TIGER 21 San Diego, CA

Driving Change – Autonomous Vehicles' Big Impact

National Economic Education Delegation

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1

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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2

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: 649+ 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: 48 Ph.D. Economists**
  - Aid in slide deck development

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**
- **Federal Budgets**
- **Federal Debt**
- **Black-White Wealth Gap**
- **Autonomous Vehicles**

Credits and Disclaimer

- **This slide deck was authored by:**
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- **This slide deck was reviewed by:**
  - Ronald Fisher, Michigan State University
  - William F. Fox, University of Tennessee, Knoxville
- **Disclaimer**
  - NEED presentations are designed to be nonpartisan.
  - It is, however, inevitable that the presenter will be asked for and will provide their own views.
  - Such views are those of the presenter and not necessarily those of the National Economic Education Delegation (NEED).

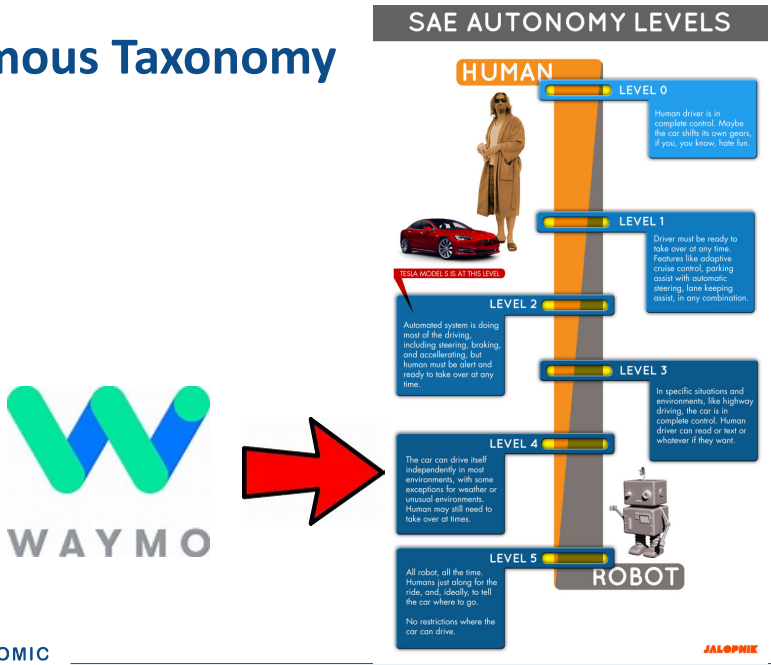
5

Outline

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

6

Autonomous Taxonomy



WAYMO

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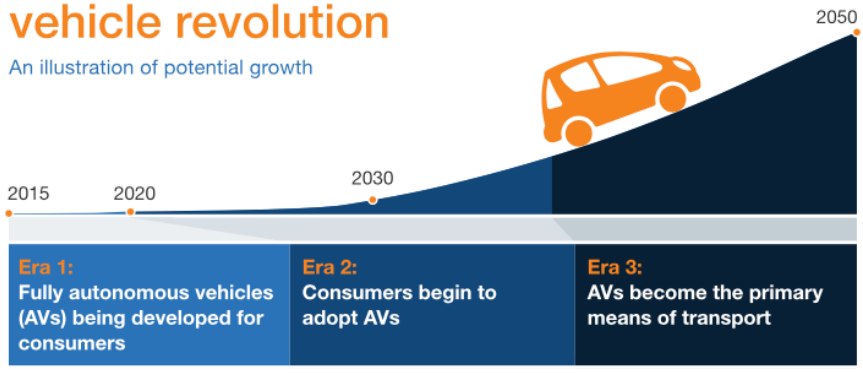
7

Growth Path

The self-driving vehicle revolution

An illustration of potential growth



McKinsey & Company

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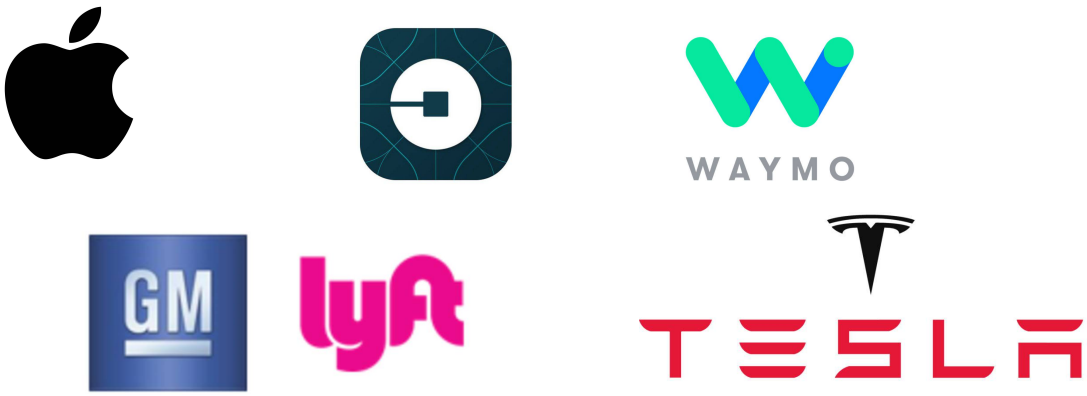
McKinsey isn't Always Spot On

- **"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

9

40+ Corporations Working On Autonomous Vehicles



10

WHEN?
What do the headlines say?

NVIDIA to introduce level-4 enabling system by 2018

Audi to introduce a self-driving car by 2020

Volkswagen expects first self driving cars on the market by 2019

First autonomous Toyota to be available in 2020

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

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11

WHEN?
What is possible?

- **By 2025 (?)**
- **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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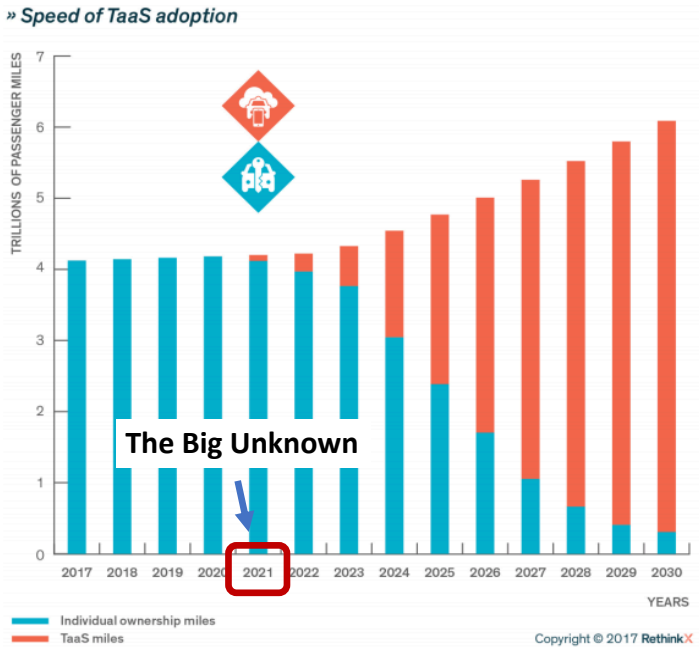
12

Forecast

Timing may be off.

But the point is:

RAPID ADOPTION!



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13

13

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'

Cruise to offer free robo-taxi rides in S.F. for the public — without backup drivers

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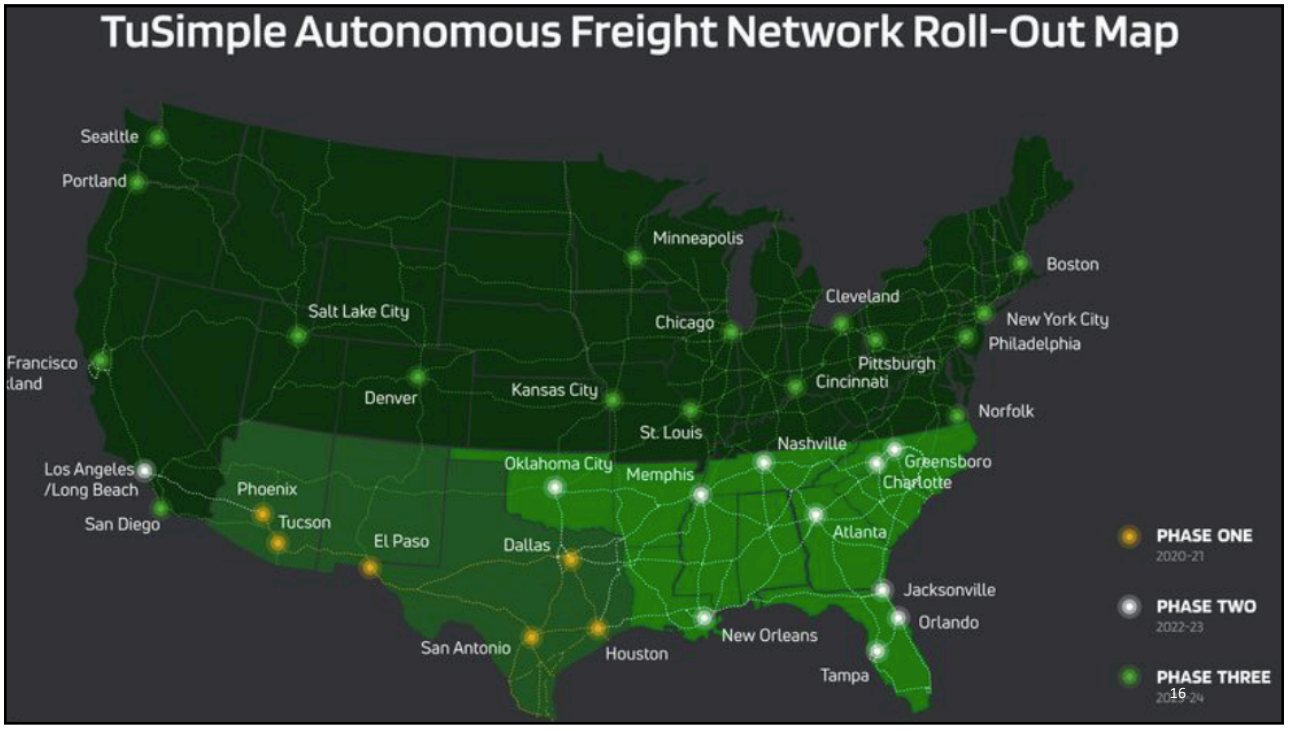
14

14

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.

15



16

What will the future look like?

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This:

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18

But, will it be:

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19

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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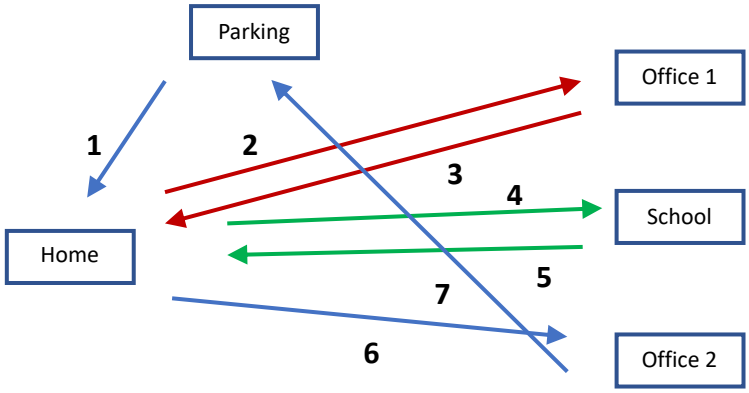
20

Two Adults and a Child: Morning Miles



And this is just the morning…..

21

Heaven

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

22

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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23

Economics Drives Transition: Private

- **Adoption dividend for private individuals**
  - Eliminate car ownership
    - Ave annual cost of owning a car: $9,561 (2020)
    - Cost per mile will fall: $0.59 to $0.19
  - Repurpose your garage
    - $50,000 from transition to bedroom

Average Costs Per Mile

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

- **Time recovery**
  - 50% of the King County workforce has a commute in excess of 30 minutes.

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24

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 **TR**illion each year

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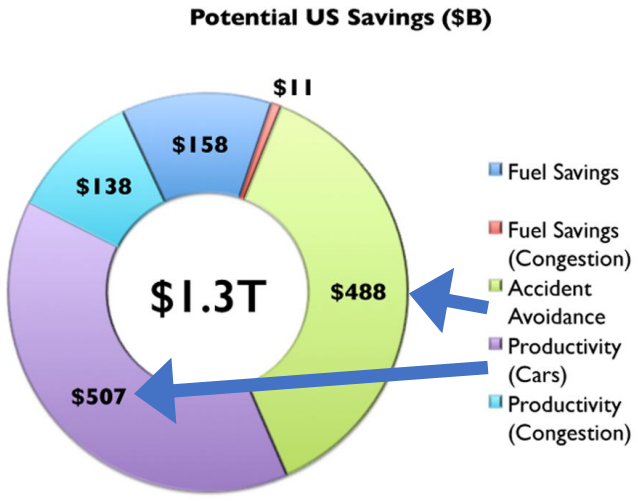
25

Potential Savings



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Morgan Stanley

26

Encourage Change

- **Mobility and equity considerations**
  - Elderly/disabled/impoverished
- **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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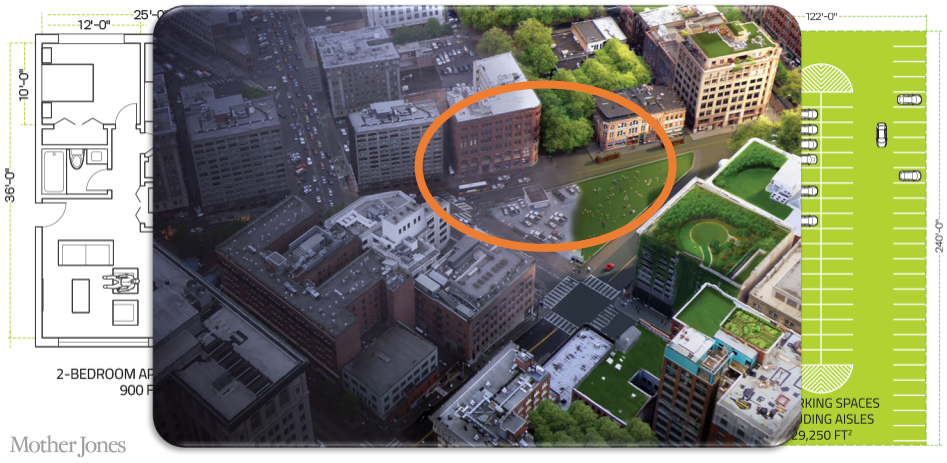
27

Environment



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28

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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29

What Changes Will This Bring?

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

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

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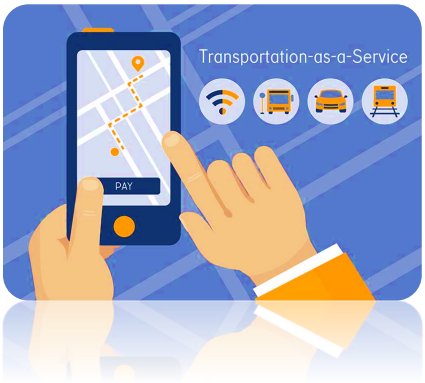
30

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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31

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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Parking

- **Greatly reduced demand for parking lots.**
- **Service providers will own parking lots in strategic places.**
- **Street parking will largely be a thing of the past.**
  - More green space in cities
- **Shopping mall and apartment parking?**
  - Converted to housing?

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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 60 miles longer than California's entire 840-mile coastline
- **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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34

34

Potential Problems and Concerns

- Expansion of the electric grid to provide sufficient capacity.
- Mining for rare earth minerals for batteries.
- Hacking of autonomous vehicles for nefarious purposes.
- Competition in service provision in some markets.
- And many more…

35

Investment Opportunities

- Parking lots/garages
- Transportation technology
- Certain residential properties
- Building apartment complexes

36

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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37

Thank you!

Any Questions?

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38

38