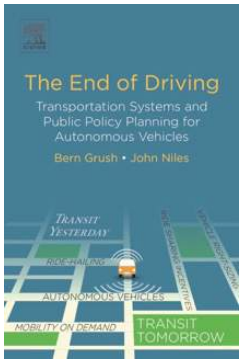
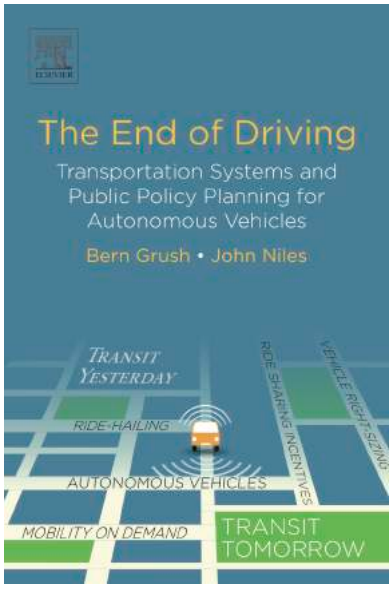
An Adult Conversation about Autonomous Vehicles:

Conflicting Narratives About the Autonomous Vehicle Future



Harmonize MOBILITY

Bern Grush
October 29, 2019



Elsevier, 2018

Systems of economics, humans, cities, and built form interact with vehicle automation

Interrelationships that frustrate resolution

Transition and diffusion issues affect planning

Human, social, and urban issues *

*NOT transient technical and vehicle issues

An Adult Conversation About Autonomous Vehicles

01 How tech hype works

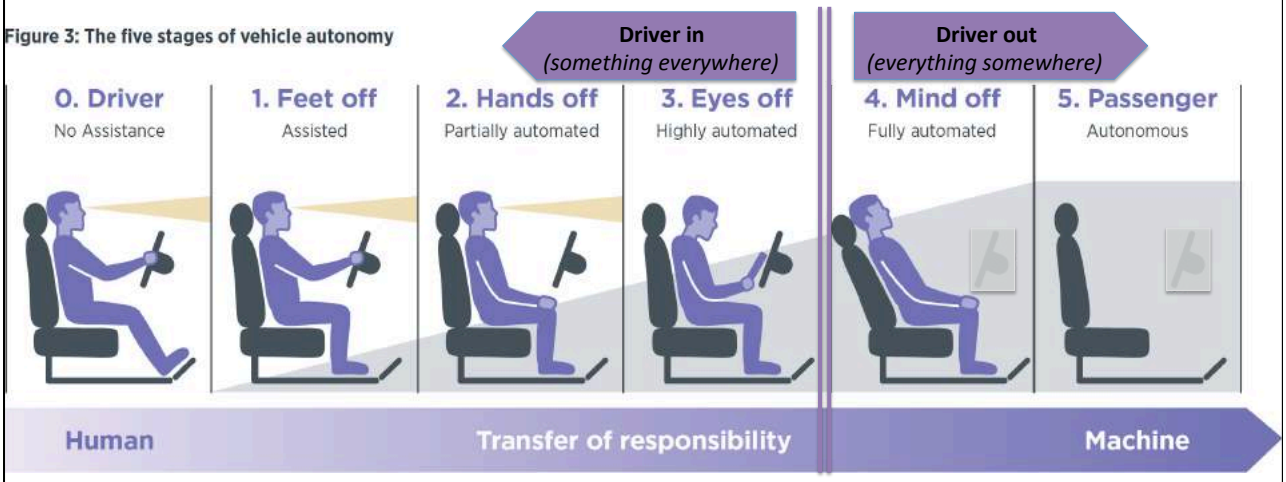
02 Conflicting narratives

03 The most dangerous narrative

The Market Buzz Since 2013

Harmonize MOBILITY

Figure 3: The five stages of vehicle autonomy



4

Consumer choices…

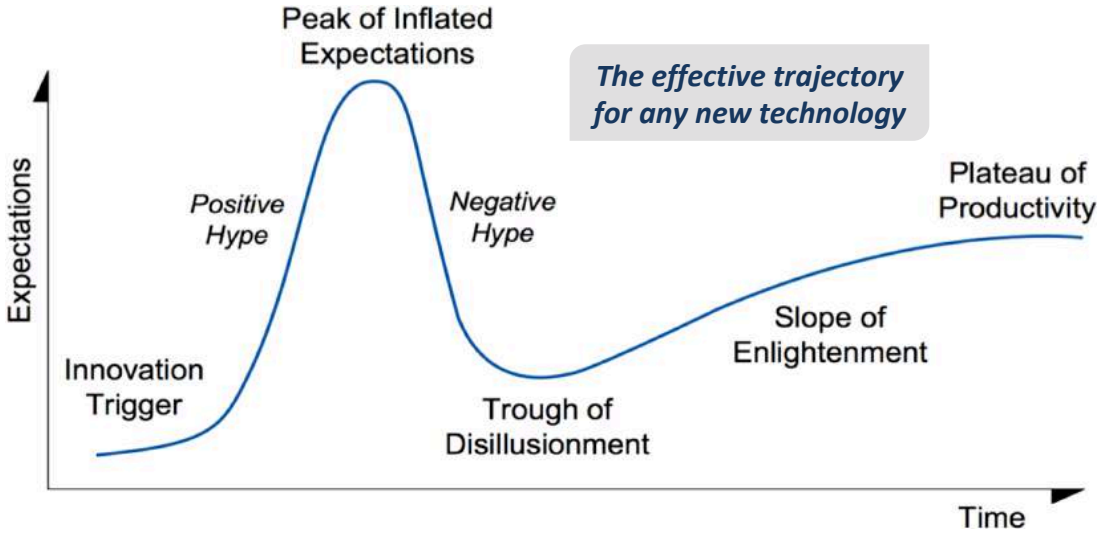
Harmonize MOBILITY

L2 Partial (personal) Hands-On	L3 Conditional (personal) Self-driving	Market 1	Market 2	L4 High (robotaxi) Driverless	L5 Full 2075? Never?



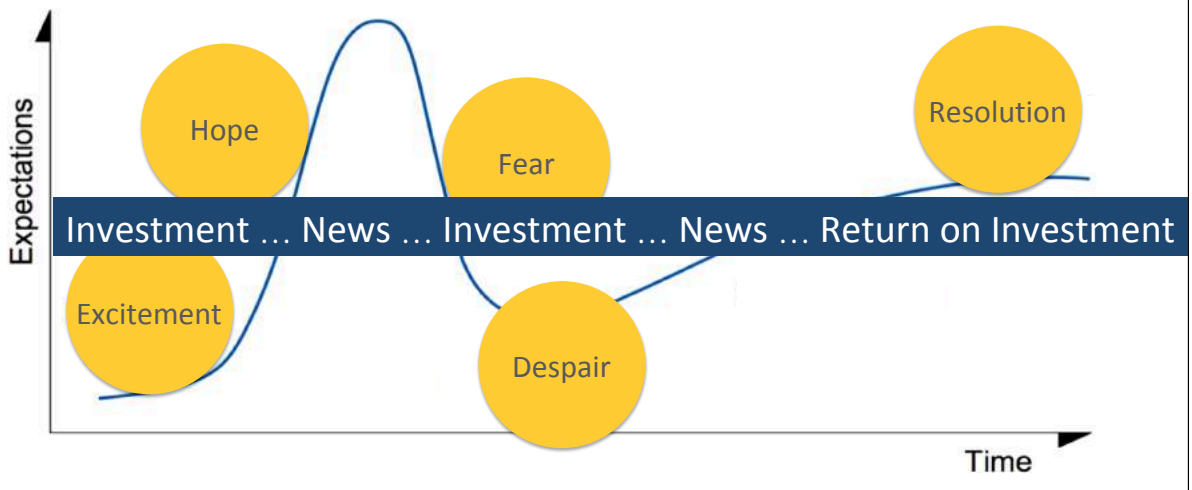
6

Gartner Hype Cycle™



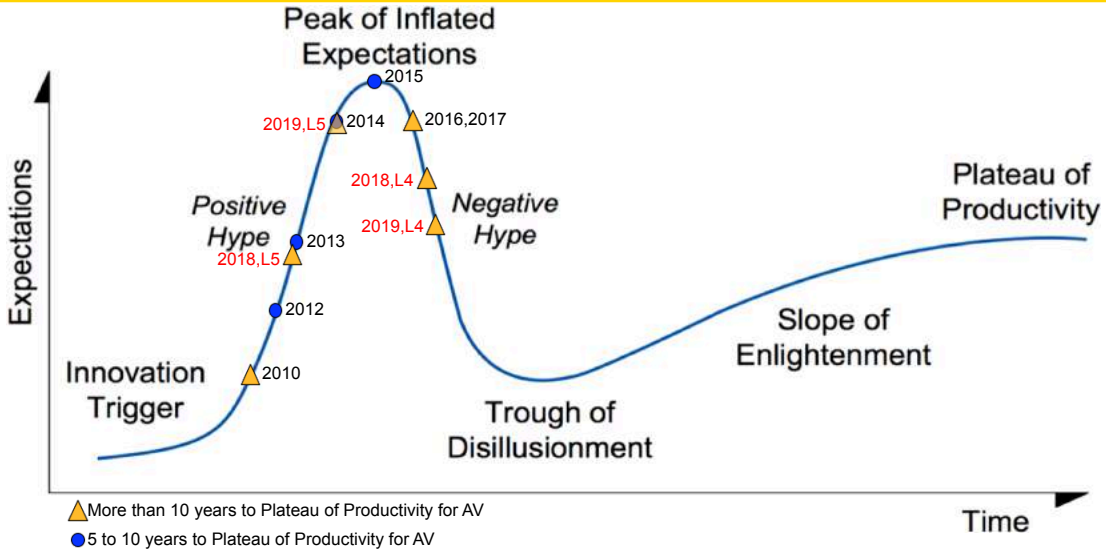
7

Hype's socioeconomic engine



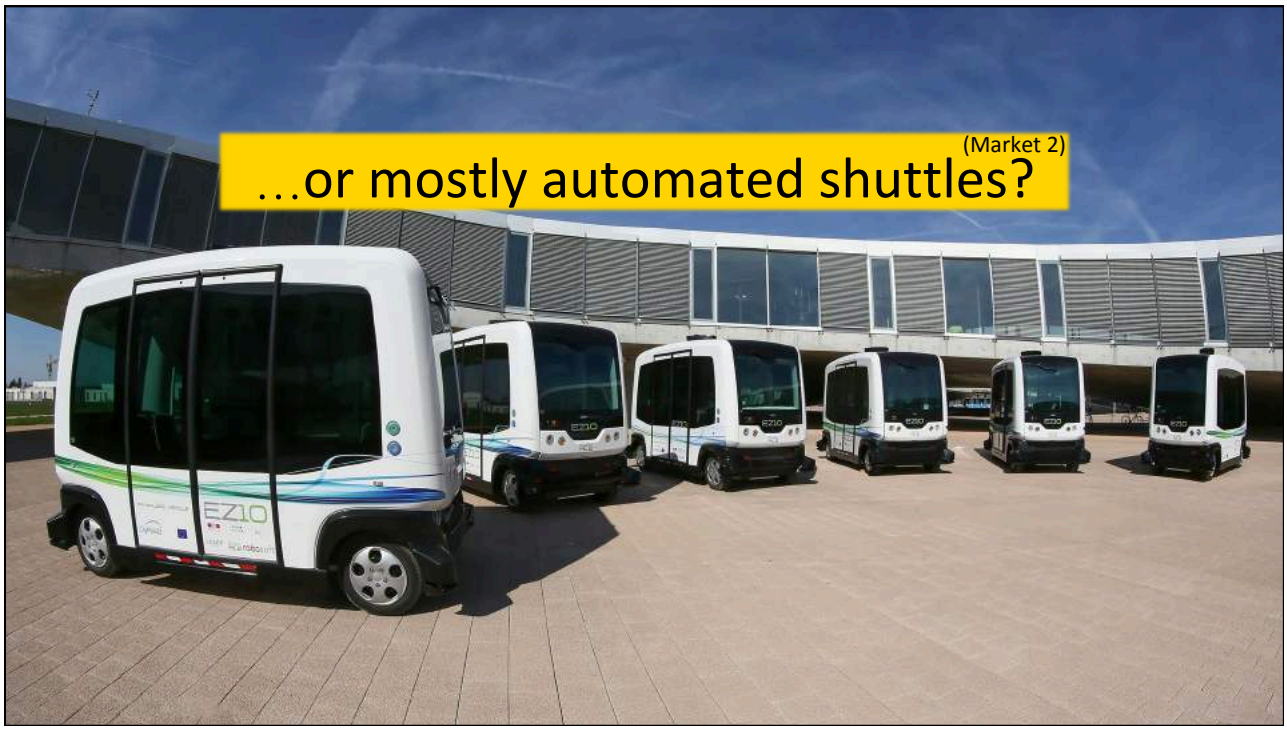
8

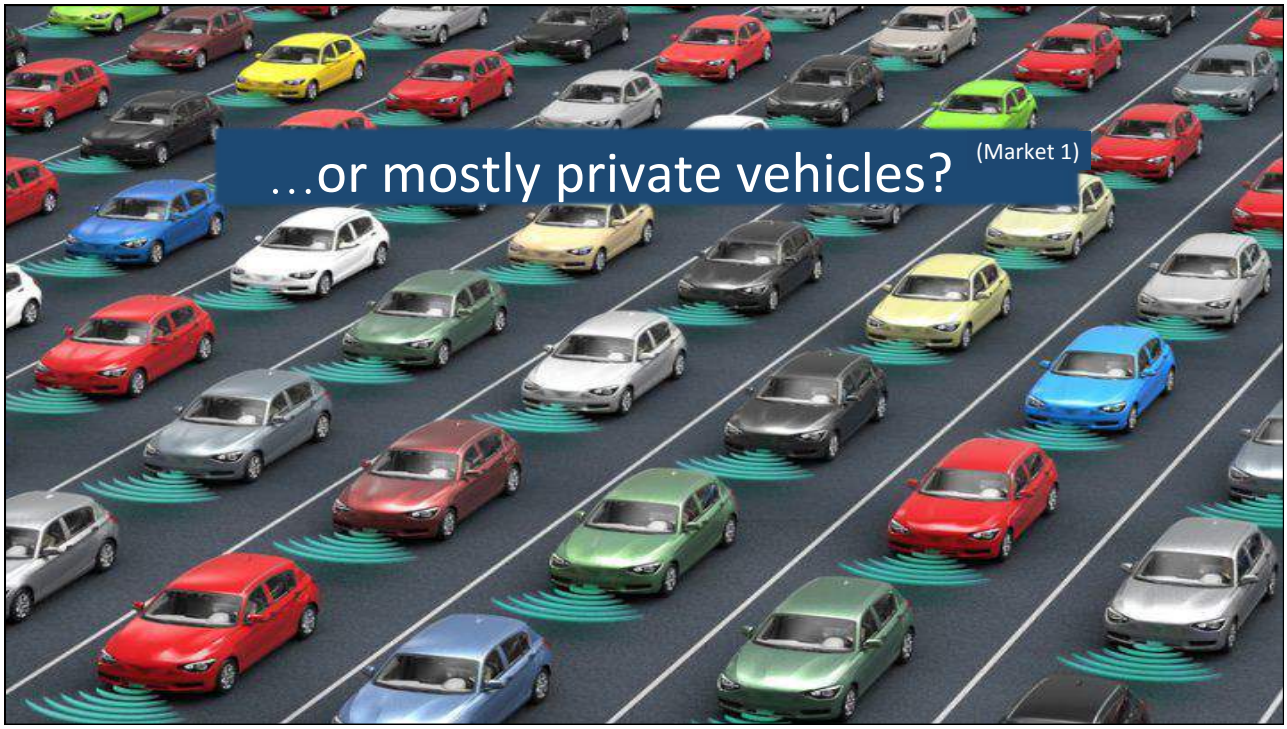
Observe a decade of AV hype, year by year



9


Will it be mostly automated taxis…
(Market 2)


…or mostly automated shuttles?
(Market 2)
EZ10



An Adult Conversation About Autonomous Vehicles

01 How tech hype works

02 Conflicting narratives

03 The most dangerous narrative

Why Conflicting Narratives?

- We anticipate change through a set of expectations
  - usually simplified stories without nuance or detail
- Some of these narratives are informed by limited analysis
  - Others are comprised of wishful thinking or fears
- Taken together, these narratives are inconsistent / contradictory
  - leading to misunderstanding, hype, reactivity
  - unintended or unrealistic expectations
- These narratives can influence planning/governance

15

Example: Zombie Miles

EDITOR'S PICK | 426 views | Oct 27, 2019, 04:11am

What's So Bad About Zombie Robotaxis?

Richard Bishop Contributor ⓘ
Transportation

16

Conflicting Narrative: Zombie Miles

Bad Zombie robotaxi

"Countless empty vehicles are roaming around looking for/going to waiting passengers"

"I don't want my robotaxi driving continuously around the block while I have dinner."

Good Zombie robotaxi

Superior to a traditional taxi

Missing 200 lb extra human weight

AC off when running empty

Drives more energy effectively

At scale, far more sustainable!

- *Network effect means far lower VKT per PKT*
- *Robotaxi fleet operators would optimize fleet & vehicle size and energy to max profit*

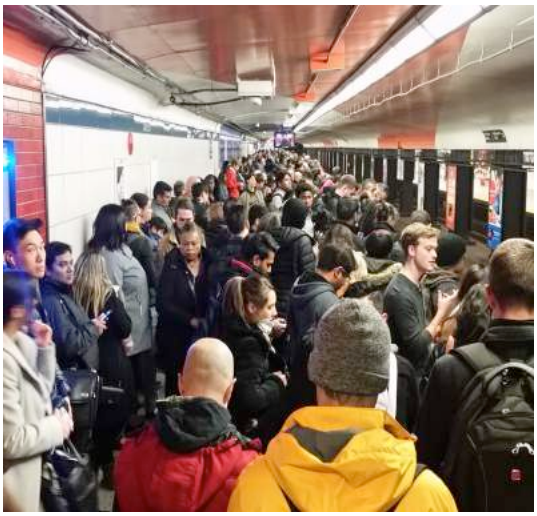
https://www.forbes.com/sites/richardbishop1/2019/10/27/whats-so-bad-about-zombie-robo-taxis/#7cbe12016832

17

Utopia vs. Dystopia

18

Torontopia - 2018



19

Conflicting government narratives

INVESTING IN PUBLIC TRANSIT

The City of Toronto will receive $184,994,655 in funding this year to improve transit projects such as the TTC from Ontario's gas tax program. The program provides municipalities with two cents per litre of provincial gas tax revenues. Municipalities receiving gas tax funding must use these funds towards their public transit capital and/or operating expenditures, including upgrading transit infrastructure, increasing accessibility, purchasing transit vehicles, adding more routes and extending hours of service.

MAKING LIFE MORE AFFORDABLE FOR DRIVERS

The Government has taken a number of steps to make life more affordable for drivers in the Province of Ontario. By eliminating the cap-and-trade carbon tax, the Government has reduced the price of gasoline by 4.3 cents a litre. The Government has also frozen driver and vehicle fees that were set to increase on September 1, 2018, including fees for vehicle validation, drivers licenses, and road and knowledge tests. As well, the cancellation of the Drive Clean program as of April 1, 2019 will save taxpayers $40 million per year.

20

Density vs Sprawl

Contradictory predictions from real-estate, housing, and transport experts:

1: Cities will grow denser as parking is reclaimed by people

2: AVs will push families further into more rural areas: "a lot of people would rather not live on top of their neighbor."

Some now suspect both are true!

https://www.marketwatch.com/story/heres-where-youll-live-when-cars-drive-themselves-2017-10-24

21

Share vs. Own

Why no one will own a car in 25 years

Cadie Thompson Jun. 29, 2015, 1:33 PM
CityLab

In just a few short decades, owning a car could be a lot like owning a horse — mostly for hobbyists and really unnecessary for transportation purposes.

A row of Google self-driving Lexus cars seen outside the Computer History Museum in Mountain View, California, on May 13, 2014. AP

Technologies such as self-driving cars paired with transportation networks such as Uber will pretty much kill the need to own a car in 25 to 30 years, Jamais Cascio, a futurist and senior fellow at the Institute for Ethics and Emerging Technologies, told Business Insider.

https://www.businessinsider.com/why-no-one-will-own-a-car-in-25-years-2015-6

Subsidize household AV purchases…

At the moment, the technology used in AVs … can cost more than US$ 30,000 … this equipment is expected to become more affordable as AVs become available to the public on a mass scale. Hensley estimates that 15 years after the commercialization of AVs, their cost will drop from a US$ 10,000 markup (i.e. the additional payment for autonomy technology) to a US$ 3,000 markup. Before reaching these affordable markups, however, we believe that **governing agencies should promote AV purchases by implementing rebates and subsidies (to families)**.

Baron, O., Berman, O., and Nourinejad, M. (2019) The Economics of Autonomous Vehicles (McKinsey)

22

Hope vs. History

Long-standing problems dramatically relieved without changing consumption behaviour!
- Reduced fatalities and injuries!
- Less congestion!
- No emissions!

Automation delivers more
- Easy sharing; less parking
- Solves drink driving and driver distraction
- Improve trip access and availability
- Addresses the mobility disadvantaged

Godsend for
- Daily commuters
- Urban planners
- Livability
- Politicians

All with few changes in consumer behaviour!

Legacy barriers
- Existing infrastructure
- Regulations
- Unions
- Extant fleets with sunk investment & remaining life cycle

These barriers
- delay benefits
- frustrate dispersion
- reduce ROI

Preferences and behaviors (some older than automobility
- Preferences for control, independence, and status turn the plausible for some into the unlikely for many
- The number of barriers to becoming a zero-car family are high.

23

Human vs. Machine

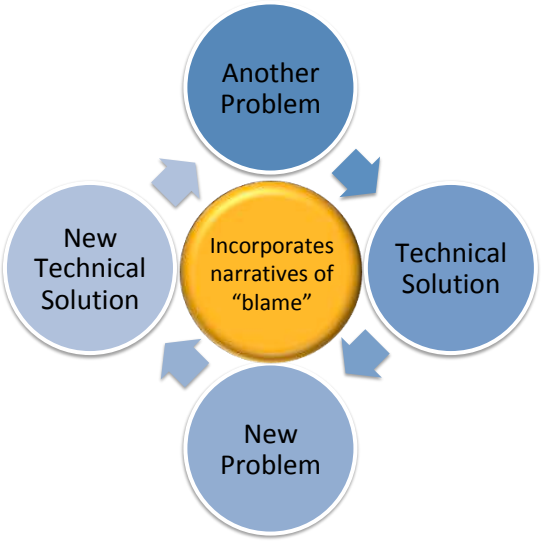
Humans are better than machines
- Solve the whole context
- Have unparalleled visual capability
- Solve problems they've never seen
- Can make ethical decisions
- Are flexible problem solvers

Machines are better than humans
- Better in narrow domains
- More accurate; don't tire
- Undistracted; don't drink
- Take away tedious work
- Cheaper (eventually)

Caution: we have greater tolerance for human error than for machine error

24

Technophile vs. Technophobe



One foot on throttle and one on brake

- Polarizes
- Inhibits acceptance
- Slows diffusion
- Safety mechanism

Conflict since the Industrial Revolution

- Generates other opposing narratives
- Will not go away
- Live with it

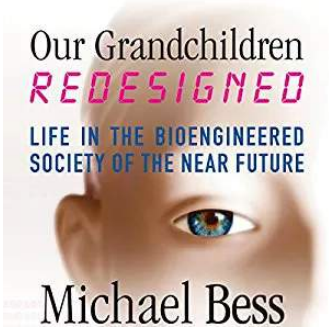
25

Technology isn't just changing society — it's changing what it means to be human

A conversation with historian of science Michael Bess.

By Sean Illing | @seanilling | sean.illing@vox.com | Feb 23, 2018, 8:40am EST

https://www.vox.com/technology/2018/2/23/16992816/facebook-twitter-tech-artificial-intelligence-crispr



- Does technology help more than hurt humans?
  - Depends which technologies
  - Depends what you measure
  - Depends how its regulated

26

Market vs. Regulated

MARKET / MARKET FORCES

- Competition
- Jobs
- Innovation
- Prices
- Services, more

- Always circumventing
- Always reaching
- Profit

Ontario vs. Toronto

…since 2018

REGULATION / GOVERNANCE

- Environment
- Jobs
- Safety
- Social equity
- Subsidies, Taxes

- Always adjusting
- Always cautious
- Largesse

27

Infrastructure: More, Less and Different

MORE
- ✓ Separate lanes
- ✓ Better stripping
- ✓ Charging stations
- ✓ Add AV fleets
- ✓ Snow removal

LESS
- ✓ Fewer lanes
- ✓ Narrower lanes
- ✓ Less parking
- ✓ No signals
- ✓ *Revenue*

DIFFERENT
- ✓ Changes to curb
- ✓ Repurpose parking
- ✓ Roundabouts
- ✓ Tighter parking
- ✓ *Pricing*

Risks
- ✓ Tech changes far faster than infrastructure can adjust
- ✓ Innovators work around problems ➔ unintended maintenance/management issues
- ✓ 30/40 years of transition will likely require multiple do-overs

28

How Long Should We Wait Before Acting?

Harmonize MOBILITY

WAIT
- ✓ Don't know what/when to change
- ✓ It'll make everything better, anyway
- ✓ Acceptance is uncertain
- ✓ This is all hype

HURRY
- ✓ We want to be the leader
- ✓ Act now or lose jobs
- ✓ Prepare for what you want and demand deployment your way

Risks
- ✓ Wait: risk another "Uber" (lose)
- ✓ Hurry: get it wrong (lose-lose!)
- ✓ Tech giants decide your city instead of you (lose big)
- ✓ Changes to an installed base are always trickier than in a greenfield (Sidewalk Labs)

29

Environment vs. Jobs

Harmonize MOBILITY

- ✓ Environment more important than jobs
  - ✓ "How can you think otherwise"
- ✓ Take this seriously
  - Transportation is now the pariah in the Climate Change battle
- ✓ It may already be late

- ✓ Jobs more important than the environment
  - "How can you think otherwise"
- ✓ "Humans who have basic needs handled pay more attention to the environment"
- ✓ Jobs get more votes.

We are VERY positional about this.

ME or *THE PLANET* is a "no-brainer" for most humans. "ME" usually wins.

30

Transit vs. AVs

Harmonize MOBILITY

TRANSIT
- ✓ No space for all the cars
- ✓ Keep building heavy transit
- ✓ Use AVs to feed transit (F/L mile)

Ezike, R., Martin, J., Catalano, K., Cohn, J., (2019) Where Are Self-Driving Cars Taking Us? Pivotal Choices That Will Shape DC's Transportation Future

"We must make the right choices today to ensure that automated vehicles do not increase traffic and pollution, undermine public transit, and exacerbate inequities in our transportation system."
— Union of Concerned Scientists

AVs
- ✓ People will prefer door to door
- ✓ Rethink transit planning
- ✓ Stop and wait transit building

https://ottawacitizen.com/opinion/columnists/kirk-potential-of-driverless-taxis-should-delay-stage-2-of-ottawa-lrt

"…public transport is painful... Why do you want to get on something with a lot of other people, that doesn't leave where you want it to leave, doesn't start where you want it to start, doesn't end where you want it to end, and it doesn't go all the time."
— Elon Musk

31

Internal Combustion Engine vs. Electric Vehicle

(As AV's base vehicle)

Harmonize MOBILITY

ICE
- ✓ Charging stations not ready
- ✓ We're totally set up for ICE fleets
  - Service Stations
  - Skills/Training
- ✓ Power is an independent issue
- ✓ Needs new training
- ✓ We'll lose jobs / companies

EV
- ✓ AVs must be about improving our environment!
  - So MUST be EV!
- ✓ Robotaxi fleets are the best opportunity to convert to EVs
  - If not now, when?
- ✓ China will beat us – we lose!

32

FASTER	vs.	SLOWER
Early Adopters Pressure *"Each year we lose 1.3M lives"* Competition Costs **Faster after it hits a tipping point**		Laggards Money Uncertainty Process Elections Assessments Complexity *Unintended consequences*

Autonomous vs. Automated

with "air-traffic control"

Harmonize MOBILITY

AUTONOMOUS VEHICLES (~L5)
- Anywhere, any condition
- Not for many years (if ever!)
  - John Krafcik, Waymo

AUTOMATED VEHICLES (~L4)
- Geofenced with…
- Ground traffic control systems
  - Monitor, intervene, takeover

https://www.cnet.com/news/alphabet-google-waymo-ceo-john-krafcik-autonomous-cars-wont-ever-be-able-to-drive-in-all-conditions/

"Today's autonomous vehicles can drive relatively well in typical settings, but they fail in exceptional situations—and it's those situations that are the most dangerous."

Walter Lasecki (U of Michigan)

https://news.umich.edu/air-traffic-control-for-driverless-cars-could-speed-up-deployment/

34

Aspirations vs. Realities

Harmonize MOBILITY

ACES — aspiration

Autonomous
Connected
Electric
Shared

35

Aspirations vs. Realities

Harmonize MOBILITY

ACES

- ~~**Autonomous**~~ **Automated**
  Connected
  Electric
  Shared

Mindell's Myths of Autonomy

Replacement
Linear progress
Full autonomy

Human

- Planning
- Direction
- Oversight
- Approvals

https://www.huffingtonpost.com/david-a-mindell/driverless-cars-and-the-myths-of-autonomy_b_8287230.html
https://www.techrepublic.com/article/why-robots-still-need-us-david-a-mindell-debunks-theory-of-complete-autonomy/

36

> “ There's really **no such thing as full autonomy**. You can always find a wrapper of human intention and direction that goes around even the most autonomous robots. It's always interacting with the human world in some way or another. The highest expression of the technologies are the ones that *work most deeply, fluidly, with human beings*.
>
> David Mindell

https://www.techrepublic.com/article/why-robots-still-need-us-david-a-mindell-debunks-theory-of-complete-autonomy/

Aspirations vs. Realities

Harmonize MOBILITY

ACES

Autonomous

➢**Connected**

Electric

Shared

CONNECTED

5G vs. DSRC for V2V, V2I

- 5G many purposes
- DSRC is dedicated

Vehicle must remain safe even in face of comm failures

- Most current AV testing is without connectivity in the way predicted

5G may be winning

https://news.itu.int/to-5g-or-not-to-5g-automotive-safety-may-hang-in-the-balance/ (Roger Lanctot)

38

Aspirations vs. Realities

Harmonize MOBILITY

ACES

Autonomous
Connected
➢**Electric**
Shared

ELECTRIC

Range anxiety remains
- Real?
- Psychological?
- Solvable?

The installed U.S. ICE eco-system:
- … is in place
- … is highly motivated to innovate
- … has new supply (shale)
  - This diminishes the U.S. "National security" motivation for EVs.

39

Aspirations vs. Realities

Harmonize MOBILITY

ACES

Autonomous
Connected
Electric
➢**Shared**

SHARED

Barriers
- Spatial distribution
- Wait time
- Social/behavioural preferences
- Habit
- Fears
- Wealth

What is the realistic diffusion limit of sharing in each/any context?

40

An Adult Conversation About Autonomous Vehicles

01 How tech hype works

02 Conflicting narratives

03 The most dangerous narrative

access,
affordability
blind
disabled
employment
environment
ridehailing
income
senior
sharing
social
social equity
sustainability
taxi
technology
transit
Uber/Lyft
University
wheelchair

3.1 times more

Social, urban, environmental justice

advertising,
gaming
purchasing
shopping
social media
video

11.7 times more

36x !

GDP, growth, jobs, exports, consumption, and entertainment

Solution to Ontario's dangerous narrative

Harmonize MOBILITY

Support intelligent technologies in Ontario that provide what the world's cities need for livability and social agendas (such as Universal Basic Mobility)

Use this to create jobs

Export our innovations

An Adult Conversation About Autonomous Vehicles

Bern Grush
blog: www.endofdriving.org
bern@harmonizemobility.com