

*Marin Academy*

# Driving Change – Autonomous Vehicles’ Big Impact

National Economic Education Delegation and Marin Academy  
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1

## Outline

- **Where does the AV path lead?**
- **Major Economic/Development Changes and Challenges**



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# Autonomous Taxonomy

## SAE AUTONOMY LEVELS

**HUMAN** LEVEL 0: Human driver is in complete control. Maybe the car shifts its own gears, if you, you know, hate fun.

LEVEL 1: Driver must be ready to take over at any time. Features like adaptive cruise control, parking assist with automatic steering, lane keeping assist, in any combination.

LEVEL 2: Automated system is doing most of the driving, including steering, braking, and accelerating, but human must be alert and ready to take over at any time.

LEVEL 3: In specific situations and environments, like highway driving, the car is in complete control. Human driver can read or text or whatever if they want.

LEVEL 4: The car can drive itself independently in most environments, with some exceptions for weather or unusual environments. Humans may still need to take over at times.

LEVEL 5: All robot, all the time. Humans just along for the ride, and, ideally, to tell the car where to go. No restrictions where the car can drive.

**ROBOT**

WAYMO

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JALOPNIK

3

3

# Waymo is in SF

And in:

- Phoenix, AZ
- Los Angeles, CA
- Austin, TX
- Dallas, TX
- Houston, TX
- San Antonio, TX
- Atlanta, GA
- Miami, FL
- Orlando, FL
- Nashville, TN

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Source: <https://waymo.com/whereyoucango/?section=san-francisco-ca>

4

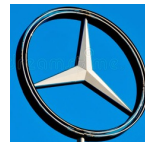
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## Three Important Questions:

1. When will Transportation as a Service (TaaS) be ubiquitously available?
2. How quick will the transition be?
3. What will the future look like?

5

## 40+ Corporations Working On Autonomous Vehicles



6

## WHEN?

### What is possible?

- In 2025, significant expansion.
- Potentially 95% of VMT by 2035.
  - Last 5% may 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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**Waymo's self-driving cars are now available on Lyft's app in Phoenix**

**Lyft and Motional's all-electric robotaxi service is now live in Las Vegas**

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

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

**Waymo's driverless taxi service expanding into the South Bay**



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8

## Fee-For-Service Autonomous TaaS

- **Waymo:** Phoenix, AZ, Los Angeles, CA, the San Francisco Bay Area, CA, Austin, TX, Dallas, TX, Houston, TX, San Antonio, TX, Atlanta, GA, Miami, FL, and Orlando, FL
- **Motional:** Las Vegas
- **Arlington, TX: Minibuses – Milo and Drive.ai**
- **More are surely coming soon....**



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9

## Actively Pursuing Autonomous Local Delivery

- **Dominos**
- **Walmart**
- **Amazon**
- **CVS Pharmacy**
- **Stop and Shop**
- **Uber Eats**
- **Kroger**



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10

10

# AV Trucking is Taking Off As Well!

 **BOT AUTO** ABOUT ▾ SAFETY ▾ CAREERS C




**Driving Innovation**  
 **BOT AUTO**

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11

# What will the future look like?

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12

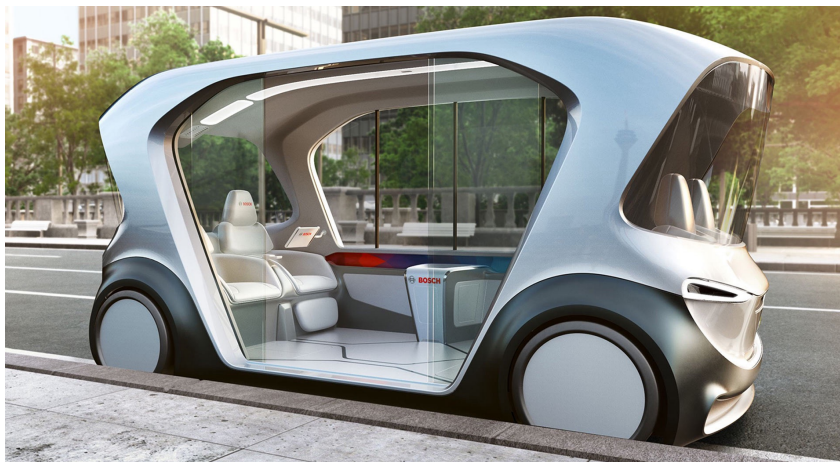
**This:**



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**Or This:**



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<https://www.carscoops.com/2018/12/boschs-autonomous-electric-shuttle-concept-aims-future-travel/>

14

14

**But, will it be:**

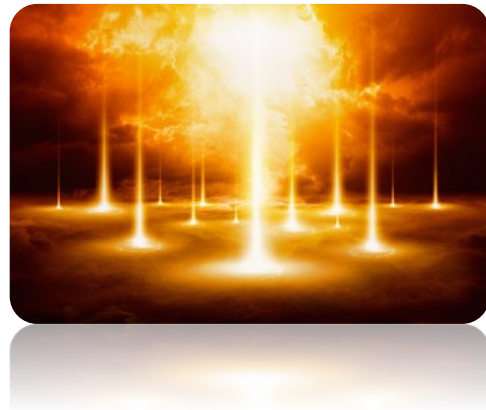


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15

**Hell**

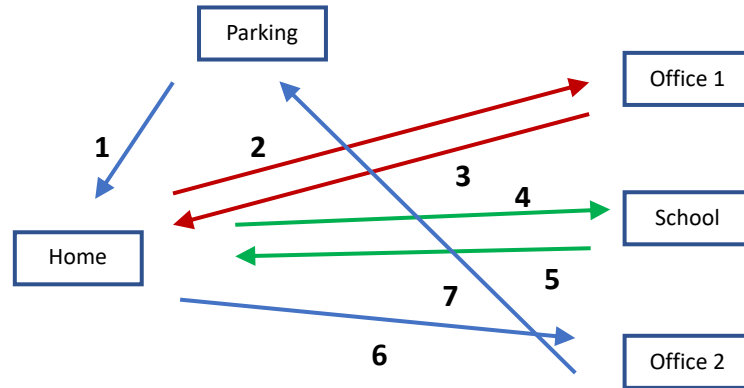
- **Primarily individual private car ownership**
  - Much as today.
- **Internal combustion engines**
- **Why Hell?**
  - Dramatically increased VMT and pollution.
  - Potentially increased congestion.
  - Parking



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## Two Adults and a Child: Morning Miles



*And this is just the morning.....*

## 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.**
  - 2035 for widespread adoption in many regions.

## Why is This Heaven?

- **Not only autonomous, but:**
  - Shared
  - Connected
  - Green
- **Far fewer cars in existence.**
  - Better resource utilization: steel, rubber, aluminum, and land!
- **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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19

## 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 – Waymo, Uber, Lyft, Google, Aurora, Kodiak, etc., with level 4/5 capability
- **Long term:**
  - Personal vehicle ownership is largely a thing of the past (hopefully!).



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## Economics Drives Transition: Private

- **Adoption dividend for private individuals**

- Eliminate car ownership
  - Ave annual cost of owning a car: \$12,297 (2024)
  - Cost per mile will fall: \$0.81 to \$0.19
- Repurpose your garage
  - \$50,000 from transition to bedroom

*Average Ownership Costs Per Mile*

Miles per Year	10k	15k	20k
Average Cost	\$1.06	82¢	70¢

- **Time recovery**

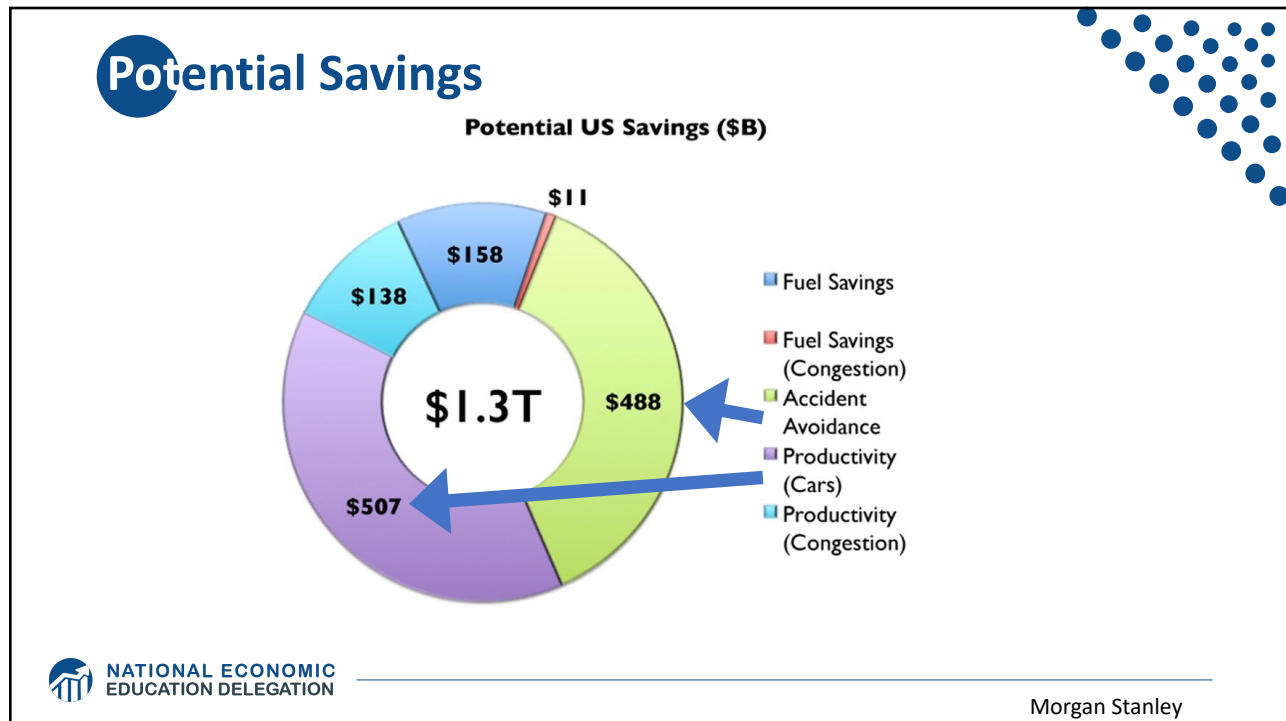
- 50% of the SF Bay Area workforce has a commute in excess of 30 minutes.

## Economics Drives Transition: Public

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

- ACCIDENTS:
  - Drive 25% of congestion.
  - Result in 40,000 deaths/yr.
  - And 2.5 million injuries/yr.
  - 90+% caused by human error.
- Increased productivity from not driving.
- Potential savings are estimated to be up to \$1.3 TRillion each year.





23

## 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.

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# 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



# Mobility and Equity

Blind Waymo users revel in joy of riding alone



"It's that feeling of independence and actually having the control," says Ruben Brunt, a Solano County resident. [Read the story](#)



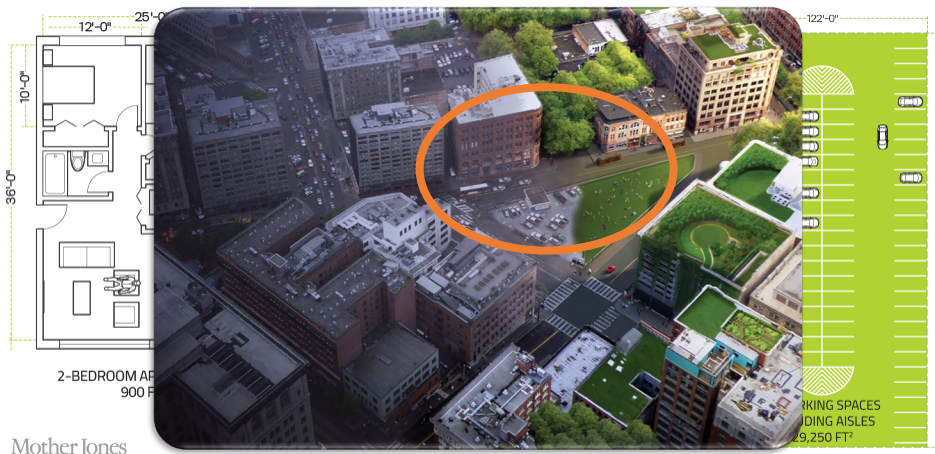
# Safety and Productivity



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# Environment



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## 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



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## What Changes Will This Bring?

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

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



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30

## Disposable Income

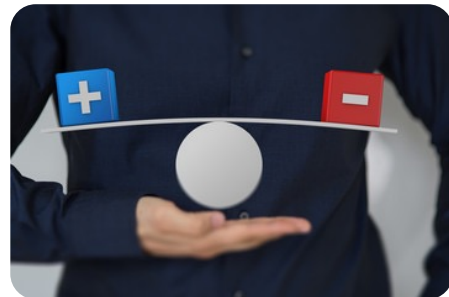


- Costs \$12,297 to own a car.
- Will cost \$3,000 to use TaaS.
- Net increase in disposable income of > \$7,000.
- Spread across all households: more than \$1 trillion in new spending in the economy.
- Major boost to economic activity.
  - CREATING JOBS!

31

## Transportation Demand

- 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



32

## 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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33

## Housing



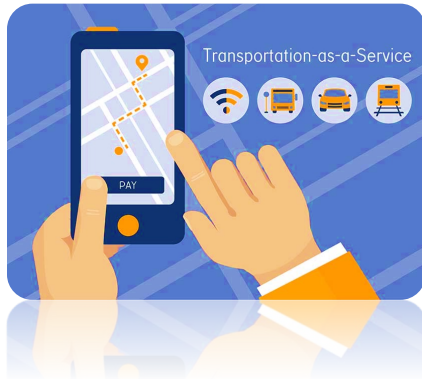
- **Housing is suddenly easier to build**
  - Issue of traffic congestion is significantly reduced.
  - Space for new housing is available where parking lots used to be.
- **Existing houses can now accommodate more people: garage to bedroom conversions.**



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34

## 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**

## 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.**

## 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.**



## 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 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).



## Summary of Change

- **Massive employment upheaval.**
- **Housing will be easier to build and more plentiful.**
- **Parking conversions will be commonplace.**
- **Demand for transportation infrastructure will likely decline.**
- **Demand for public transportation may well decline.**
- **Coming likely sooner rather than later!**



**Thank you!**

# Any Questions?

[www.NEEDEcon.org](http://www.NEEDEcon.org)

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41