reflect the consensus of the economics profession.



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# Who Are We?

## • Honorary Board: 54 members

- 2 Fed Chairs: Janet Yellen, Ben Bernanke
- 6 Chairs Council of Economic Advisers
  - Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
- 3 Nobel Prize Winners
  - Akerlof, Smith, Maskin

## • Delegates: 600+ members

- At all levels of academia and some in government service
- All have a Ph.D. in economics
- Crowdsource slide decks
- Give presentations

## • Global Partners: 45 Ph.D. Economists

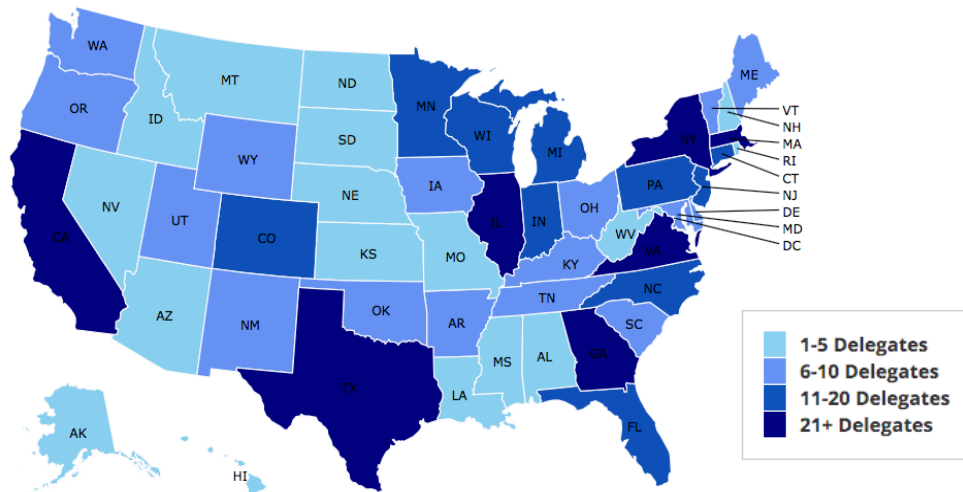
- Aid in slide deck development



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# Where Are We?



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## Available NEED Topics Include:

- Coronavirus Economics
- Climate Change
- Economic Inequality
- Economic Mobility
- US Social Policy
- Trade and Globalization
- Minimum Wage
- The U.S. Economy
- Immigration Economics
- Housing Policy
- Cryptocurrencies
- Federal Debt
- Black-White Wealth Gap
- Autonomous Vehicles



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## Credits and Disclaimer

- **This slide deck was authored by:**
  - Jon Haveman, NEED
- **This slide deck was reviewed by:**
  - Ronald Fisher, Michigan State University
  - William F. Fox, University of Tennessee, Knoxville
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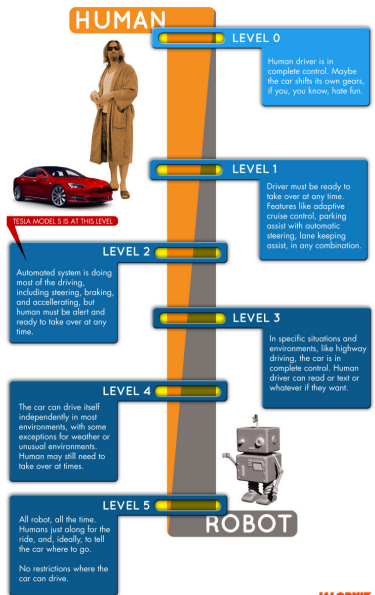
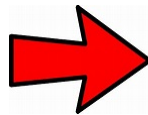
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# Outline

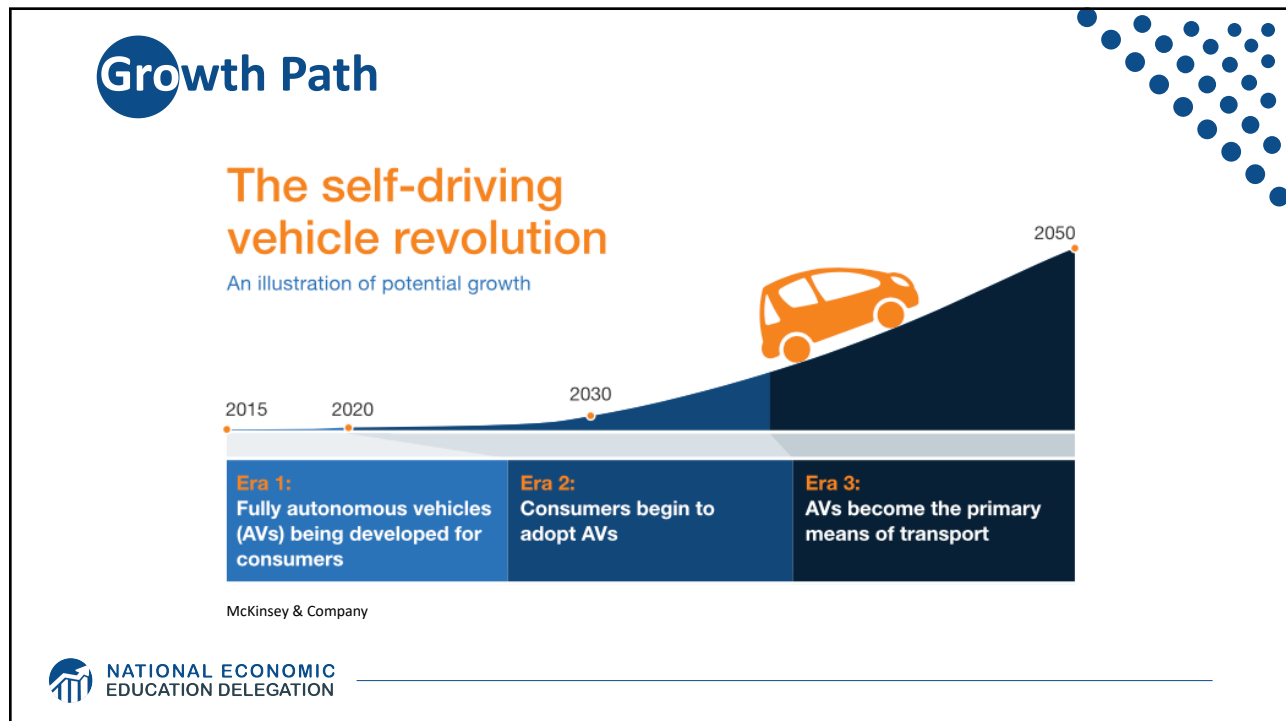
- Where does the AV path lead?
- Transition
- Policy/Planning Issues
- Major Economic/Development Changes

# Autonomous Taxonomy

## SAE AUTONOMY LEVELS








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## McKinsey isn't Always Spot On

- "In 1980, McKinsey & Company was commissioned by AT&T to forecast cell phone penetration in the U.S. by 2000.
  - The consultant's prediction, 900,000 subscribers,
  - was less than 1% of the actual figure, 109 Million."
    - Professor Angel Lozano, 2014

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## Two Important Questions:

1. When will Transportation as a Service (TaaS) be available?
2. How quick will the transition be?

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## WHEN? What do the headlines say?



NVIDIA to introduce level-4  
enabling system by 2018



First autonomous Toyota  
to be available in 2020



**Volkswagen**

Volkswagen expects first  
self driving cars on the  
market by 2019



**Audi**

Audi to introduce a self-  
driving car by 2020



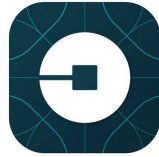
**TESLA MOTORS**

Elon Musk now expects  
first fully autonomous  
Tesla by 2019, approved by  
2021

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## Wildly Optimistic, But...

### 40+ Corporations Working On Autonomous Vehicles



WAYMO



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## WHEN?

### What is possible?

- By 2025 (?)
- Potentially 95% of VMT by 2035.
- Last 5% is going to be very difficult to achieve.
- Is this possible?
  - Horses to cars: 10 years – early 1900s
  - But adoption of EVs is so slow!
  - Adoption of AVs will be rapid.



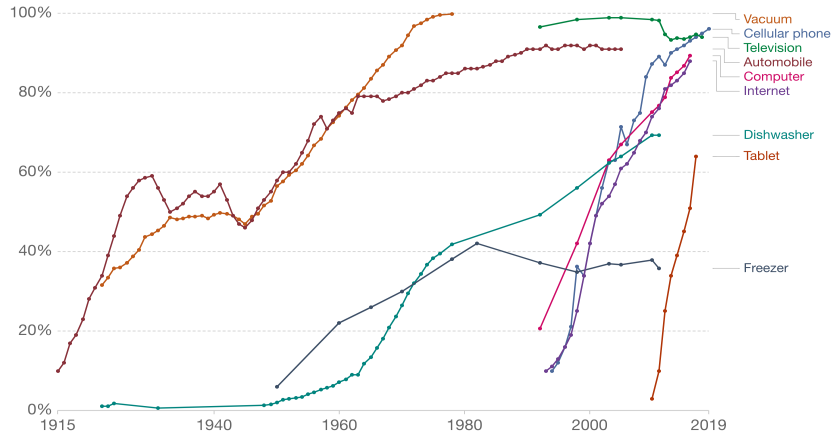
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# Rate of Technology Adoption – Faster!

## Technology adoption in US households, 1915 to 2019

Technology adoption rates, measured as the percentage of households in the United States using a particular technology.



Source: Comin and Hobijn (2004) and others. OurWorldInData.org/technology-adoption/ - CC BY  
Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.

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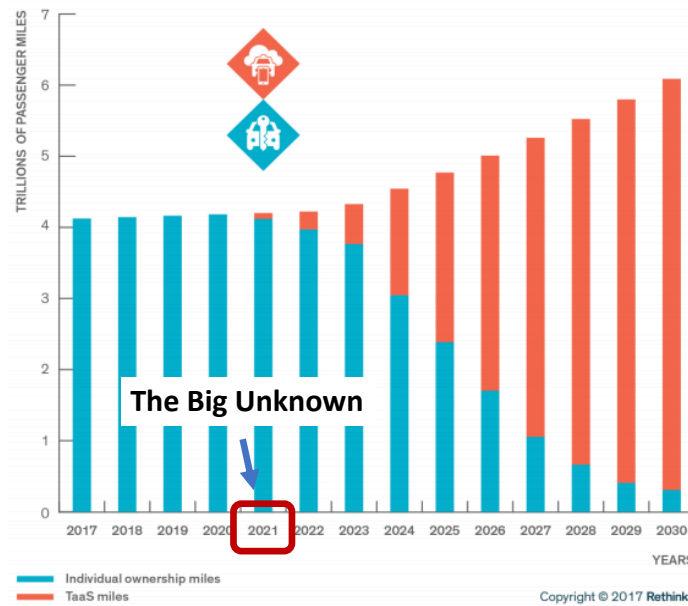
# Forecast

Timing may be off.

But the point is:

RAPID ADOPTION!

## » Speed of TaaS adoption



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**Waymo's self-driving cars are now available on Lyft's app in Phoenix**

**Hyundai plans to launch a free robot taxi service in California**

**Singapore's self-driving cars can now be hailed with a smartphone**

*NuTonomy joins forces with 'the Uber of Southeast Asia'*



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**What will the future look like?**



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**This:**



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**But, will it be:**





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# Hell

- **Primarily individual private car ownership**
  - Much as today.
- **Internal combustion engines**
- **Why Hell?**
  - Dramatically increased VMT and pollution.
  - Potentially increased congestion
  - Parking.

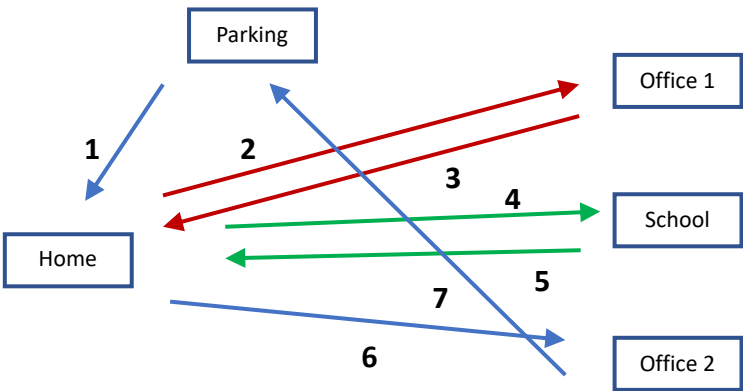





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# Two Adults and a Child: Morning Miles



And this is just the morning.....



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## Heaven



- **Vehicle ownership will be very limited**
  - Private ownership for those with specialized vehicle needs.
  - Fleet ownership will serve everybody else.
- **Engines: electric**
- **Insurance: product liability**
- **Not clear when we will get there, but this is the likely model.**
  - 2030 for widespread adoption in many regions.



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## Why is this Heaven?

- **Not only autonomous, but:**
  - Shared
  - Connected
  - Green
- **Far fewer cars in existence.**
  - Better resource utilization.
- **VMT could go up or down, but more productive than in Hell.**
- **Congestion effects – unclear, but likely reduced.**
  - Right-sized vehicles, platooning, sharing, V2V communication
- **Minimal need for parking.**




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# Transition

- **Short term: Tesla model of highway autonomy**
  - Level 2, adaptive cruise control
  
- **Medium term:**
  - short period of personal vehicle ownership with level 3 capability
  - introduction of independent private fleets – Uber, Lyft, Google, nuTonomy, etc., with level 4/5 capability
  
- **Long term:**
  - Personal vehicle ownership is largely a thing of the past




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# Economics Drives Transition: Private

- **Adoption dividend for private individuals**
  - Eliminate car ownership
    - Ave annual cost of owning a car: \$9,561
    - Cost per mile will fall: \$0.64 to \$0.19
  - Repurpose your garage
    - \$50,000 from transition to bedroom
  
- **Time recovery**
  - 50% of Bay Area workforce has a commute in excess of 30 minutes

Miles per Year	10k	15k	20k
Average Cost	82¢	64¢	55¢



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Source: NEED Calculations and AAA Driving Cost Fact Sheet, 2020

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## Economics Drives Transition: Public

- Economic and social costs associated with human drivers are enormous:

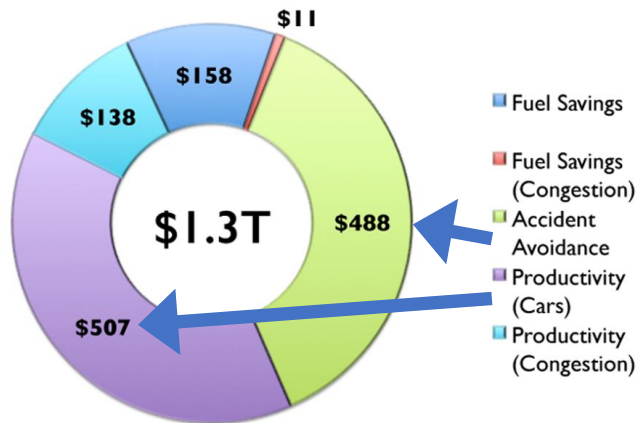
- ACCIDENTS:
  - Drive 25% of congestion.
  - Result in 40,000 deaths.
  - And 2 million injuries.
  - 90+% caused by human error.
- Increased productivity from not driving.
- Costs of human drivers estimated at up to \$1.3 TRillion each year



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## Potential Savings

Potential US Savings (\$B)



Morgan Stanley

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## Public Policy/Planning Issues

- **Government buy-in:**
  - Essential – gov't must encourage progress
  - Difficult – because of displacement issue
- **Important transitional issues:**
  - What infrastructure should be developed?
  - What to do about public transportation?
  - What to do with all of the parking spaces?



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## Planning

- **Respond to the coming changes**
  - The planning horizon for any investment in transportation infrastructure based on today's predominant technology has changed.
    - It may have gotten **MUCH shorter**.
- **Encourage the changes to happen more quickly**
  - Mobility, safety, productivity, and environmental benefits abound.



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## Responding to the coming changes:



- **Transportation organizations must develop a forecast for adoption in their specific geography**
  - San Francisco – faster than Chicago
  - Chicago – faster than Fresno
  - Fresno - faster than Kansas
- **How does this affect the ROR calculation on projects?**
  - Highway expansion? Public Transportation?

## Encourage Change

- **Mobility and equity considerations.**
  - Elderly/disabled/impooverished
- **Safety:** only way to reduce traffic fatalities is by coordinated effort.
- **Productivity:** reduced congestion.
- **Environment:** speed transition to electric vehicles.

These are all societal benefits that come about too slowly  
if the private market is left to itself.

## Mobility and Equity

- **Mobility**

- Handicapped
- Elderly
- Lower income

- **Equity**

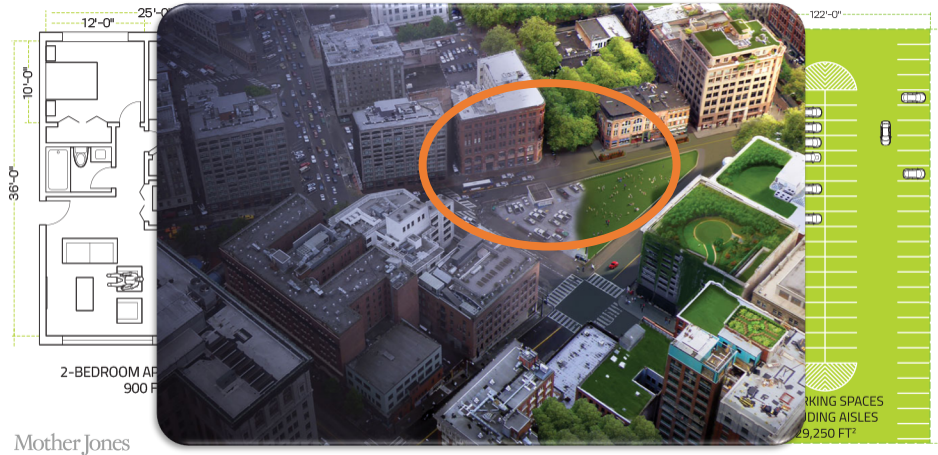
- Public Transportation often does not work well for low-income workers/residential workers
  - Does not go from residential to residential, but from residential to commercial



## Safety and Productivity



# Environment



# Environmental Implications Depends: Heaven or Hell

- **Improved resource utilization**
- **More efficient travel**
  - Right sized vehicles
  - Optimized routes
  - Reduced congestion
  - No searching for parking
- **Increased VMT**
- **Cleaner technologies**
  - Electric
  - Lighter vehicles
- **Energy use of onboard electronics**
  - Weight and functional
- **Increased urban sprawl**

Bottom line: push governments at all levels to embrace and to implement policies deterring private vehicle ownership and zero passenger miles

## Incentives Through Policy and Planning

- **Allow vehicles equipped with ACC into HOV lanes**
  - Eventual conversion of HOV lanes to ACC/AV lanes
- **Allow ACC equipped vehicles to travel faster in HOV lanes**
- **Subsidize ACC upgrades**
  - Arguably more concrete benefits than electric vehicles
- **Sticks: higher costs of vehicle ownership**
  - Registration fees, VMT taxes, etc.



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Note: ACC = Adaptive Cruise Control

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## Interim Summary

- **Transition is coming very quickly!**
  - Most reports are extremely conservative
  - Apply generally, but faster in many regions.
- **Very important to start incorporating AVs into planning now.**
  - To realize the benefits of AVS.
  - Sacrifice expansion for maintenance.



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## What Changes Will This Bring?

- Disposable income
- Government finances
- Transportation
- Infrastructure
- Public transportation
- Employment
- Housing
- Parking

Potentially dramatic improvements in infrastructure planning and maintenance -  
Data sharing and integration



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## Disposable Income



- Costs \$9,282 to own a car
- Will cost \$3,000 to use TaaS
- Net increase in disposable income of > \$6,000
- Spread across all households:  
more than \$1 trillion in new spending in the economy
- Major boost to economic activity
  - CREATING JOBS!



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## Government Finances



### • Government finances thrown for a loop:

- Revenues up and down:
  - Parking revenue, tickets, traffic violation revenues
  - More commercial, retail and residential space
- Less spending on road development
- More (maybe less) spent on road maintenance
  - Fewer road miles
  - but perhaps more VMT

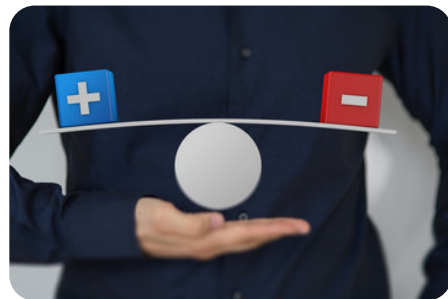
## Transportation

### • Demand for transportation will likely increase significantly: price falls, demand rises

- Commutes may increase in distance, but not necessarily in duration
- Zero passenger trips will arise
  - Deliveries

### • At the same time, demand for roadway lane-miles will likely decrease

- AVs make significantly more efficient use of space
- Front to back and side to side



## Infrastructure

- **Focus of transportation infrastructure:**

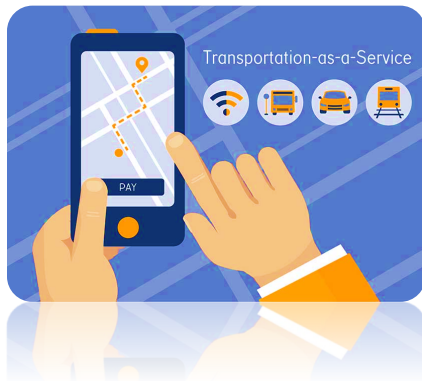
- Currently on expansion
- Will turn toward:
  - Maintenance
    - Signage and striping has to be robust
    - TaaS providers push for fewer potholes?
  - Adding technology
    - Stop lights will be digital as well as visual
- Some will disappear: Signs!



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## Public Transportation



- **Ambiguous implications for public transportation**
- **Demand may:**
  - Shrink because of low cost of TaaS
  - Grow because last mile problem is solved
- **Extensions may be added through contract with TaaS company**



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## Cautionary Tale From Long Ago

- **Automobiles impact on rail:**

“The increasing dominance of cars was also felt by railway companies, which by June 1894 had to start making **pricing concessions** for transporting goods, even including free transport.”



- Samuel I. Schwartz, No One at the Wheel, 2018

## Employment

- **Massive job displacement/relocation (Millions!):**

- Drivers of all varieties: truck, taxi, delivery...
- Car production jobs, car parts production jobs
- Gas station, vehicle repair, and body shop
- Police and fire
- Health care workers
- And so on...



## Employment (con't)



- **What jobs will be created?**
  - IT jobs
  - Retail/Production jobs
  - ??
- **Always easier to identify things that will go away than to identify what will pop up in its place.**
- **Regardless of where they are created, training programs will be crucial to the transition.**



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## Housing



- **Housing is suddenly easier to build**
  - Issue of traffic congestion is significantly reduced.
  - Space for new housing is available where parking lots used to be.
- **Existing houses can now accommodate more people: garage to bedroom conversions.**



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## Parking

- **Greatly reduced demand for parking lots.**
- **Service providers will own parking lots in strategic places.**
  - Where the cost of land is low.
- **Street parking will largely be a thing of the past.**
  - More green space in cities.
- **Shopping mall parking will be converted to:**
  - More shopping mall? Housing?
- **Apartment complexes will convert parking.**



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## Freeing Up Urban Space from Parking

- **Los Angeles: 14% of incorporated land area**
  - 200 Square miles
- **San Francisco: 275,450 on-street parking spaces**
  - Enough to parallel-park a line of cars 900 miles.
    - California's entire coastline is 840-miles.
  - Enough parking to fill parking lots that would cover the **Presidio, Golden Gate Park, and Lake Merced.**
- **Nationwide: (estimate) 500 million spaces**
  - That's larger than Delaware and Rhode Island combined.
  - Could be as many as 2 billion (add in Connecticut and Vermont).



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## Summary of Change

- **Massive employment upheaval.**
- **Local government finances will look very different.**
- **Housing will be easier to build and more plentiful.**
- **Parking conversions will be commonplace.**
- **Demand for transportation infrastructure will likely decline.**
  - Transportation infrastructure technology will be a booming business.
- **Demand for public transportation may well decline.**
- **Coming likely sooner rather than later!**



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## Thank you!

## Any Questions?

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Jon Haveman, Ph.D.

Jon@NEEDelegation.org

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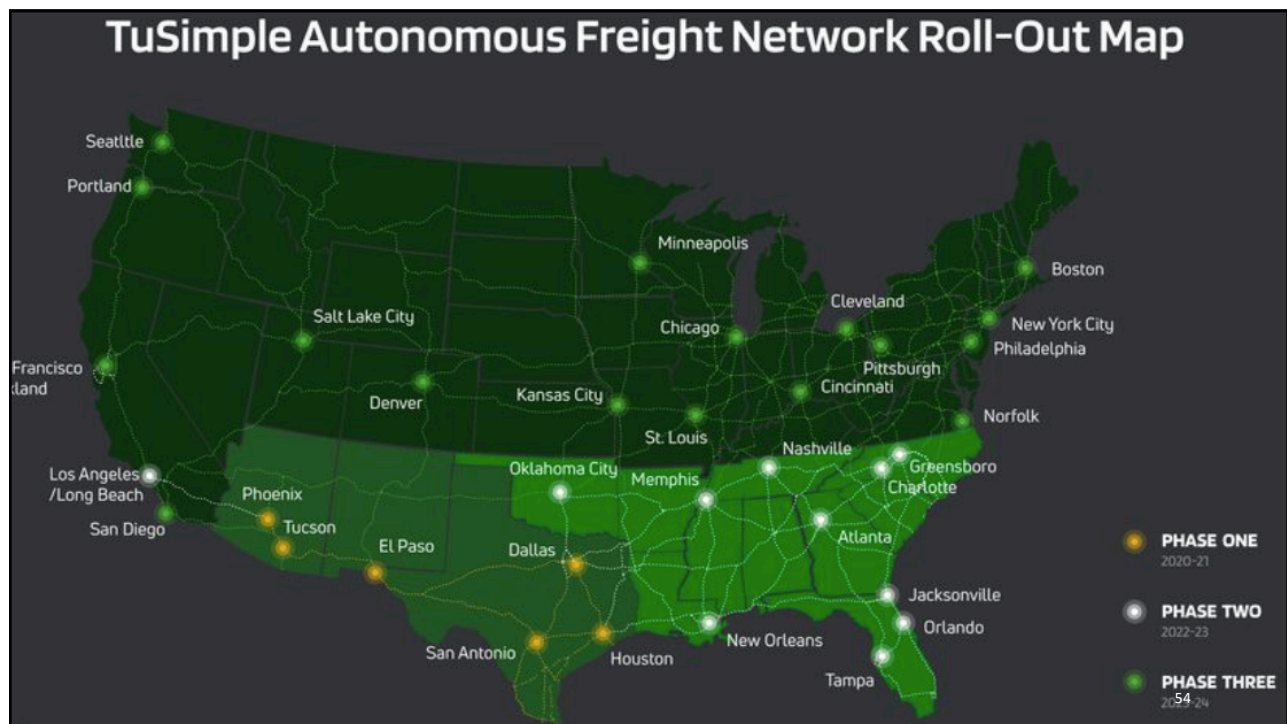
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# Trucking – Highly Fertile Ground

- **Long haul trucking is likely the first place we will see it adopted.**
  - Reduces costs associated with drivers.
  - End run around limits on hours of driving.
- **Where does it stand?**
  - Lots of trials underway.
  - TuSimple – actively building a long haul network.
  - Waymo – focused more on last mile/local delivery.

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