

Loch Lomond Yacht Club

Driving Change – Autonomous Vehicles' Big Impact

National Economic Education Delegation

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Outline

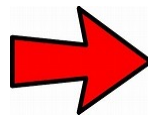
- Where does the AV path lead?
- Major Economic/Development Changes and Challenges



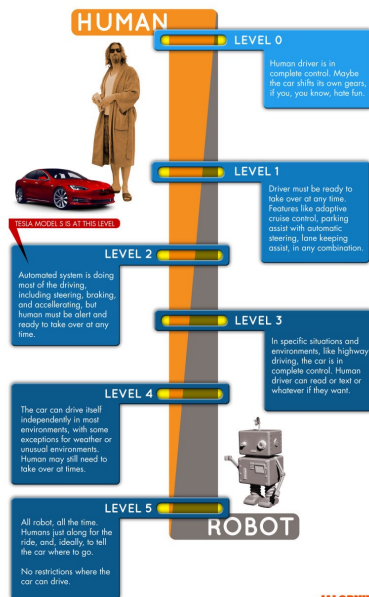
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Autonomous Taxonomy



SAE AUTONOMY LEVELS



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JALOPNIK

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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>

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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?



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40+ Corporations Working On Autonomous Vehicles



TOYOTA



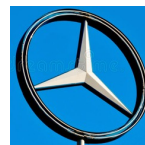
WAYMO



HONDA



Audi



TESLA



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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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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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Actively Pursuing Autonomous Local Delivery

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



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AV

Trucking is Taking Off As Well!

BOT AUTO

ABOUT

SAFETY

CAREERS

C

Driving Innovation

BOT AUTO

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What will the future look like?

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This:



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Or This:



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But, will it be:



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Hell

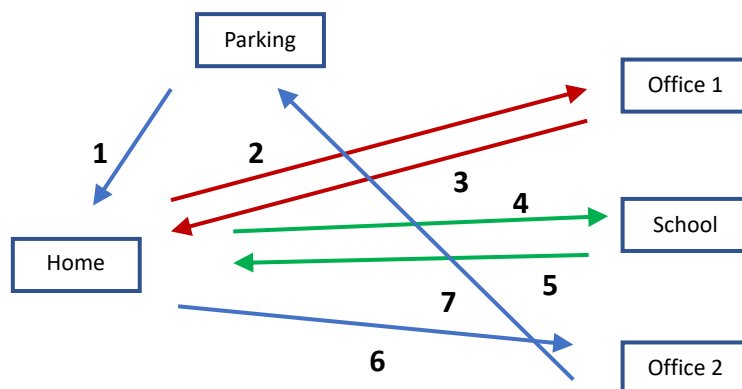
- **Primarily individual private car ownership**
 - Much as today.
- **Internal combustion engines**
- **Why Hell?**
 - Dramatically increased VMT and pollution.
 - Potentially increased congestion.
 - Parking



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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.**
 - 2035 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: 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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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: \$0.82 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

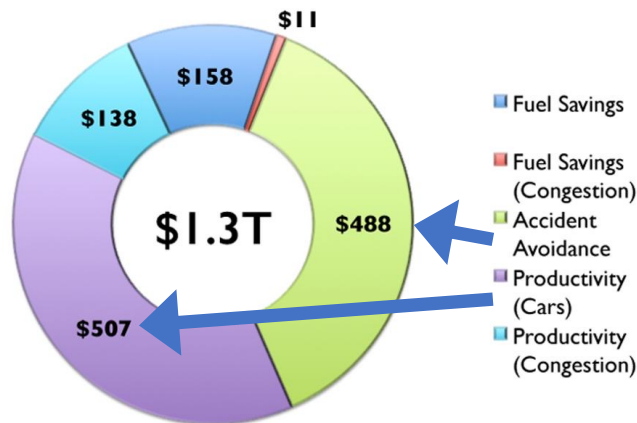
- **Economic and social costs associated with human drivers are enormous:**

- 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.



Potential Savings

Potential US Savings (\$B)



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Morgan Stanley

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Government Should 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



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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](#)



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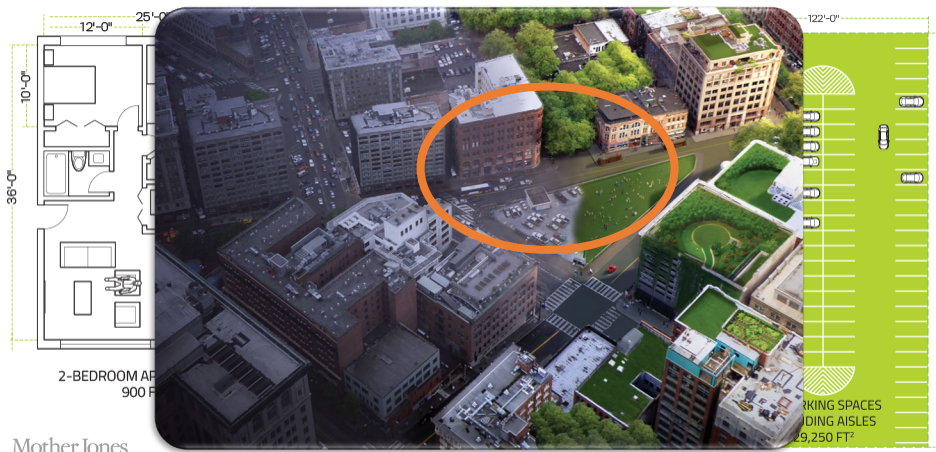
Safety and Productivity



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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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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!

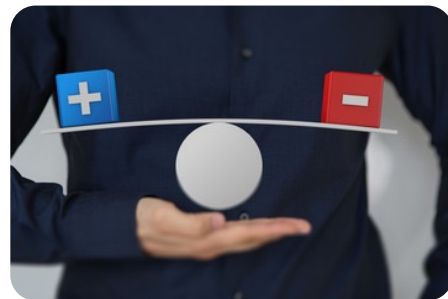


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Transportation Demand

- 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.



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Infrastructure

- **Focus of transportation infrastructure:**

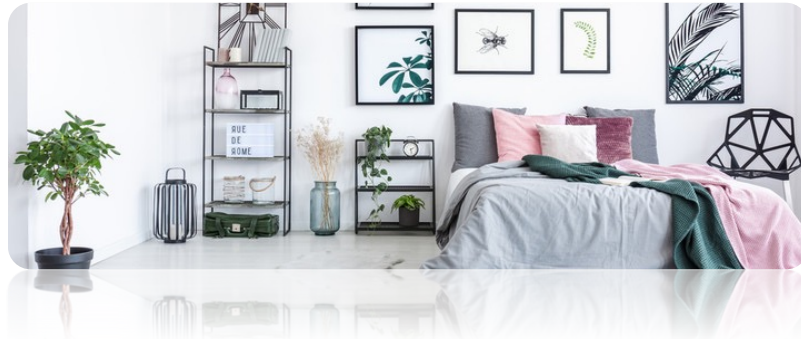
- Currently on expansion
- Will turn toward:
 - Maintenance
 - Signage and striping has to be robust
 - TaaS providers push for fewer potholes?
 - Adding technology
 - Stop lights will be digital as well as visual
- Some will disappear: Signs!



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Housing



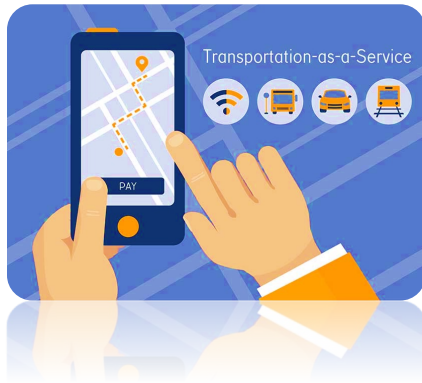
- **Housing is suddenly easier to build**
 - Issue of traffic congestion is significantly reduced.
 - Space for new housing is available where parking lots used to be.
- **Existing houses can now accommodate more people: garage to bedroom conversions.**



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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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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...



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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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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 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.**
- **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!**



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Thank you!

Any Questions?

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