Sam Schwartz
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World Bank

February 11, 2019

THE GOOD, THE BAD AND THE UGLY (POSSIBILITIES)

MaaS + Transit Integrated

MaaS vs. Transit

Private Ownership
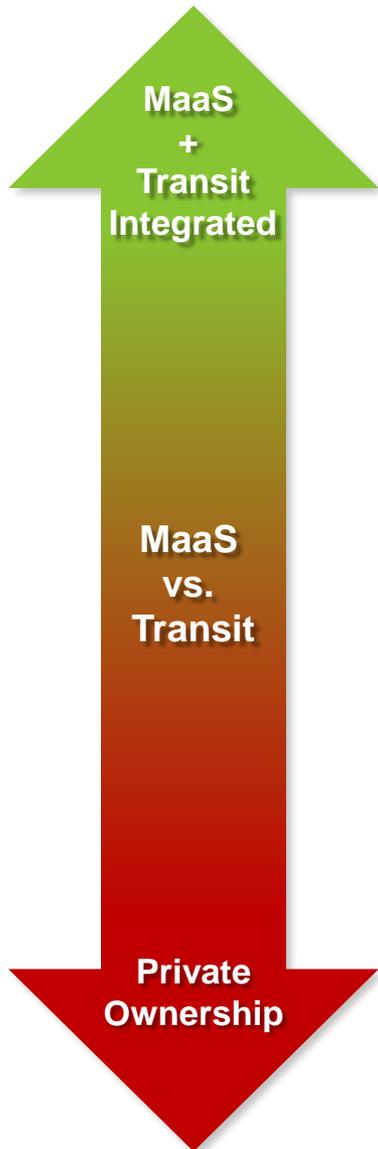
the GOOD
- Congestion diminishes
- Crashes, injuries, and deaths plummet
- Disabled and low-income well-served
- Mobility as a Service (MaaS) with transit integration
- Last mile solved
- Parking demand goes way down

the BAD
- VMT soars & congestion increases
- Many jobs disappear
- Peds, bikes squeezed out
- Unaffordable for poor and rural dwellers
- Reverses millennial trend eschewing driving
- Competes with and undermines existing transit

and the UGLY
- Widespread gridlock
- Public transportation decimated
- Heart disease/stroke/diabetes skyrocket
- Everybody gets a license (even your dog)
- A new "modernist" view of cities
- Encourages sprawl

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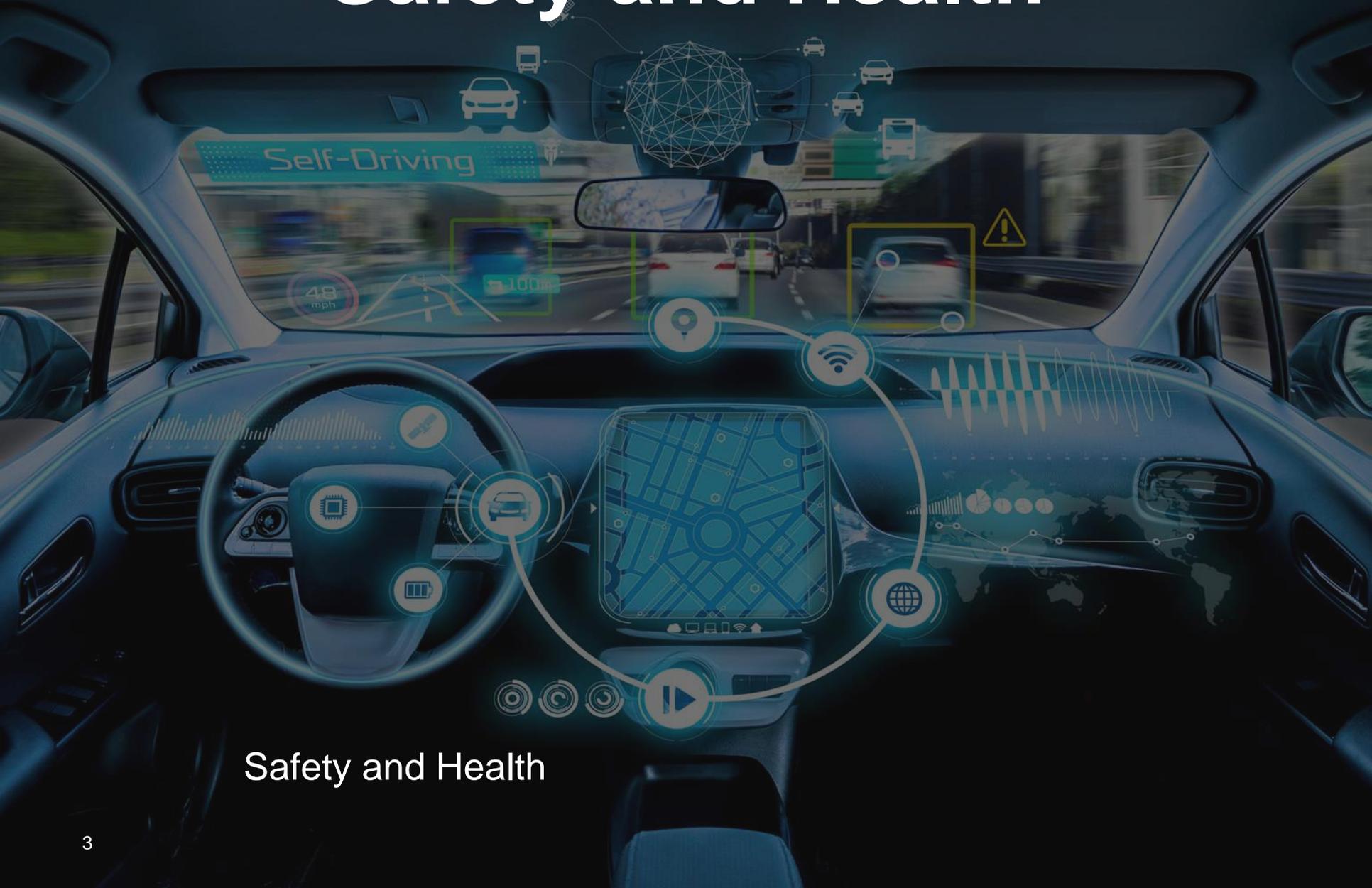
Safety and Health

Safety and Health

EVEN IF 90% SAFER THAN CARS

Passenger Deaths per 1 Billion Passenger Miles, 2000-2014

## Deaths per Billion Passenger-Miles

Mode	Value
Car	6.53
Ferry	2.46
Train	0.36
Subway	0.33
Bus	0.2
Plane	0.02

0   1   2   3   4   5   6   7

Source: Passenger Deaths By Mode, 2000-2014, APTA

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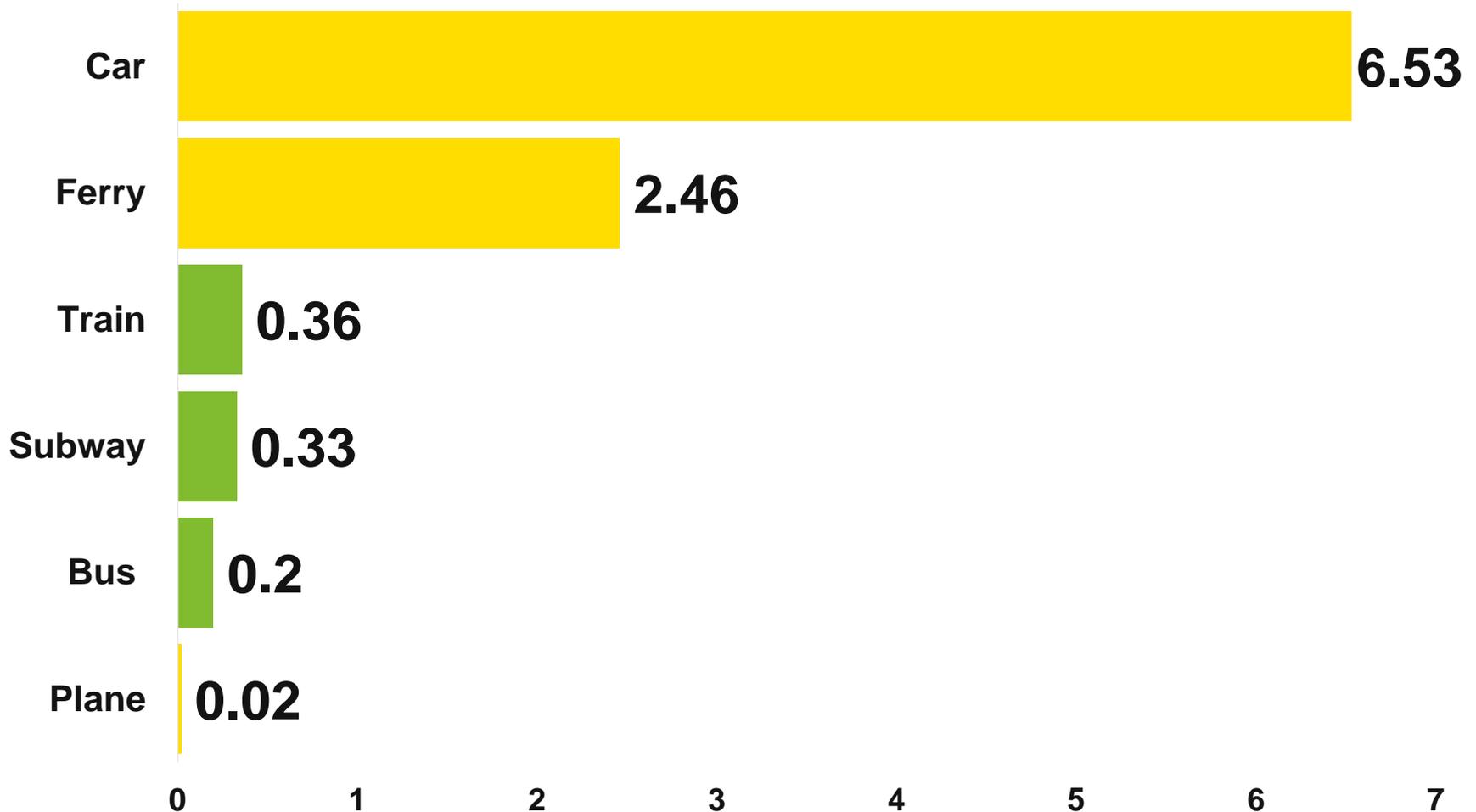
EVEN IF 90% SAFER THAN CARS

Passenger Deaths per 1 Billion Passenger Miles, 2000-2014

Transit is Already 95% Safer

Mode	Passenger Deaths per 1 Billion Passenger Miles
AVs	0.65
Ferry	2.46
Train	0.36
Subway	0.33
Bus	0.2
Plane	0.02

Source: Passenger Deaths By Mode, 2000-2014, APTA

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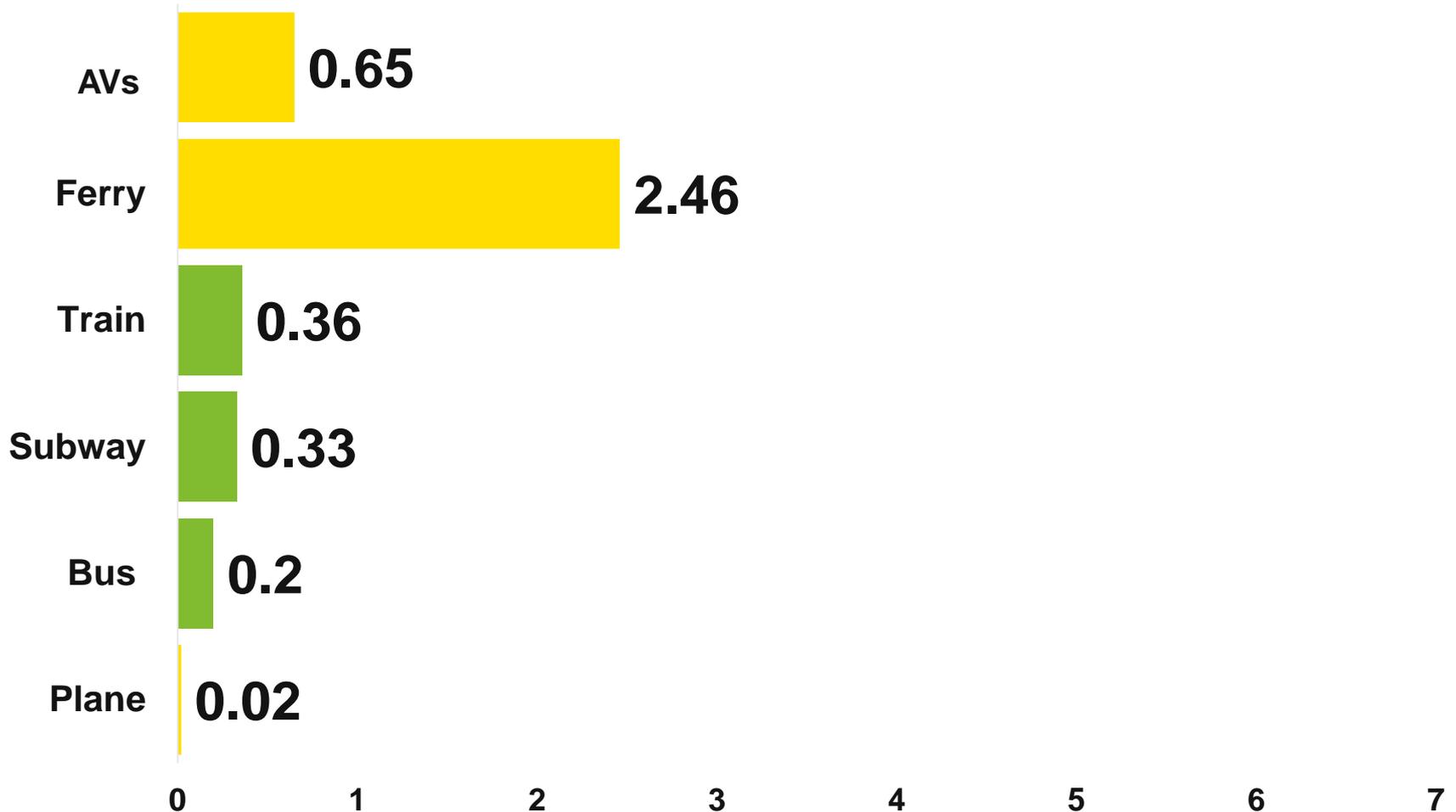
NO REASON TO WAIT FOR AVs TO SAVE LIVES

Most safety benefits can be achieved with "safe cars" without full automation.

Professor Alain Kornhauser,
Princeton University

U.S. Meme: 94% of traffic fatalities due to human error

Swedish Meme: Humans are fallible and make mistakes. **Vision Zero** through design: road system, vehicles, technology, enforcement

**Fatality Reduction
(1997-2017)**

U.S.	Sweden
-11.6%	-53.2%

**Fatalities Per 100 Million VMT Reduction
(2000-2015)**
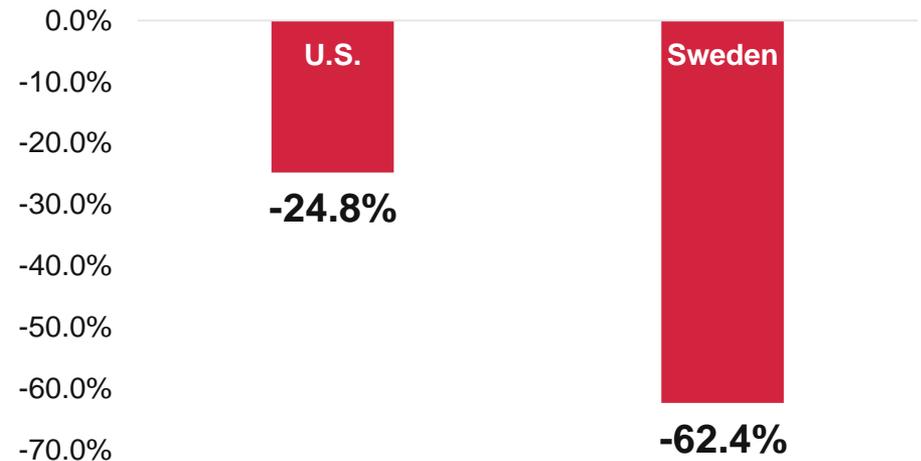
U.S.	Sweden
-24.8%	-62.4%

Source: Motor Vehicle Fatality Rate In U.S. By Year, (NHTSA) 2016, U.S. fatalities (1997-2016), Sweden fatalities (1997-2017)

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Don't let the safety argument blind you to a more holistic approach toward the introduction of AVs to our society.

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" ..if, in writing some article that's negative,

" If you're not concerned about A.I. safety, you
should be. Vastly more risk than North Korea."

Elon Musk
Twitter, August 11, 2017

SELF-DRIVING CRASH HISTORY (WHAT WE KNOW*)

Fatalities: 3 Known in USA

- In 2016, there were 1.17 fatalities per 100 million miles, conventional driving
- 3 fatalities in conventional vehicles would take avg. 258 million miles driven
- Number of miles driven to date in AV mode unknown
- AVs may have to be driven hundreds of billions of miles to demonstrate safety per Rand Corporation Study

**Crash Frequencies: Self-Driving vs Conventional Vehicles
(September 2014 - November 2017)**

	Miles Driven
Google/Waymo	56,510
GM Cruise	6,160
Conventional Vehicles	492,000
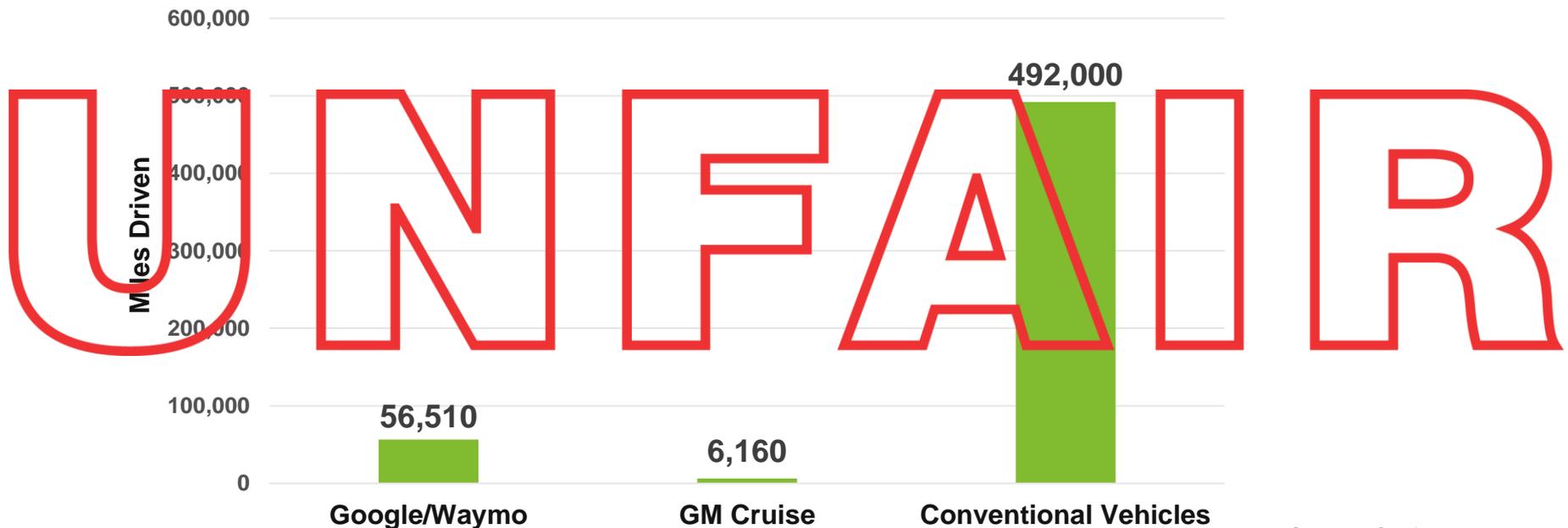
Source: California DMV

*Help me get the data

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DISENGAGEMENTS – DRIVER TAKES OVER

Triggered by:

Car 68% / Driver 32%
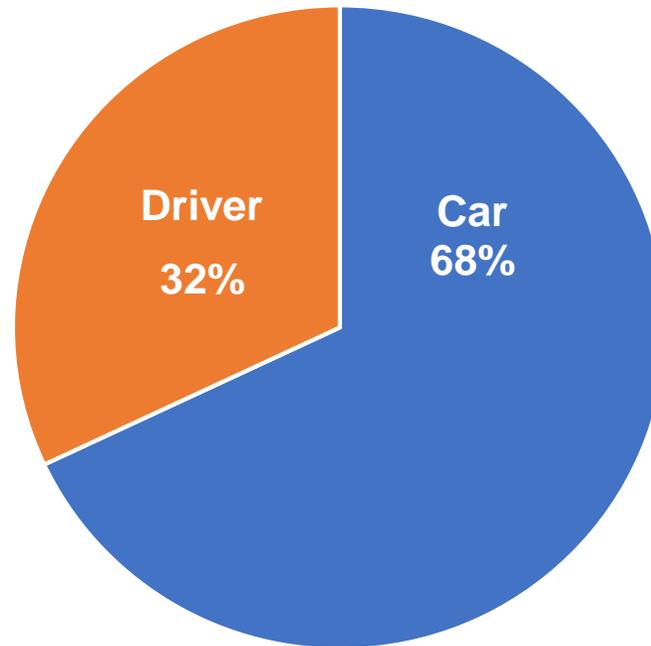
1 crash every 178 disengagements

- Occurs 2,882 miles on average (Waymo, Cruise)
- In 12,000 miles/year 4-5 disengagements

Sources: California DMV, Favaro et al. 2017 "Analysis of Disengagements in Autonomous Vehicle Technology"

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AV CARS WORK WELL WITHOUT PEDESTRIANS & CYCLISTS

Some pedestrians such as the following may not be detected by the radar sensor and camera sensor, preventing the system from operating properly:

- Pedestrians shorter than approximately 3.2 ft. (1 m) or taller than approximately 6.5 ft. (2 m)
- Pedestrians wearing oversized clothing (a rain coat, long skirt, etc.), making their silhouette obscure
- Pedestrians who are carrying large baggage, holding an umbrella, etc., hiding part of their body
- Pedestrians who are bending forward or squatting
- Pedestrians who are pushing a stroller, wheelchair, bicycle or other vehicle
- Groups of pedestrians which are close together
- Pedestrians who are wearing white and look extremely bright
- Pedestrians in the dark, such as at night or while in a tunnel

Toyota 2018 Camry From Aug. 2017 Prod. Owner's Manual (OM06139U), Page 251

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MOTOR VEHICLES USED AS WEAPONS RISING

Nice Attack: At Least 84 Killed By Lorry At Bastille Day Celebrations
BBC News – July 15, 2016
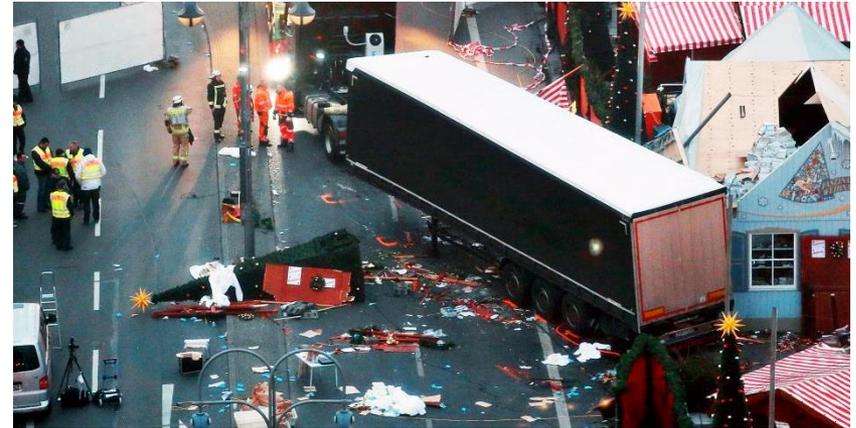
Christmas Carnage In Berlin
12 Killed
The Times – December 20, 2016

**Van Hits Pedestrians in Deadly Barcelona Terror Attack 13 Killed**
NY Times – August 17, 2017

8 Killed As Truck Plows Into Pedestrians In Downtown NYC Terror Attack
NY Post – October 30, 2017

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MORE INACTIVITY: A LEADING CAUSE OF DEATH

"The leading causes of death aren't infections or accidents, but non-communicable diseases like diabetes, stroke and cardiovascular disease…. and probably 80% of all preventable deaths. A sizeable chunk … is due to inadequate exercise…"

- *Street Smart: The Rise of Cities and The Fall of Cars*, based on interview with Dr. Karen Lee

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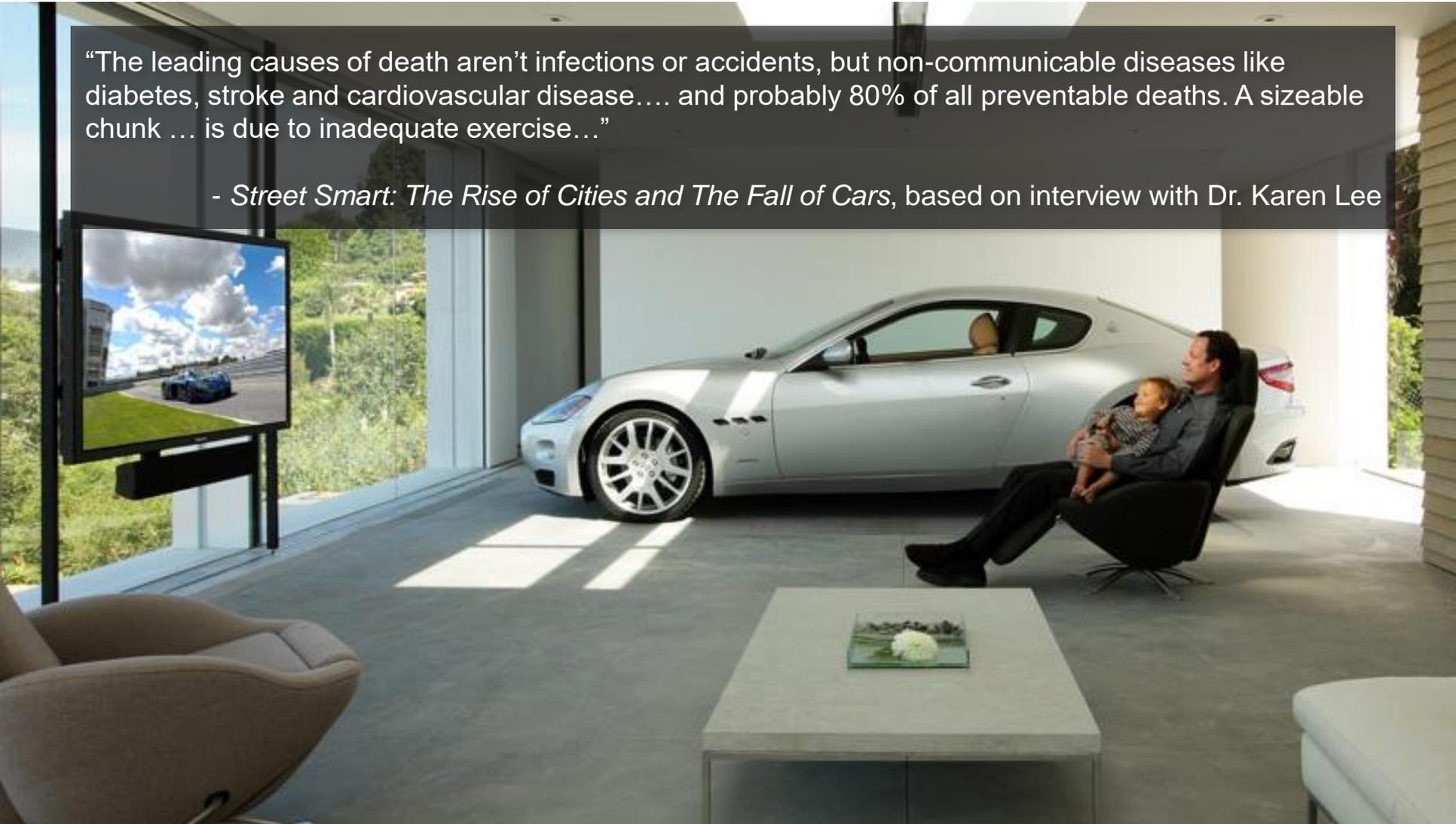
INACTIVITY TAKES MORE LIVES THAN CRASHES

World Deaths (Inactivity vs. Crashes)

Number of Deaths (Millions) vs. Cause of Death

- Obesity/Inactivity (World): 3.2 (WHO estimate), 5.3 (Lancet estimate)
- Motor Vehicle Crashes (World): 1.25
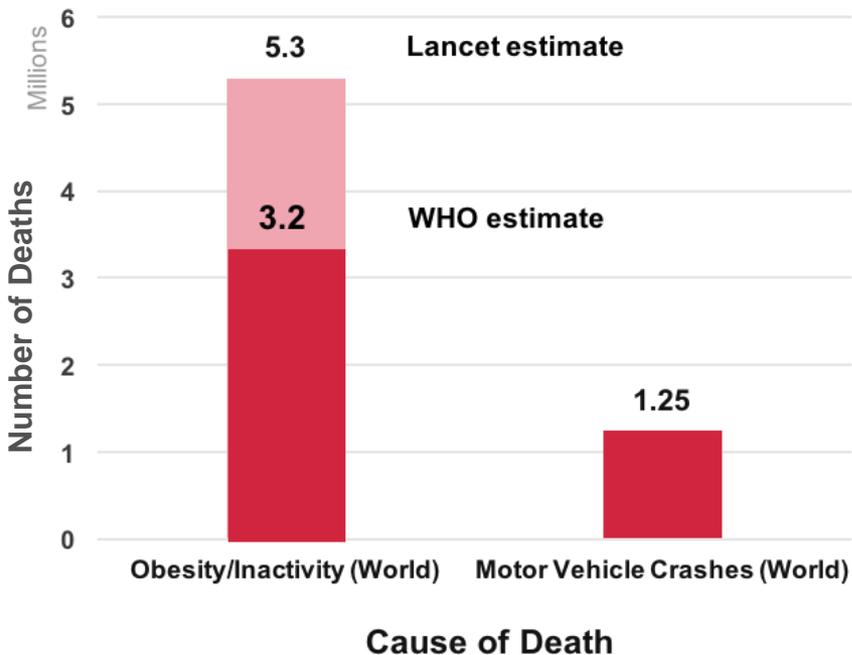
U.S. Percent of Deaths Attributable to Inactivity

- Heart Disease: 6.70%
- Type 2 diabetes: 8.30%
- Breast Cancer: 12.40%
- Colon Cancer: 12%
- All-Cause Mortality: 10.80%
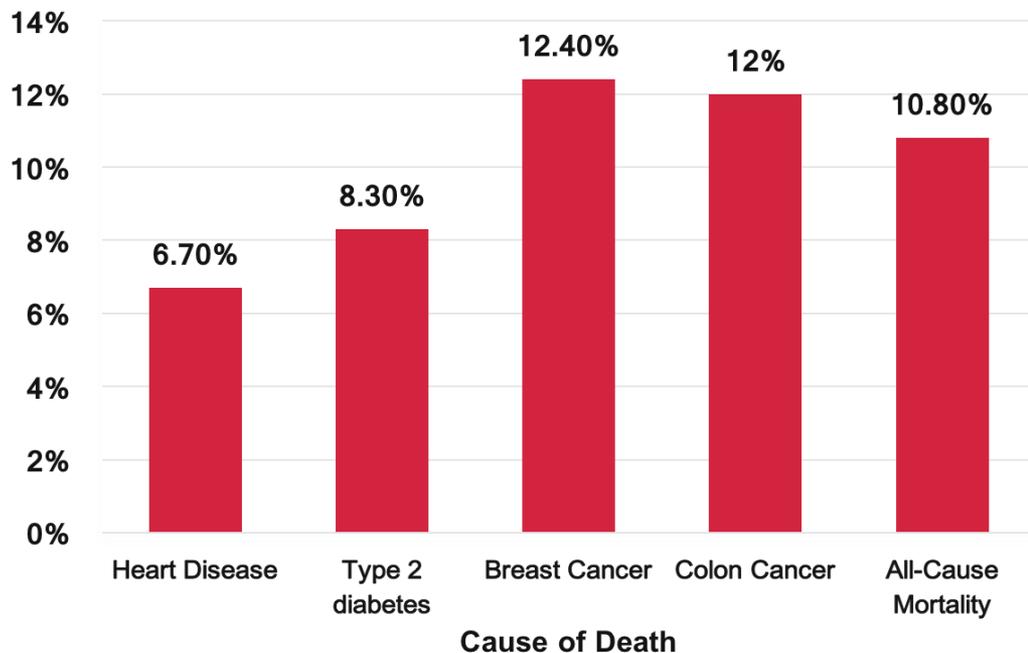
Inactivity Levels:
U.S. - 40.5%

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WALL-E

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WALL-E

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WALL-E IS NOT FAR-FETCHED

Source: Volvo 360c Product Video

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WALL-E IS NOT FAR-FETCHED

Source: Volvo 360c Product Video

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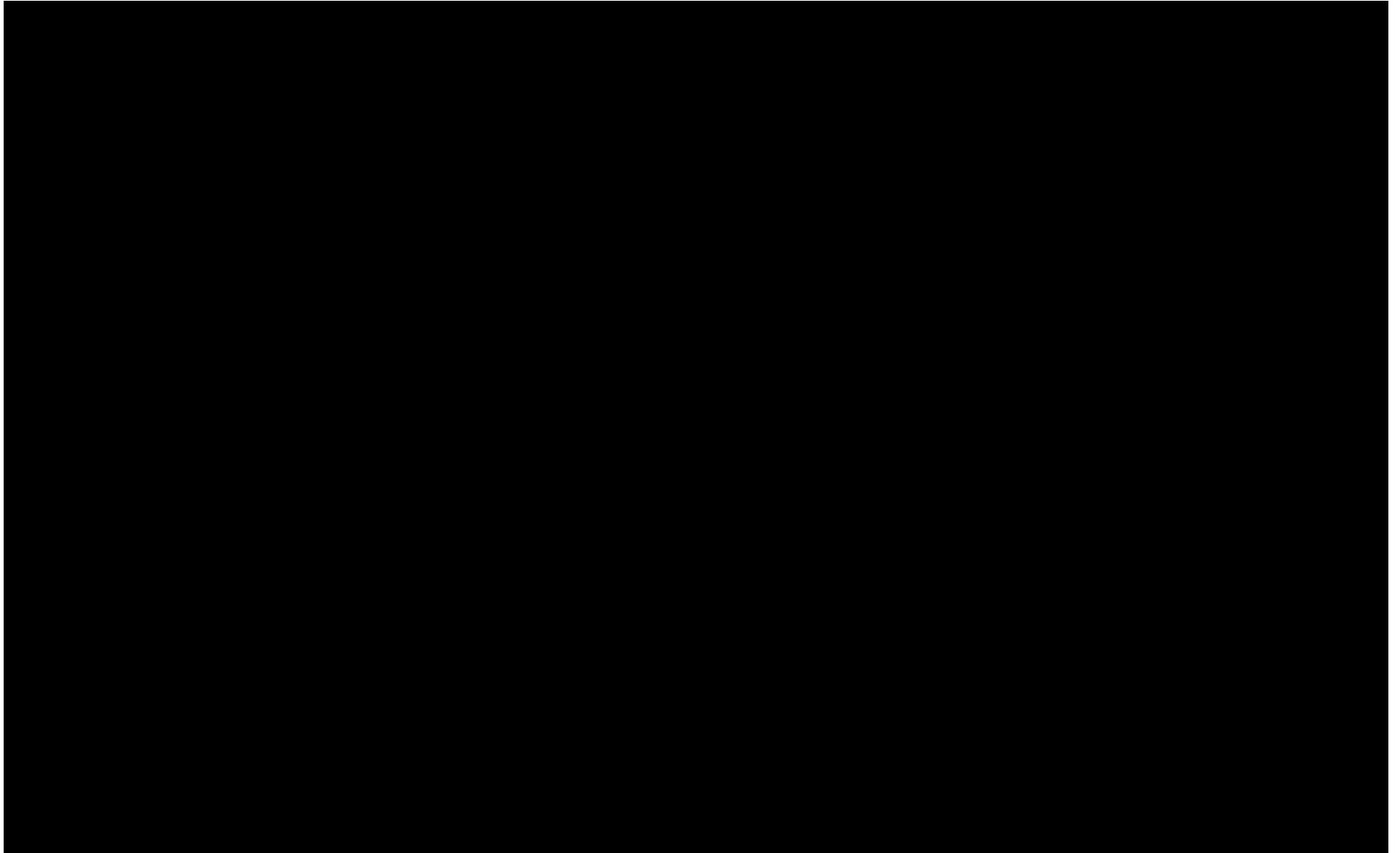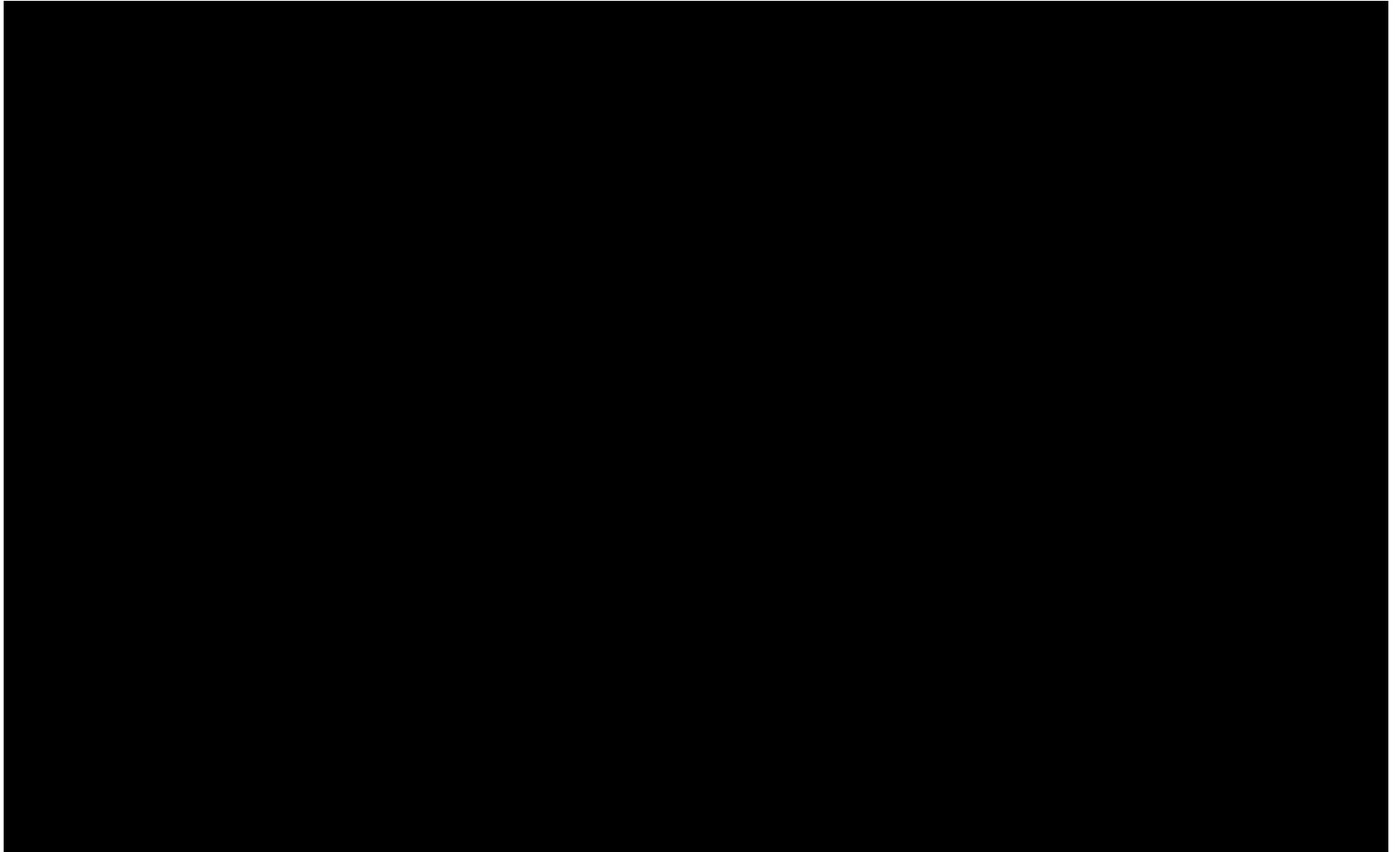
Traffic Impacts

NOW

PROMISE

Traffic Impacts

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# THE PROMISE: IMPROVED LAST MILE FOR TRANSIT ACCESS & SHARP REDUCTION IN TRAFFIC

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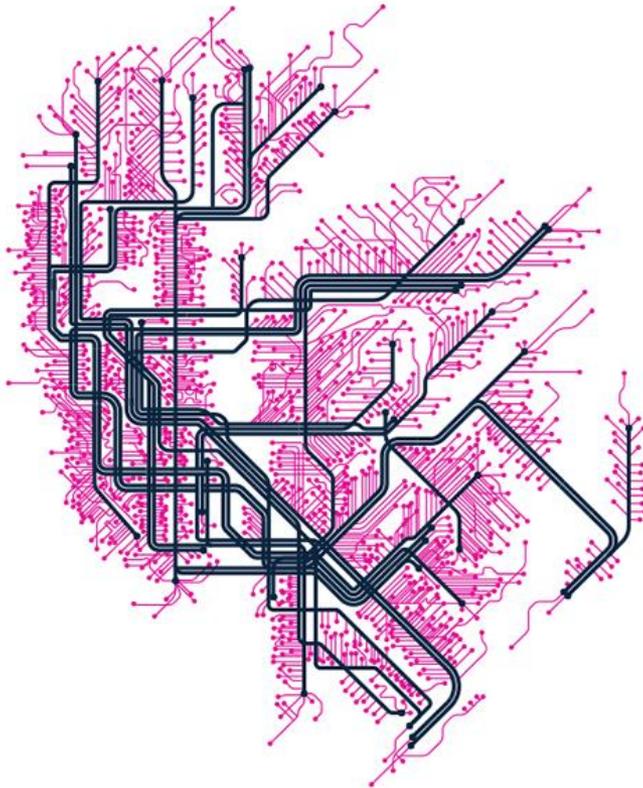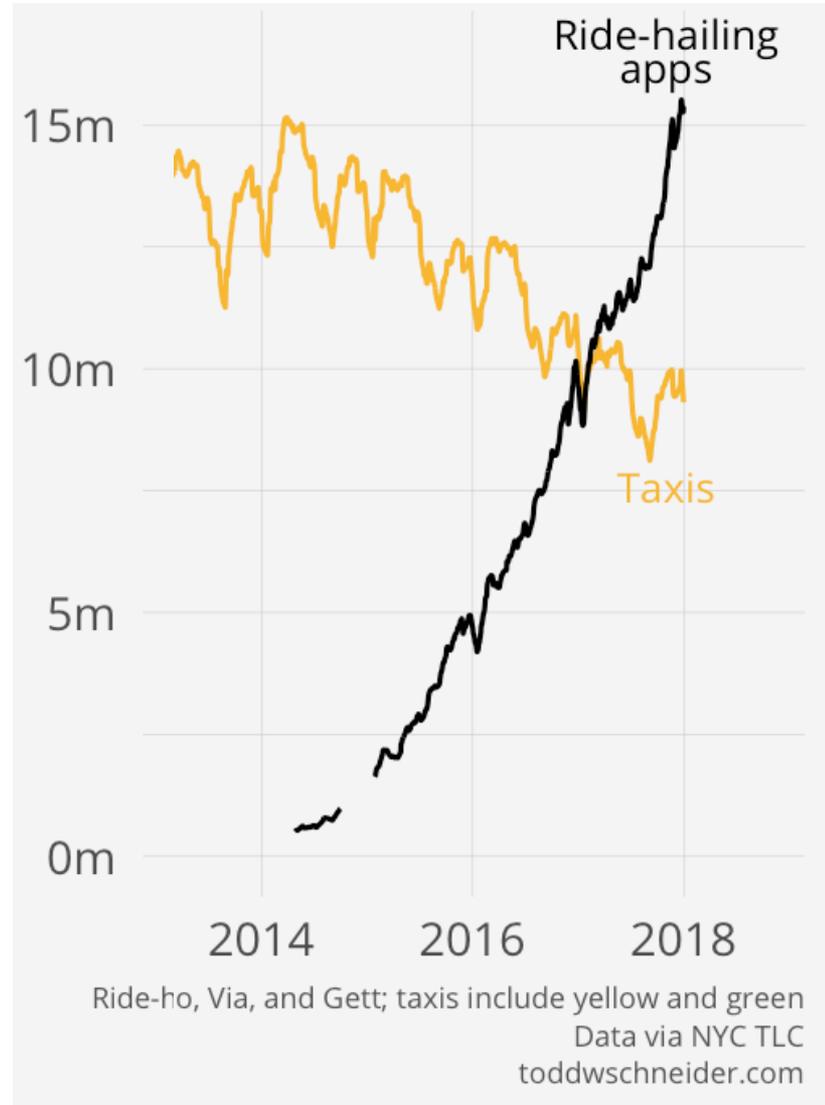
THE REALITY – APPs concentrate where transit's rich, traffic's jammed, and highest income people live

Core 78%

Outskirts 19%

Traffic volumes + 7%

**Speeds -28% in Midtown**

Airports 19%
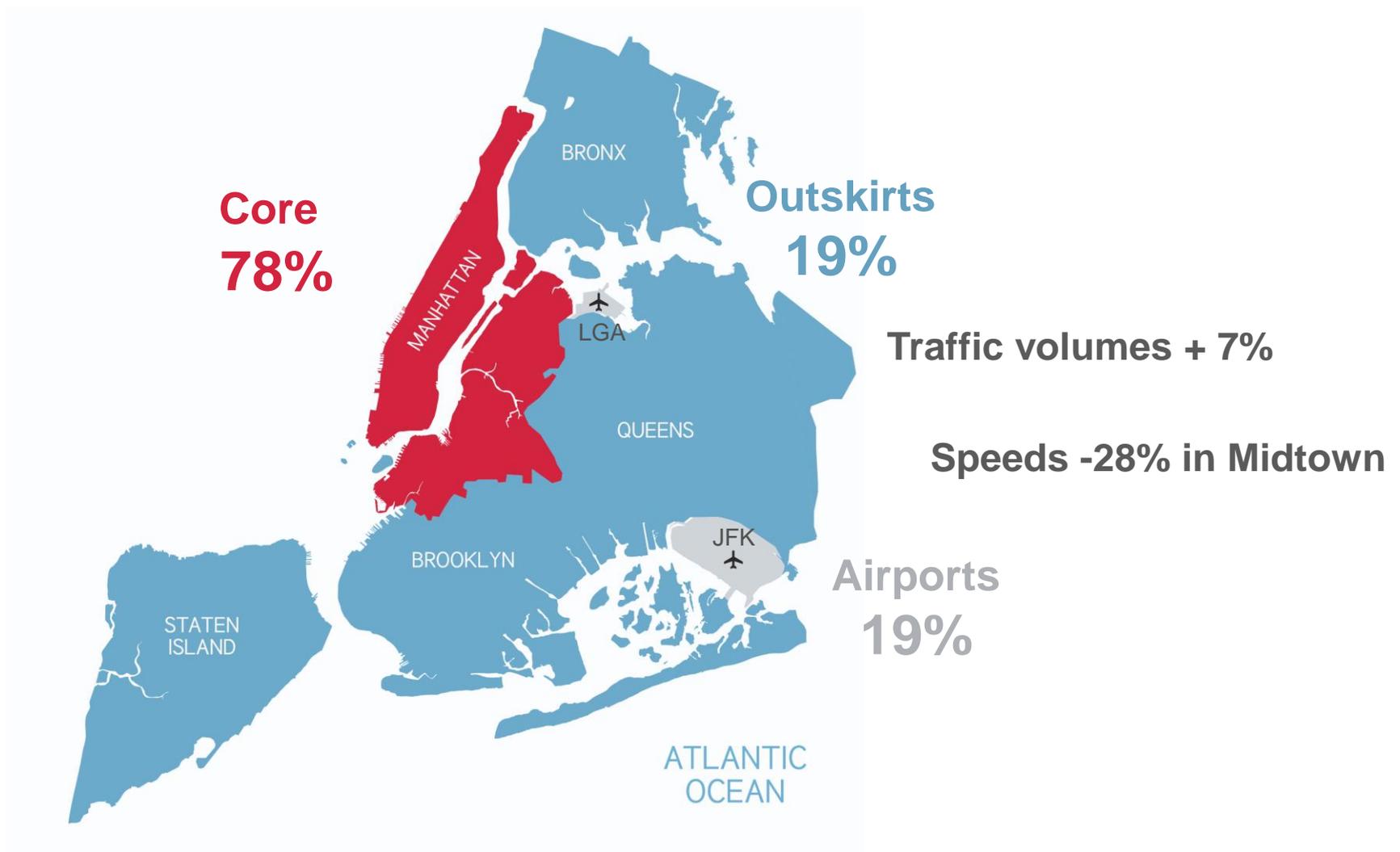
Source: "Unsustainable? by Bruce Schaller, February 2017. Commissioner Polly Trottenberg, NYT October 23, 2017.

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NYC APP-BASED RIDERS SECOND CHOICE

What mode of transportation would you have used had ride-hailing service not been available?

New York
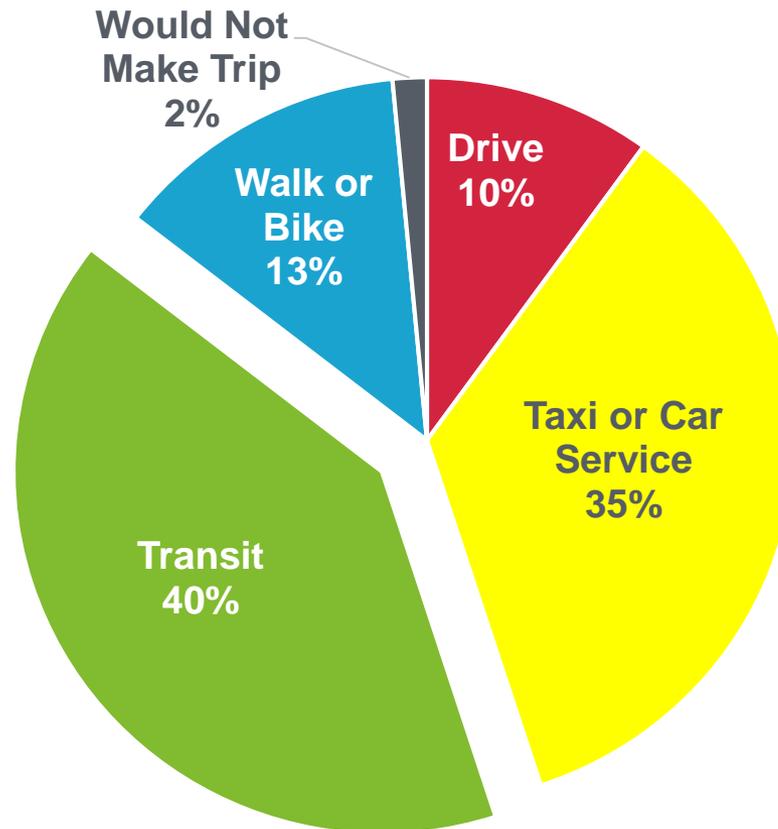
Source: NYC DOT Mobility Report 2018, 616 respondents; normalized to equal 100% by Sam Schwartz

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MODE REPLACEMENT BOSTON AND CALIFORNIA

Boston

- Would not have made the trip 5%
- Walk or Bike 12%
- Drive 18%
- Taxi 23%
- Public Transportation 42%
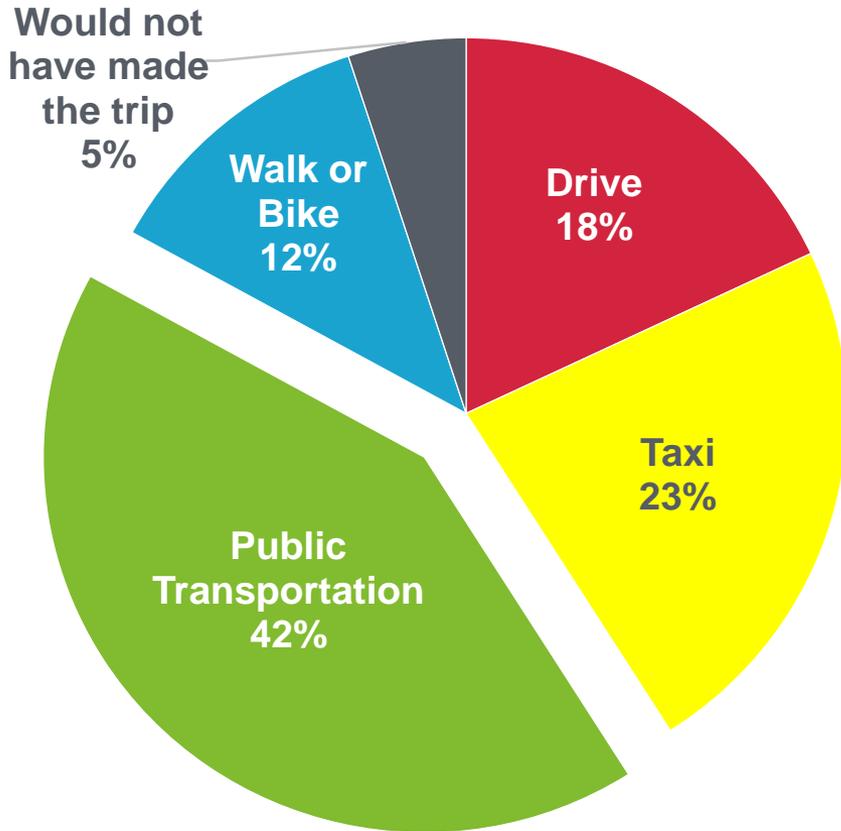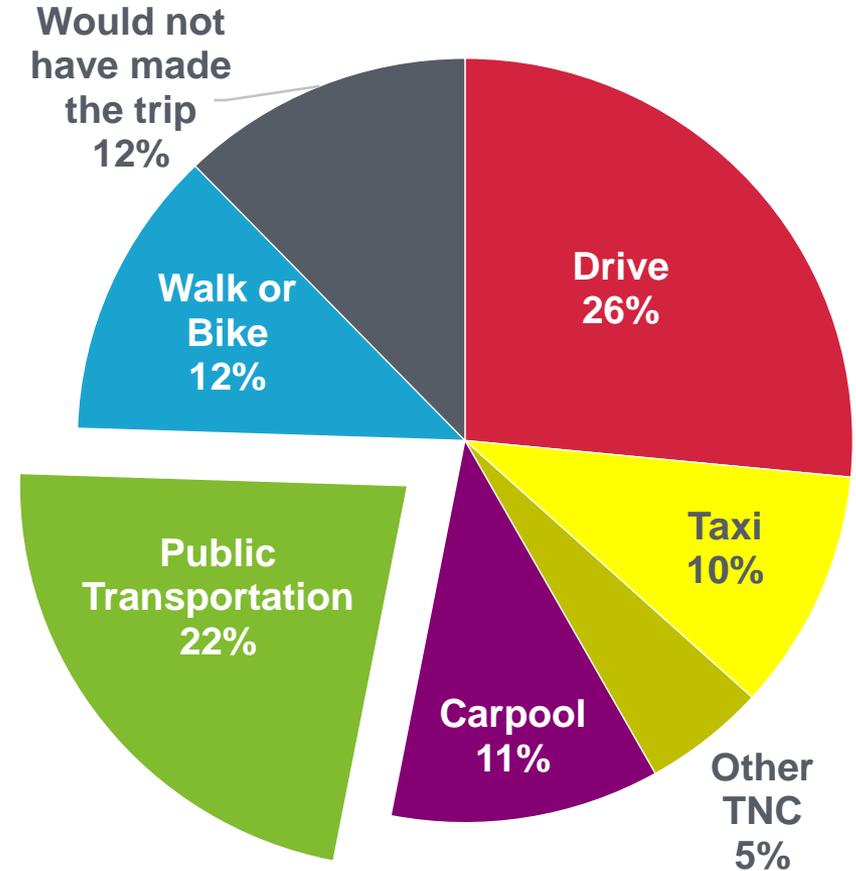
Source: Fare Choices: A survey of Ride Hailing passengers in Metro Boston, Metropolitan Area Planning Council, MAPC 2018; The Adoption of Shared Mobility in California, Circella et al. 2018

Denver

- Would not have made the trip 12%
- Walk or Bike 12%
- Drive 26%
- Taxi 10%
- Other TNC 5%
- Carpool 11%
- Public Transportation 22%

Source: "Impacts of Ridesourcing–Lyft and Uber –on Transportation including VMT, Mode Replacement, Parking, and Travel Behavior," Henao 2017.

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# APP-BASED CARS TRAVEL 1.58m FOR EACH PASSENGER MILE

Additional VMT Induced by TNC Rides
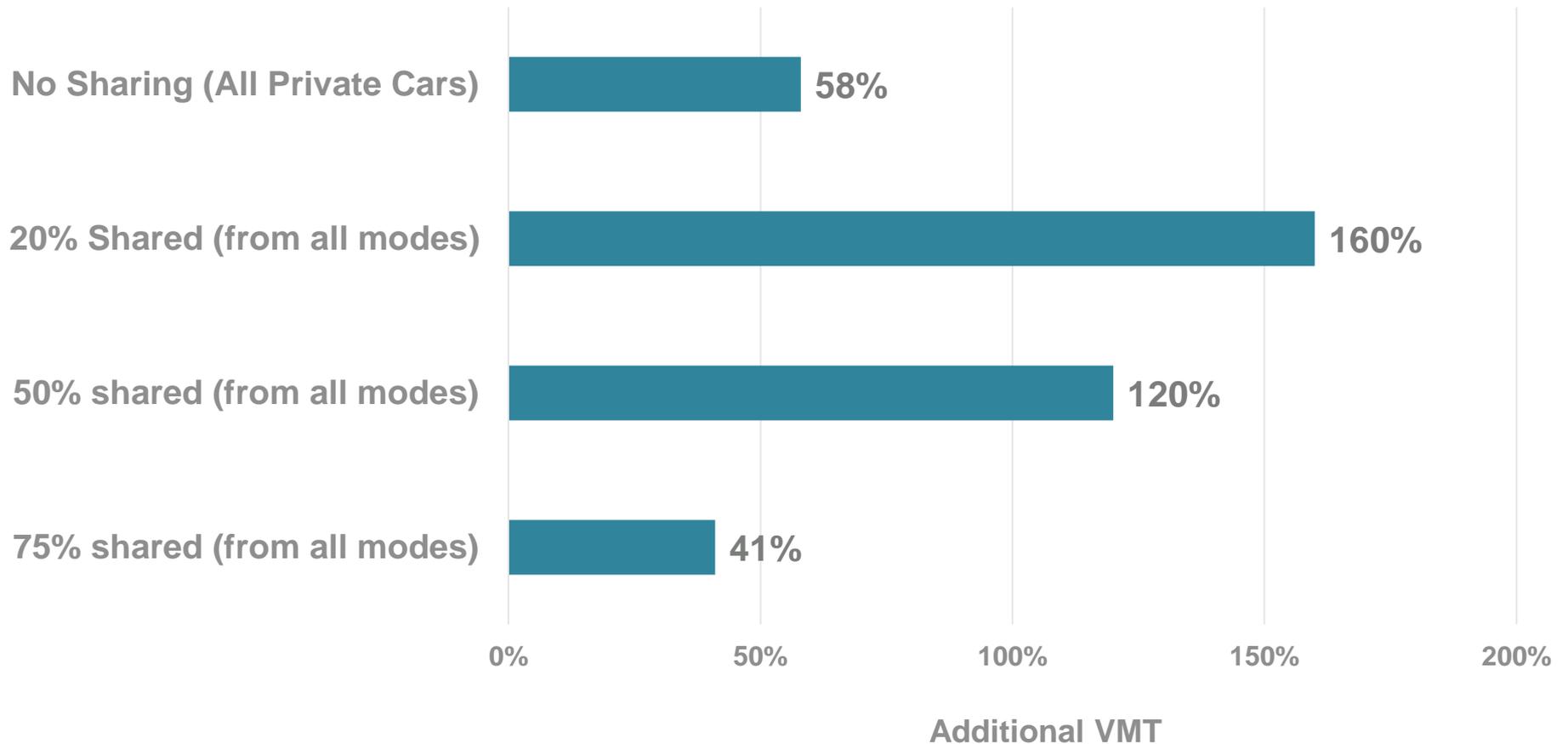
Source: The New Automobility: Lyft, Uber and the Future of American Cities by Schaller Consulting, July 2018

WARNING: MIXED TECHNOLOGIES AHEAD
## (UNCERTAIN TIME SCALE)

Ownership outcome apparent here

Government decides ownership direction here

Non-Automated

Semi-Automated L1-3

Fully-Automated L4-5

Time

Diffusion Percentage

100%

80%

60%

40%

20%

0%
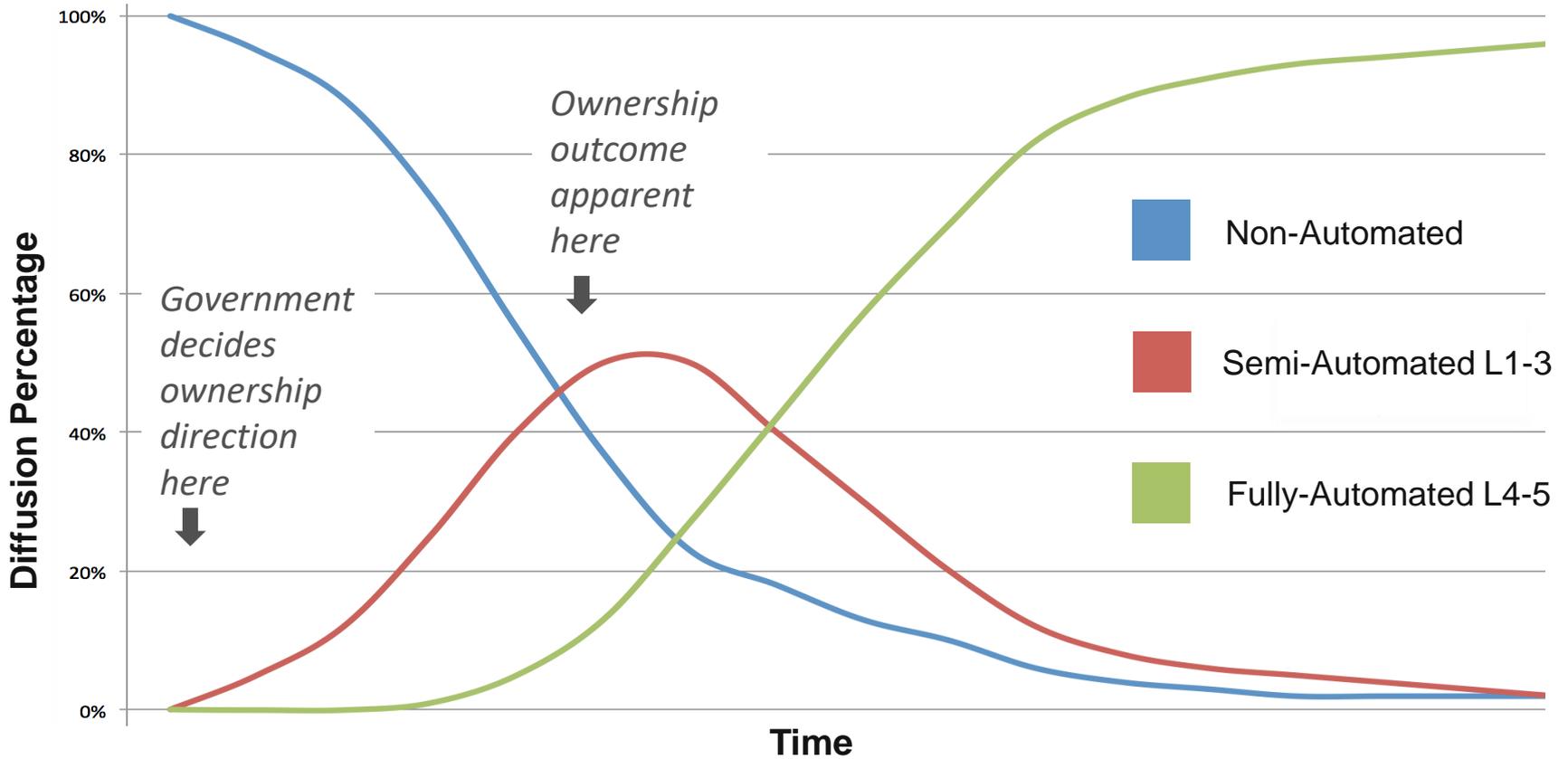
2020

40 - 50 years of mixed car technologies

2050-2100

© Grush Niles Strategic

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WARNING: MIXED TECHNOLOGIES AHEAD
(UNCERTAIN TIME SCALE)

Ownership outcome apparent here

Government decides ownership direction here

Diffusion Percentage

Time

Horses
Streetcars
Automobiles
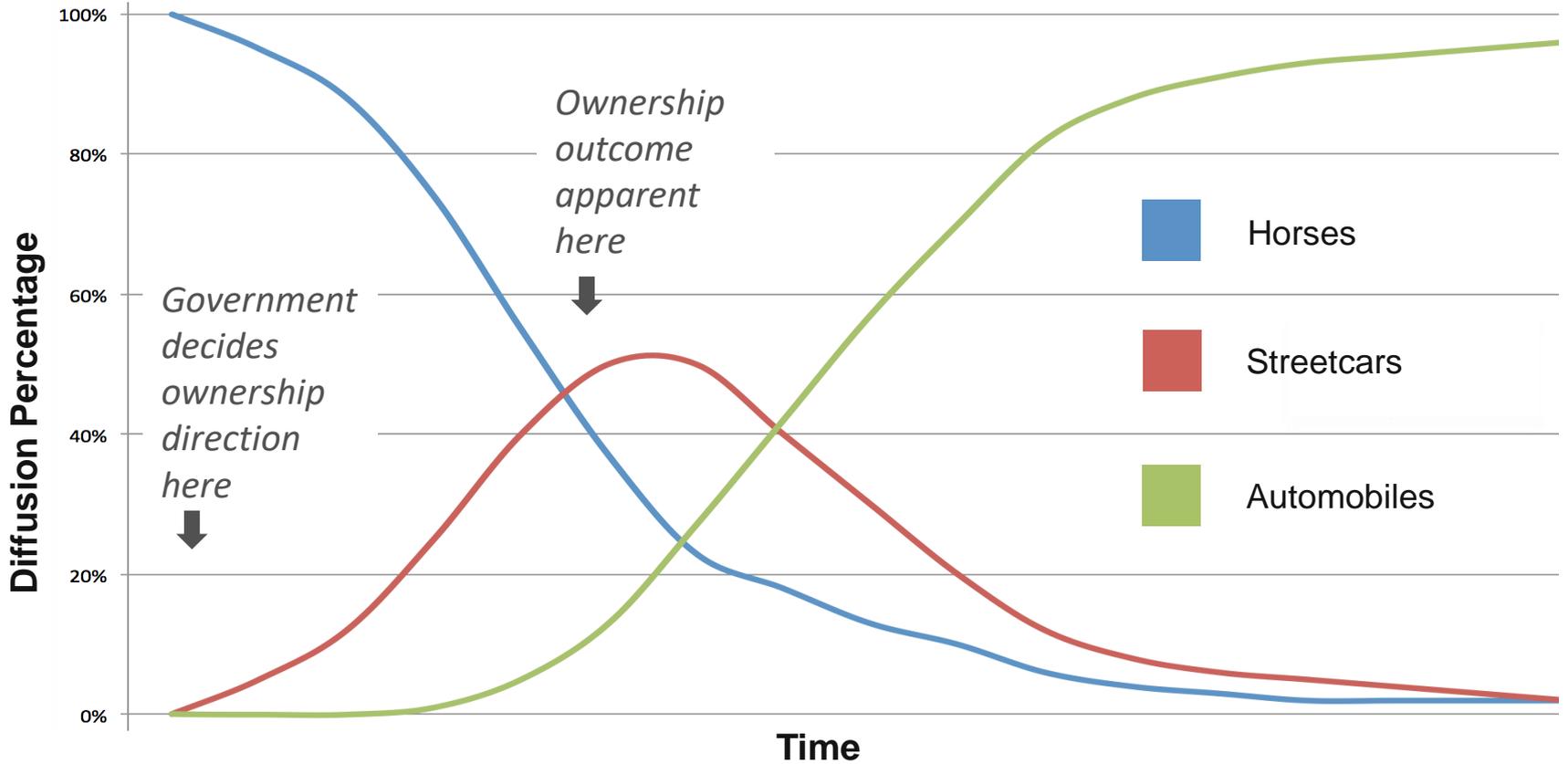
1900

30 years of mixed car technologies

1930

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AVs NEED NOT LOOK LIKE CARS OF TODAY, COULD BE WIDER + LONGER, AND ANY SHAPE

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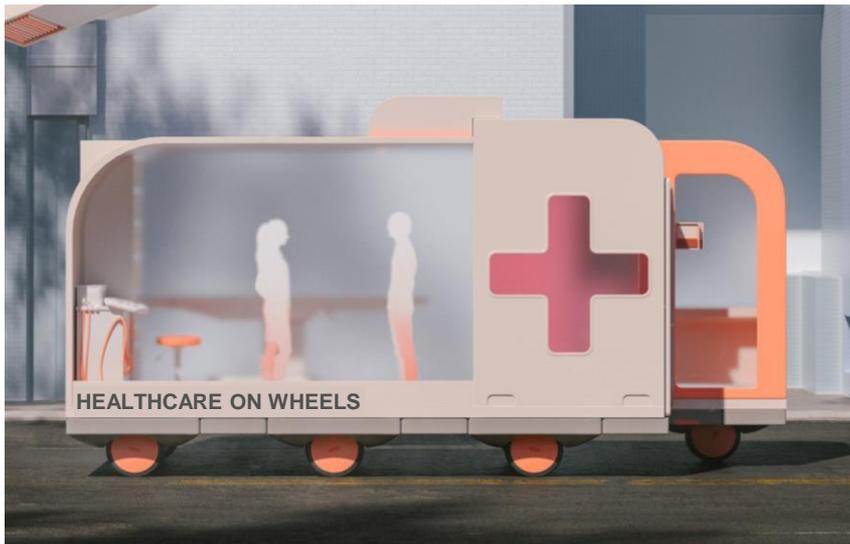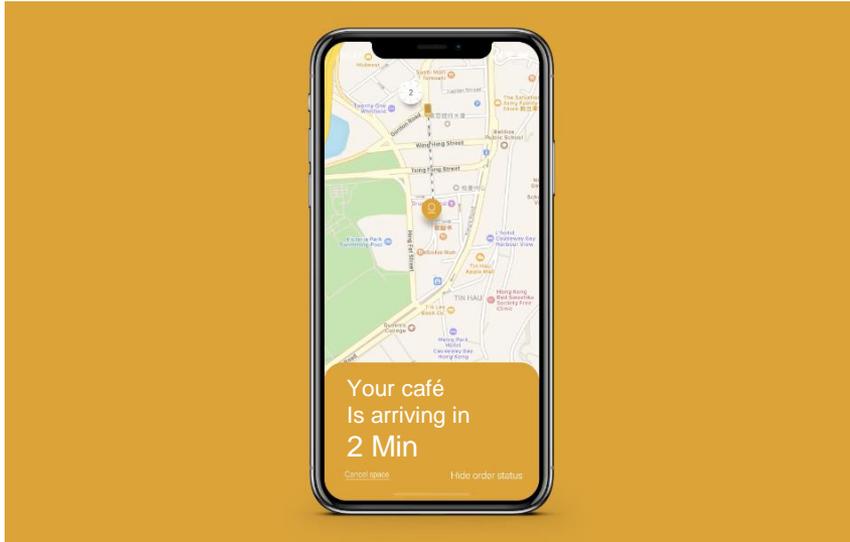
DON'T BELIEVE THE HYPE ON "ROAD TRAINS"

Join a road train
A safe and energy-efficient way to travel
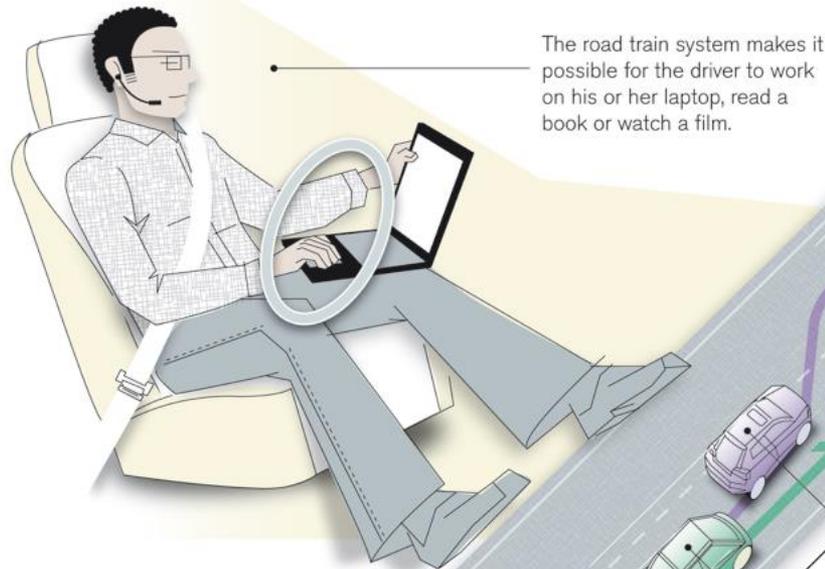
The road train system makes it possible for the driver to work on his or her laptop, read a book or watch a film.

6-8 vehicles in each convoy

- "Road Trains" - a fraction of transit capacity
- Instead, maintain good existing systems
- Use AVs for last mile transport
- Prepare transit workers for jobs in AV transit

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VMT SOARS, CONGESTION REMAINS AWFUL

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Recommendations

Recommendations

30
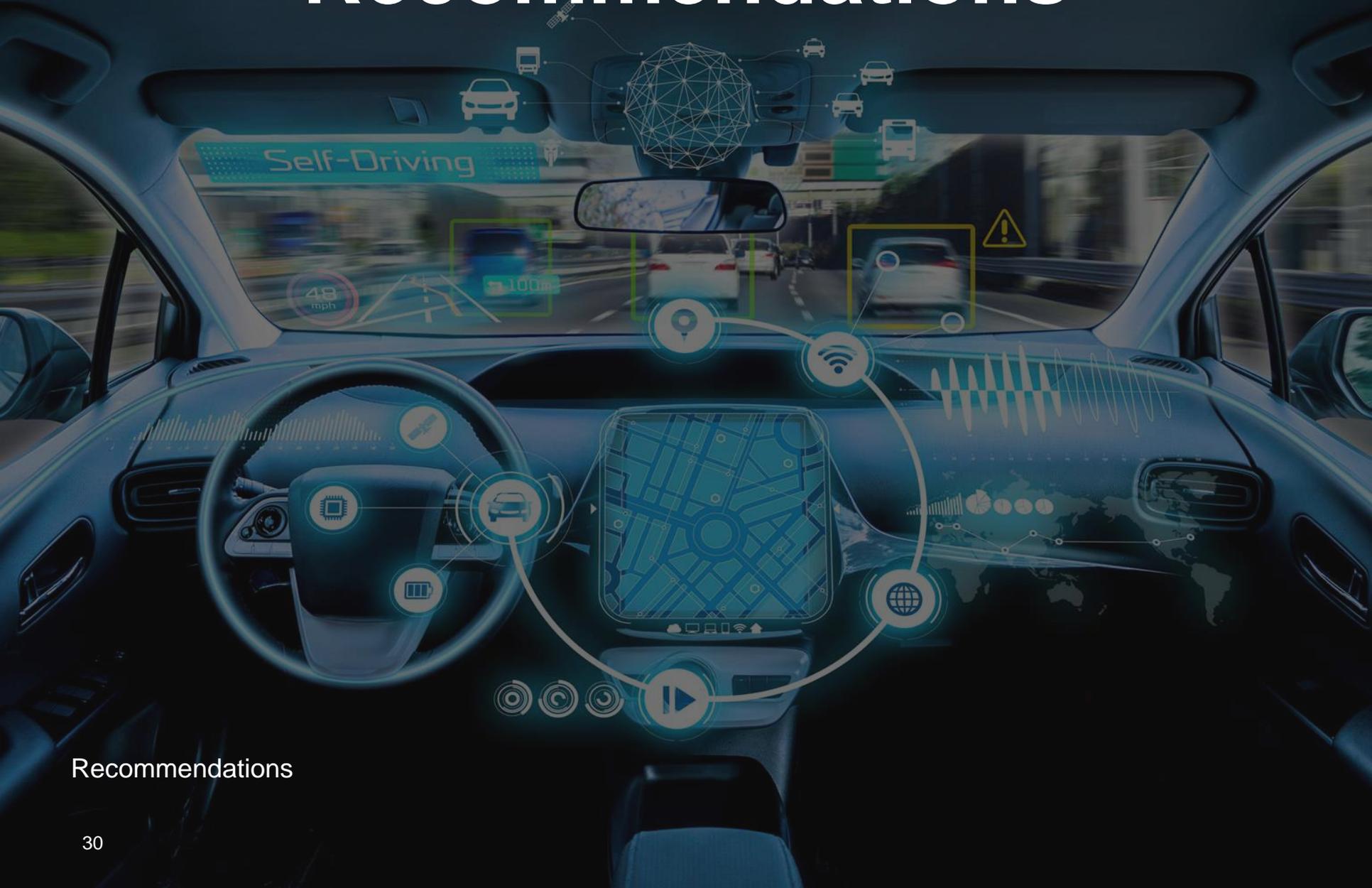
SO WHAT SHOULD WE DO?

Government and Society Should Get Ahead of the Curve

- Discourage private AV ownership; support AV-transit integration
- Maintain and support good *mass* transit
- Emphasize last mile in sprawl areas and transit deserts
- Ensure system equity for low income, disabled, and elderly
- Utilize congestion pricing strategies to maintain adequate mobility
- Don't mess with bike/ped growth in cities
- Reallocate parking for better use
- Enact legislation and enforcement policies preemptively
- Get AV sector $upport for some infrastructure upgrades & maintenance
- Develop a counter-terrorism strategy
- Humanize street design: narrow lanes, widen sidewalks, don't add lanes
- Establish AV street typology plan

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STREET TYPOLOGIES FOR AVs
Compliance Through Public - Private Agreements

South St. Seaport, NY — SCHOOL

Car Free

Woonerf, Nederlands — 18 MPH

Pedestrians Rule, Car is Intruder
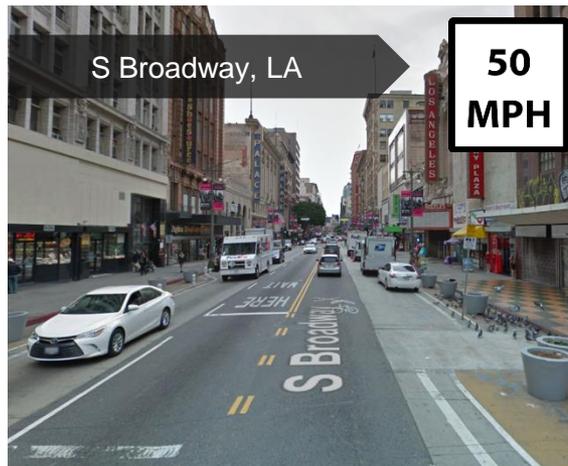
Queens, NY — 24 MPH — 6 MPH — 12 MPH

Slow Streets

S Broadway, LA — 50 MPH

Moderate

Champs-Elysees, France

Urban Arterial

Autobahn, Germany — 50 MPH

Freeway/Highway

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HUMANIZE STREET DESIGN

New York City: Amsterdam Avenue

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HUMANIZE STREET DESIGN

New York City: Amsterdam Avenue

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HUMANIZE STREET DESIGN

Credit: Clarence Eckermen - StreetFilms

New York City: Amsterdam Avenue

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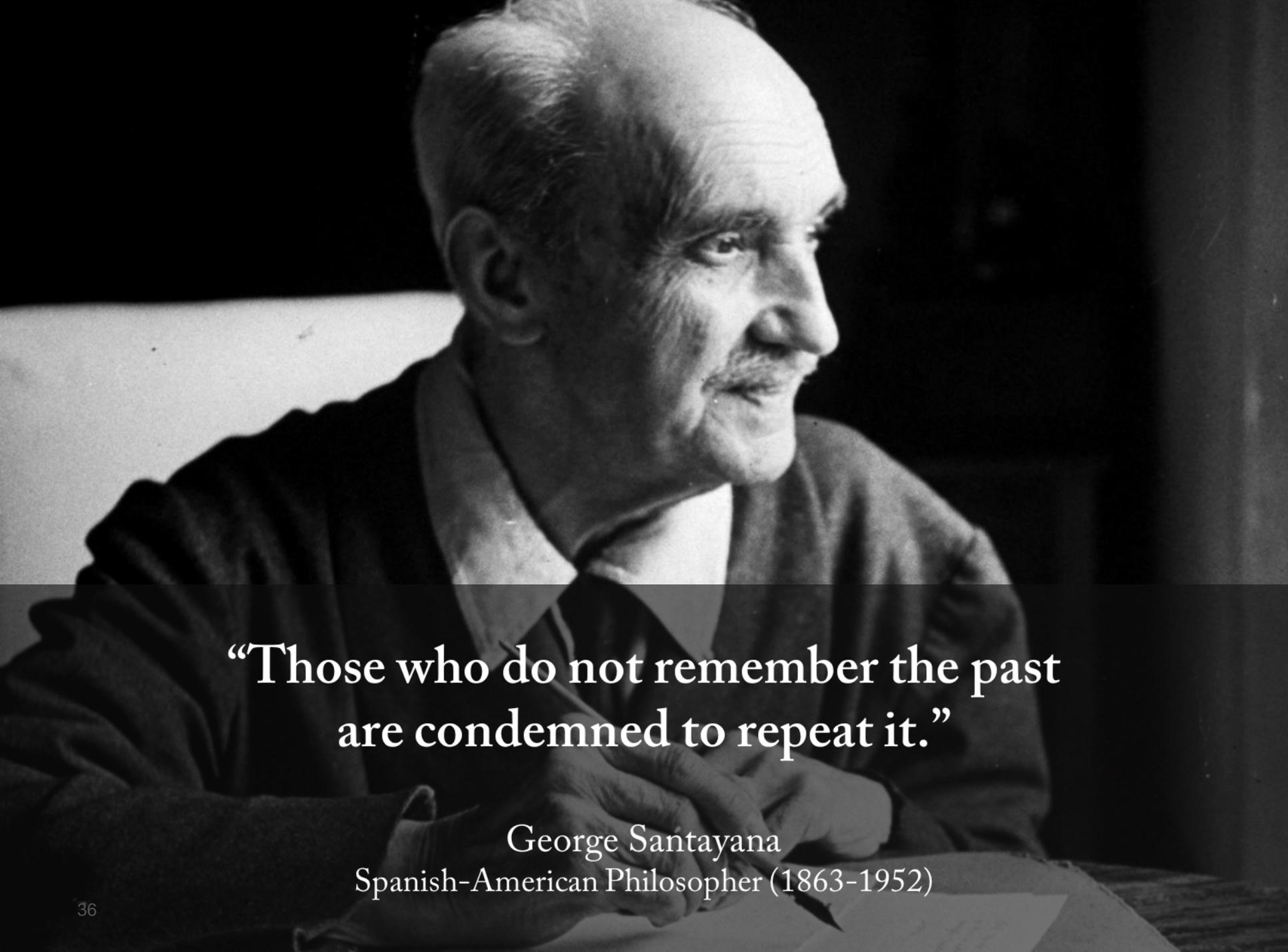
"Those who do not remember the past are condemned to repeat it."

George Santayana
Spanish-American Philosopher (1863-1952)

"I don't even know why we study history. It's entertaining, I guess—the dinosaurs and the Neanderthals … stuff like that…In technology, all that matters is tomorrow."

Source: "Did Uber Steal Google's Intellectual Property?" New Yorker, October 22, 2018

Anthony Levandowski
Google self-driving car engineer +
Otto Co-founder

Let's go back to 1911

RESPECTING HISTORY – A WALK BACK IN TIME
NYC 1911

Sam Schwartz

RESPECTING HISTORY – A WALK BACK IN TIME
NYC 1911

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RESPECTING HISTORY – A WALK BACK IN TIME
NYC 1911

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BY 2030 WALKERS IN CITIES SLOWED AV TRAFFIC TO A CRAWL
IN 2035, WE FENCED IN PEDESTRIANS LIKE CATTLE, AND SOON WE
**HOLLOWED OUT CITIES WHICH LED TO THE RIOTS OF THE 6Os**

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NEXT GENERATION MOBILITY

NEXT GENERATION MOBILITY

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No One at the Wheel

Driverless Cars and the Road of the Future
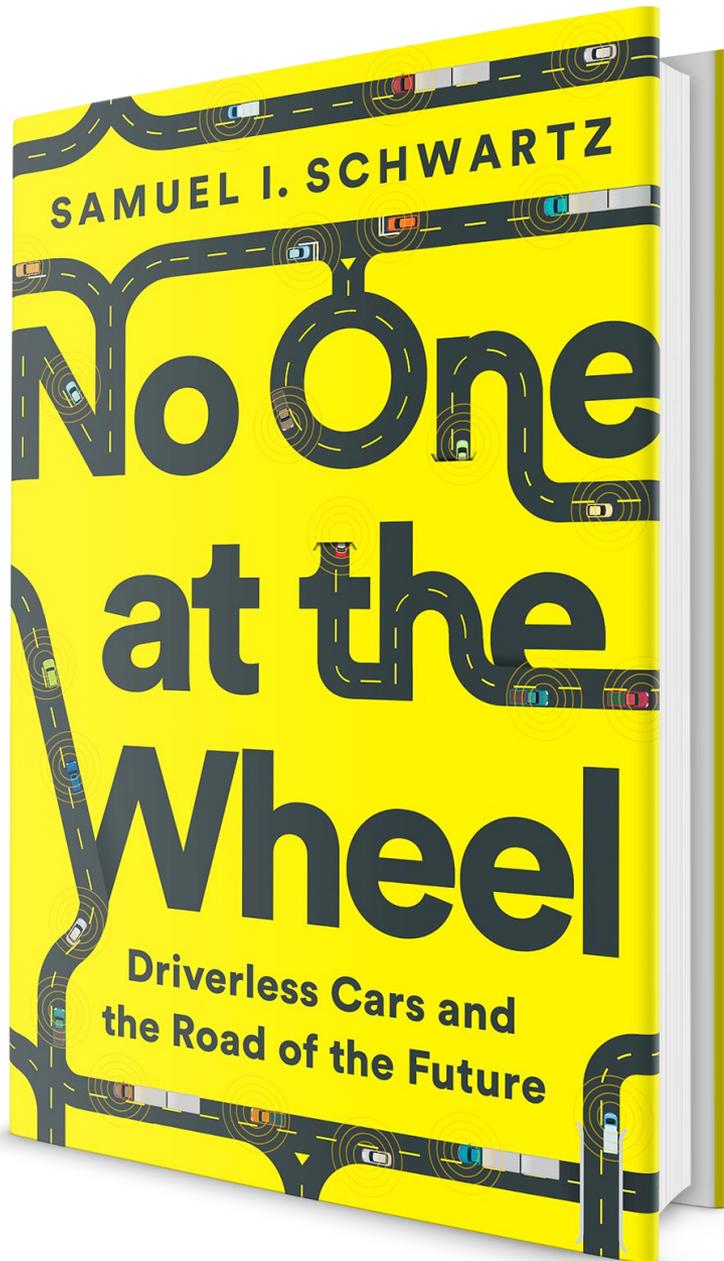
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