THE GOOD, THE BAD AND THE UGLY (POSSIBILITIES)

**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

**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
EVEN IF 90% SAFER THAN CARS

Passenger Deaths per 1 Billion Passenger Miles, 2000-2014

Deaths per Billion Passenger-Miles

<table>
<thead>
<tr>
<th>Mode</th>
<th>Deaths per Billion Passenger-Miles</th>
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<tbody>
<tr>
<td>Car</td>
<td>6.53</td>
</tr>
<tr>
<td>Ferry</td>
<td>2.46</td>
</tr>
<tr>
<td>Train</td>
<td>0.36</td>
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<tr>
<td>Subway</td>
<td>0.33</td>
</tr>
<tr>
<td>Bus</td>
<td>0.2</td>
</tr>
<tr>
<td>Plane</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Source: Passenger Deaths By Mode, 2000-2014, APTA
EVEN IF 90% SAFER THAN CARS

Passenger Deaths per 1 Billion Passenger Miles, 2000-2014

Transit is Already 95% Safer

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
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.** -11.6%
- **Sweden** -53.2%

### Fatalities Per 100 Million VMT Reduction (2000-2015)

- **U.S.** -24.8%
- **Sweden** -62.4%

KEY TAKEAWAY

Don’t let the safety argument blind you to a more holistic approach toward the introduction of AVs to our society.
"..if, in writing some article that’s negative, you effectively discourage people from using something which, you’re killing people."

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)

Source: California DMV

*Help me get the data

Sam Schwartz
DISENGAGEMENTS – DRIVER TAKES OVER

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”
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
MOTOR VEHICLES USED AS WEAPONS RISING

Nice Attack: At Least 84 Killed By Lorry At Bastille Day Celebrations

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
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
INACTIVITY TAKES MORE LIVES THAN CRASHES

World Deaths (Inactivity vs. Crashes)

- Lancet estimate: 5.3 million
- WHO estimate: 3.2 million
- Motor Vehicle Crashes (World): 1.25 million

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%

Sources:
WHO, National Safety Council, 2013
The Lancet, 2008

Source:
CDC, 2014
WALL-E
WALL-E IS NOT FAR-FETCHED
WALL-E IS NOT FAR-FETCHED
Traffic Impacts

NOW

PROMISE

Traffic Impacts
THE PROMISE: IMPROVED LAST MILE FOR TRANSIT ACCESS & SHARP REDUCTION IN TRAFFIC
THE REALITY – APPs concentrate where transit’s rich, traffic’s jammed, and highest income people live

Traffic volumes + 7%

Speeds -28% in Midtown

Core 78%

Outskirts 19%

Airports 19%

NYC APP-BASED RIDERS SECOND CHOICE

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

New York

- Taxi or Car Service: 35%
- Transit: 40%
- Walk or Bike: 13%
- Drive: 10%
- Would Not Make Trip: 2%

Source: NYC DOT Mobility Report 2018, 616 respondents; normalized to equal 100% by Sam Schwartz
## Mode Replacement Boston and California

### Boston

- **Drive**: 18%
- **Walk or Bike**: 12%
- **Public Transportation**: 42%
- **Taxi**: 23%
- **Would not have made the trip**: 5%

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

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


Sam Schwartz
APP-BASED CARS TRAVEL 1.58m FOR EACH PASSENGER MILE

Additional VMT Induced by TNC Rides

- No Sharing (All Private Cars): 58%
- 20% Shared (from all modes): 160%
- 50% shared (from all modes): 120%
- 75% shared (from all modes): 41%

WARNING: MIXED TECHNOLOGIES AHEAD
(UNCERTAIN TIME SCALE)

Ownership outcome apparent here

Government decides ownership direction here

Diffusion Percentage

Time

Non-Automated

Semi-Automated L1-3

Fully-Automated L4-5

40 - 50 years of mixed car technologies

© Grush Niles Strategic
WARNING: MIXED TECHNOLOGIES AHEAD
(UNCERTAIN TIME SCALE)

Ownership outcome apparent here

Government decides ownership direction here

Horses
Streetcars
Automobiles

30 years of mixed car technologies

© Grush Niles Strategic

1900
1930
AVs NEED NOT LOOK LIKE CARS OF TODAY, COULD BE WIDER + LONGER, AND ANY SHAPE
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.

- “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

Sam Schwartz
VMT SOARS, CONGESTION REMAINS AWFUL

Life without driverless cars

Life with driverless cars

All hail the revolution!

Sam Schwartz
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 support 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
STREET TYPOLOGIES FOR AVs
Compliance Through Public - Private Agreements

- **Car Free**: South St. Seaport, NY
- **Pedestrians Rule, Car is Intruder**: Woonerf, Nederlands
- **Slow Streets**: Queens, NY
- **Moderate**: S Broadway, LA
- **Urban Arterial**: Champs-Elysees, France
- **Freeway/Highway**: Autobahn, Germany
HUMANIZE STREET DESIGN

New York City: Amsterdam Avenue
New York City: Amsterdam Avenue
HUMANIZE STREET DESIGN

New York City: Amsterdam Avenue

Credit: Clarence Eckerman - StreetFilms
“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
RESPECTING HISTORY – A WALK BACK IN TIME
NYC 1911
A visitor from 2100 travels back to 2019
BY 2030 WALKERS IN CITIES SLOWED AV TRAFFIC TO A CRAWL
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 60s
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