AUTONOMOUS VEHICLE BEHAVIOR TESTING

WITH THE COG/TPB MODEL

Kevin Johnson, Fehr & Peers
Will Lisska, Fehr & Peers
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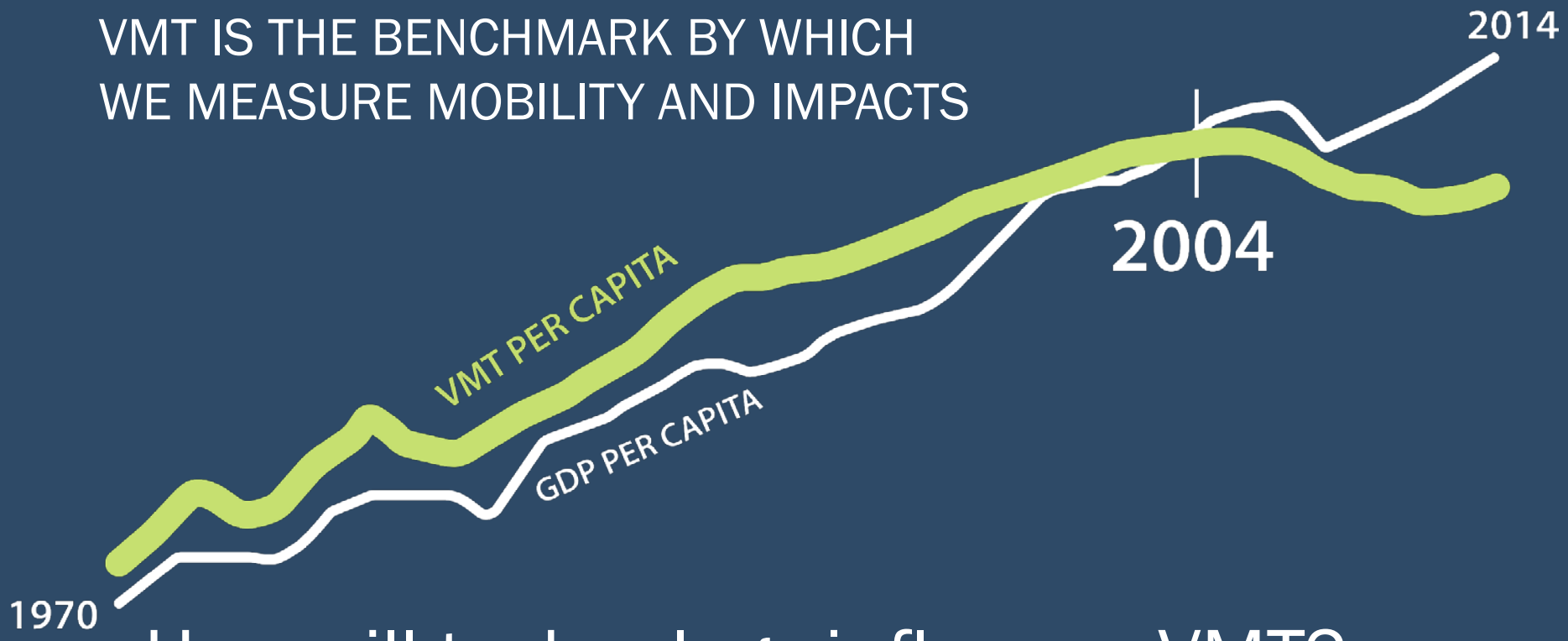
why WE DID THIS

"Very smart people have very different opinions on the pace of implementation, market acceptance, and impacts of technology in transportation. But, folks are hungry for answers, and in the absence of information speculation is running rampant"

Steven Polzin, University of South Florida

why. WE DID THIS

VMT IS THE BENCHMARK BY WHICH
WE MEASURE MOBILITY AND IMPACTS



How will technology influence VMT?

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why WE DID THIS

Here are some opinions.

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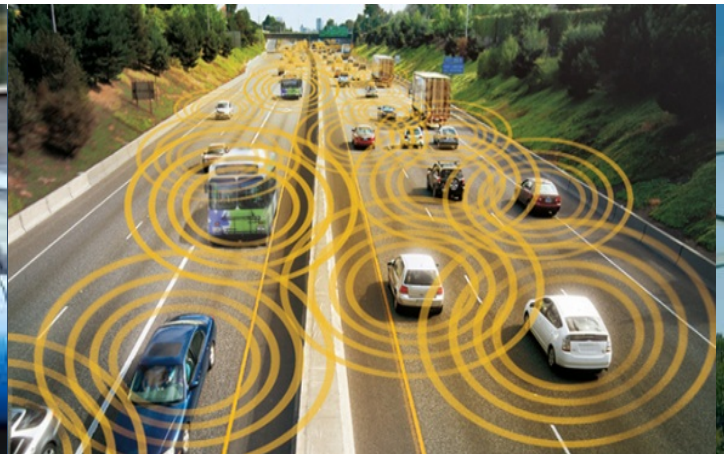
why. WE DID THIS

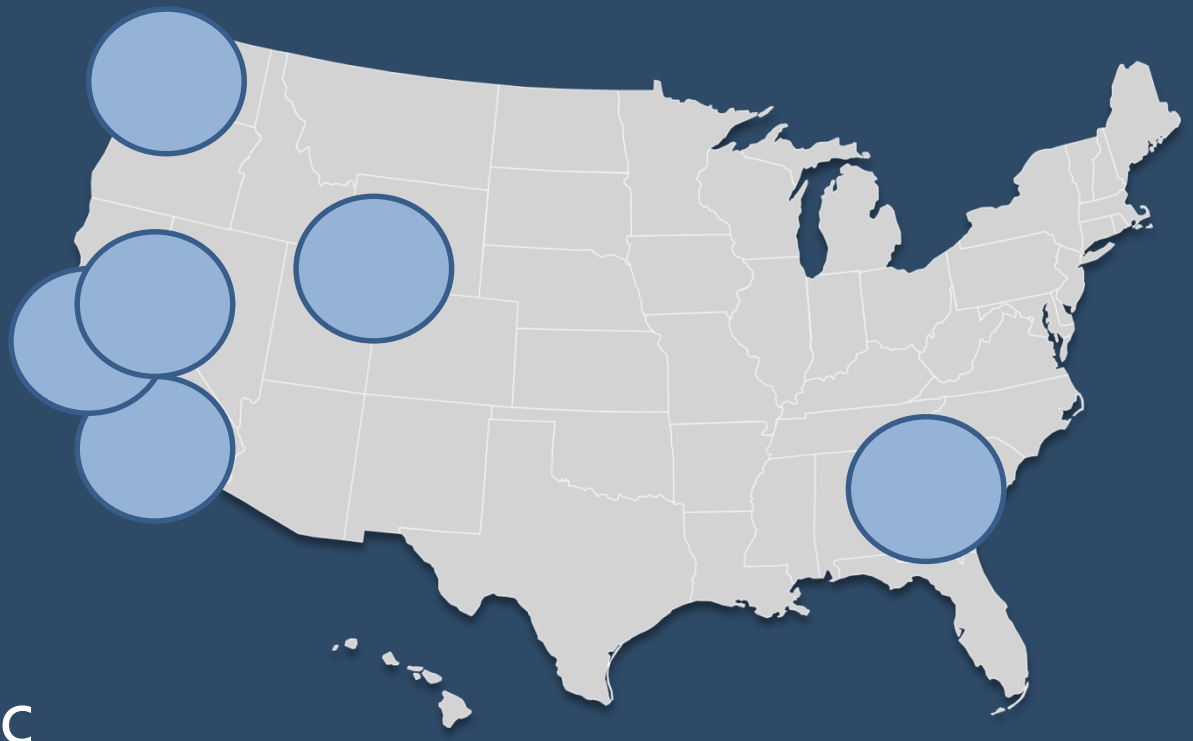
Gauge how sensitive our models currently are

Help our clients understand the uncertainty and make a more informed decision



what. WE DID

- Tested four regional models + two others
- Tested eight effects + cumulative effects

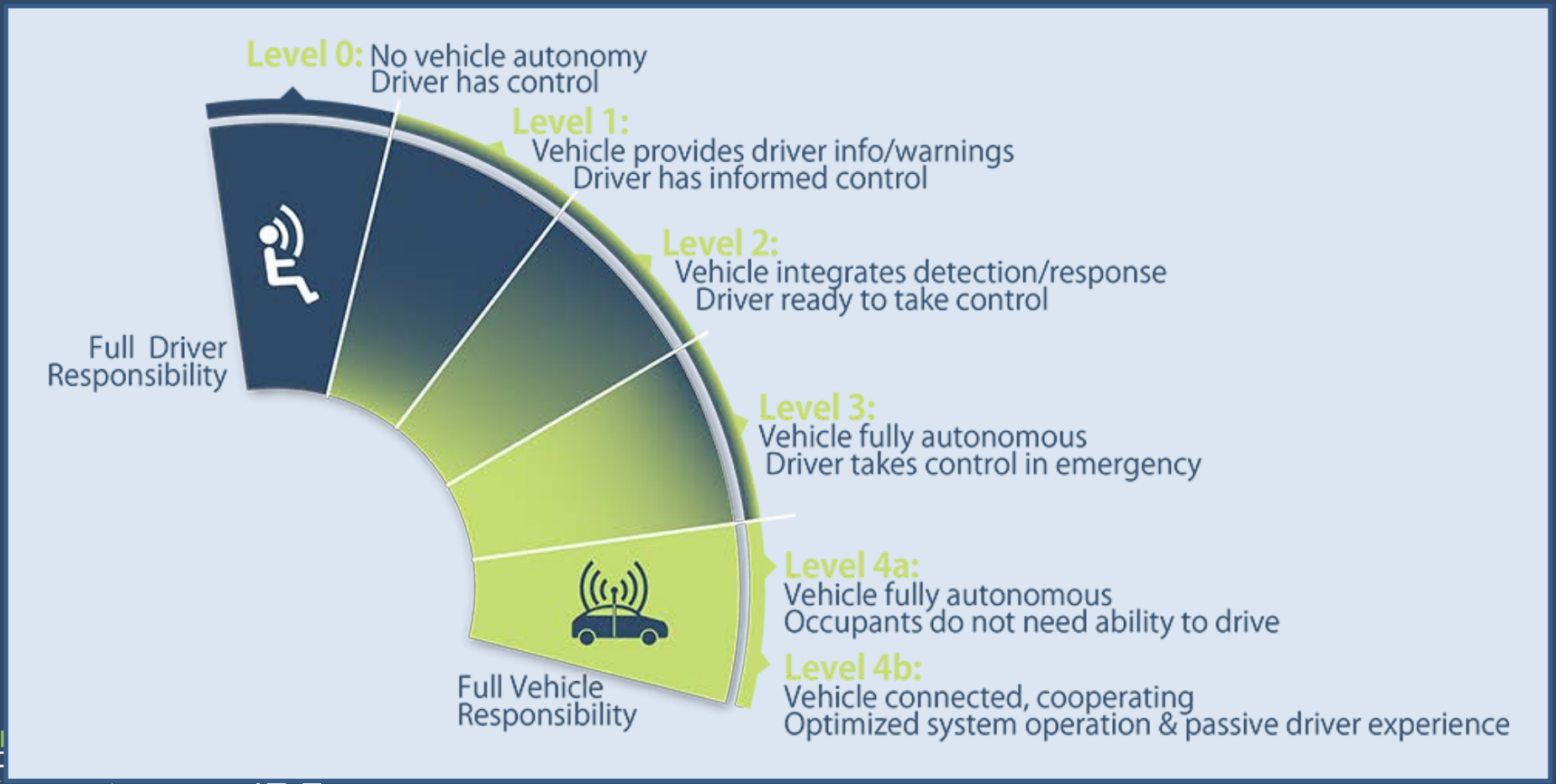


what. ARE WE DOING DIFFERENTLY

- Multiple models
- Broader range of results
- Variations across geographies
- Unbiased results

what WE ASSUMED

- Assumed Level 4, 100% fleet mix



what HAPPENED

What We Did	What We Thought	Results					
Model Test	Professional Perceptions & Expectations	Model A	Model B	Model C	Model D	Model E	Model F
VEHICLE MILES TRAVELED							
Decrease Access Time	Potential effects of Privately-Owned AVs						
Decrease Parking Costs							
Decrease Vehicle Operating Costs							
Decrease Value of Time in Auto							
Increase Auto Availability							
Increase Freeway Capacity							
Increase Non-Work Trip Making							
Increase Vehicle Occupancy	More shared trips results in fewer vehicles and less VMT						
VEHICLE TRIPS							
Decrease Access Time	Potential effects of Autonomous Taxis simultaneously serving multiple trips						
Decrease Parking Costs							
Decrease Vehicle Operating Costs							
Decrease Value of Time in Auto							
Increase Auto Availability							
Increase Freeway Capacity							
Increase Non-Work Trip Making							
Increase Vehicle Occupancy							
TRANSIT TRIPS							
Decrease Access Time	Some mode shift to auto						
Decrease Parking Costs	Some mode shift to auto						
Decrease Vehicle Operating Costs	Some mode shift to auto						
Decrease Value of Time in Auto	Big mode shift to auto						
Increase Auto Availability	People reliant on transit shift to auto						
Increase Freeway Capacity	Some mode shift to auto						
Increase Non-Work Trip Making	More auto and transit trips						
Increase Vehicle Occupancy	Fewer vehicles may induce a small mode shift to auto						

what HAPPENED

Model data available on our website:

http://www.fehrandpeers.com/fpthink/

Cumulative effect of privately-owned autonomous vehicles (100% share):

- 12% to 68% **increase in VMT**
- 2% to 16% **increase in vehicle trips**
- 43% **decrease** to 16% **increase** in transit trips

Cumulative effect of shared autonomous vehicles simultaneously serving multiple trips (50% share):

- 4% to 43% **increase in VMT**
- 1% **increase** to 7% **decrease** in vehicle trips
- 43% **decrease** to 16% **increase** in transit trips

Comparison to other research:

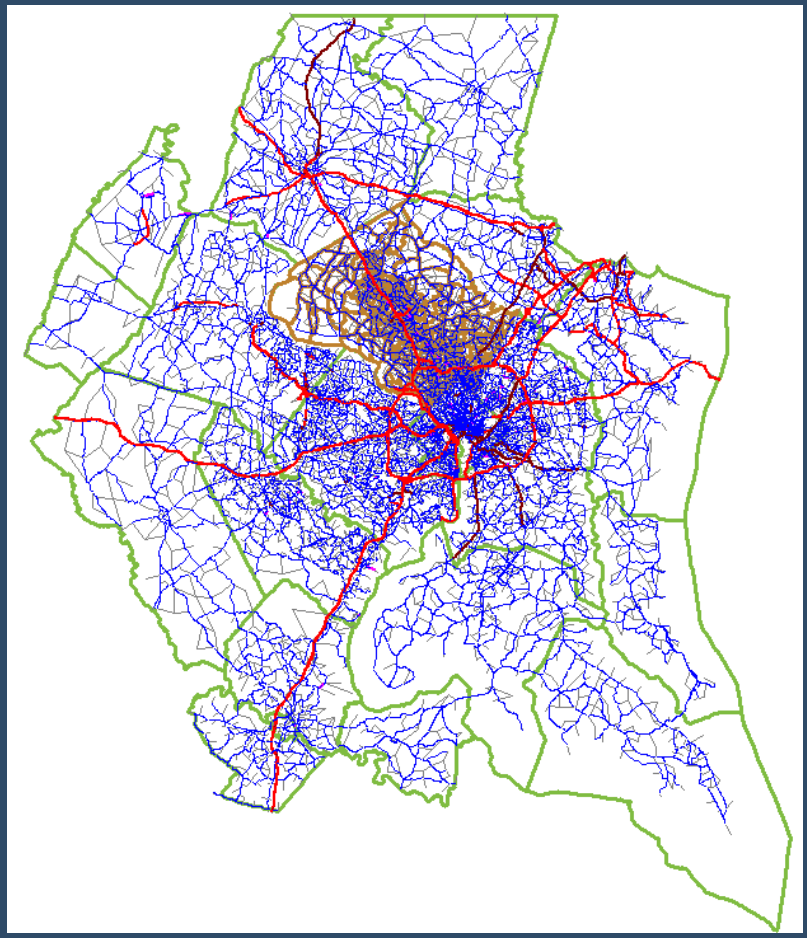
- Study from University of Leeds projected as much as a **60% increase in VMT**
- Study by the Atlanta Regional Commission predicted a **decrease in public transit trips by as much as 42%**

what. WERE THE KEY FINDINGS

- Future is uncertain and inevitably different
- Current tools are sensitive (but inconsistently so)
- Range of results generally consistent with professional expectations
- Models need to be refined

MWCOG Testing Overview

- Version 2.3.57a
- 2040 Modelling Year (base and future)
- GIS walkability module outputs do not change
- Urban core transit capacity constraint (year 2020) outputs do not change



Sensitivity Tests

1. Decrease access time
2. Decrease parking costs
3. Decrease impact of lost in-auto time
4. Increase auto availability
5. Increase freeway capacity
6. Increase non-work trip-making
7. Increase auto occupancy

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Decrease Access Times

MWCOG TESTING

- Test– set access time for vehicles to zero
- Method – set highway terminal times = 0

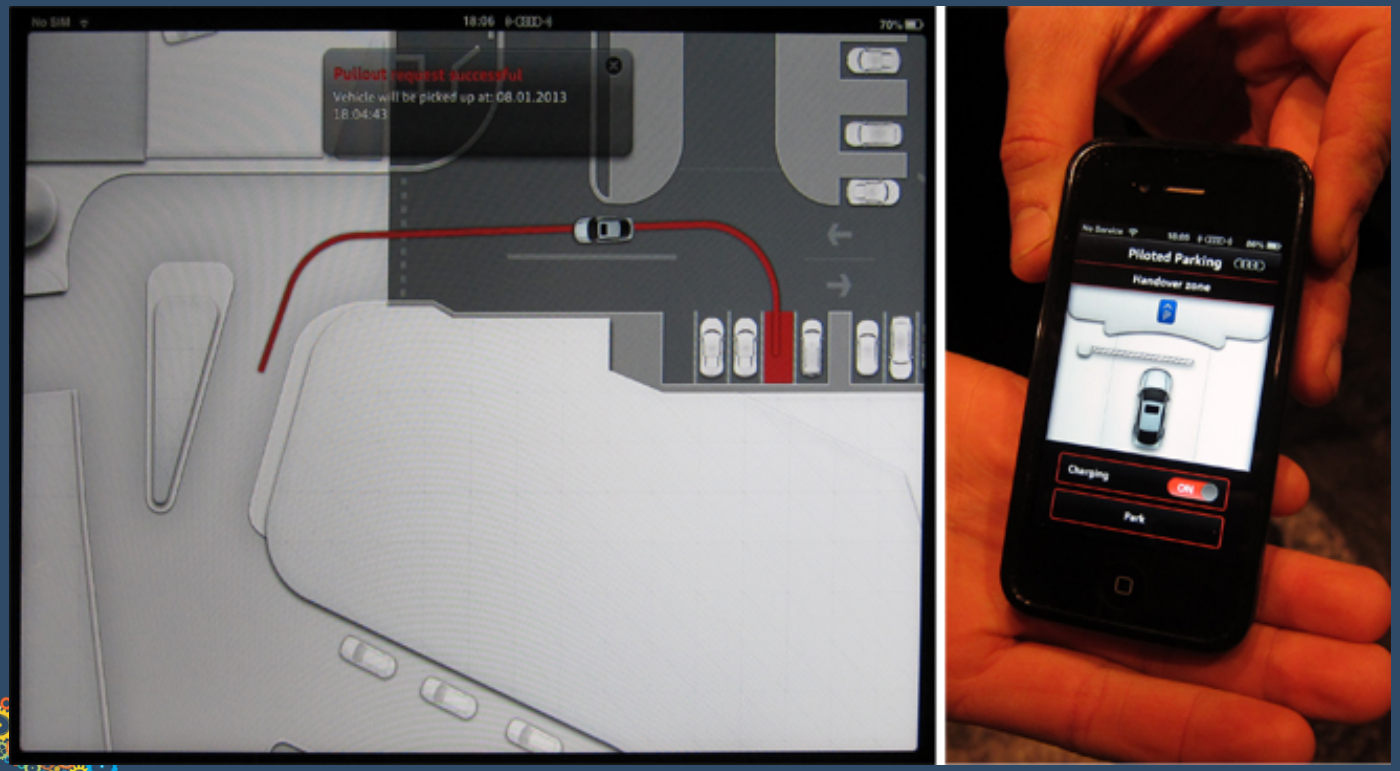

Image Source: Wired
https://www.wired.com/2013/01/ces-2013-audi-self-parking/

Decrease Access Times

MWCOG TESTING

- Test – set access time for vehicles to zero
- Expectation – some mode shift to auto

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	0.5%	-0.7%	1.4%	-5.8%	-	-	-
Vehicle Trip Growth	0.9%	0.0%	1.7%	0.1%	-	-	-
Transit Trip Growth	-15.3%	-4.3%	-10.4%	-14.9%	-	-	-

Decrease Parking Costs

MWCOG TESTING

- **Test** – halve all auto trip parking costs (no capacity constraint)
- **Method** – halve highway parking costs in every area type

Image Source: Futureuta
http://futureuta.blogspot.com/2014/10/how-self-driving-cars-will-change-world.html

Image Source: Arrowstreet Architects
http://www.arrowstreet.com/2016/03/the-self-driving-car-could-eliminate-the-parking-garage/

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Decrease Parking Costs

MWCOG TESTING

- Test – halve all auto trip parking costs (no capacity constraint)
- Expectation – some mode shift to auto

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	1.1%	0.1%	1.0%	0.0%	-0.1%	14.6%	0.1%
Vehicle Trip Growth	2.8%	0.2%	0.4%	0.0%	1.0%	2.4%	0.1%
Transit Trip Growth	-7.0%	-5.0%	-3.2%	-0.3%	-1.0%	-11.5%	-4.1%

Decrease Impact of Lost Auto Travel Time

MWCOG TESTING

- Test – halve perceived time spent in auto
- Method – modify skim tables to half congested time cost

Advertisement from 1957 for "America's Independent Electric Light and Power Companies"

Image Source: Rinspeed. (2014). "XchangE" http://www.rinspeed.eu/aktuelles.php?aid=14

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Decrease Impact of Lost Auto Travel Time

MWCOG TESTING

- Test – halve perceived time spent in auto
- Expectation – significant mode shift to auto

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	25.8%	1.8%	39.3%	41.4%	-	1.4%	9.1%
Vehicle Trip Growth	4.5%	0.6%	3.7%	2.4%	-	0.0%	1.2%
Transit Trip Growth	-1.8%	-10.8%	0.3%	-18.9%	-	0.0%	-24.6%

Increase Auto Availability

MWCOG TESTING

- Test – all households have access to at least one vehicle
- Method – modify vehicle availability coefficients to eliminate zero auto households

Image Source: BMW Blog
http://www.bmwblog.com/2011/03/21/bmw-and-sixt-establish-drivenow-joint-venture-for-premium-car-sharing/

Increase Auto Availability

MWCOG TESTING

- Test – all households have access to at least one vehicle
- Expectation – those reliant on transit shift to auto

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	0.5%	0.7%	0.5%	0.7%	-	-	-
Vehicle Trip Growth	1.3%	1.1%	1.3%	2.8%	-	-	-
Transit Trip Growth	3.5%	-23.9%	-6.3%	-31.2%	-	-	-

Increase Freeway Capacity

MWCOG TESTING

- Test – increase freeway capacity to 3,300 vphpl
- Method – modify roadway capacity reference file

Image Source: USDOT
http://www.its.dot.gov/communications/image_gallery/image14.htm

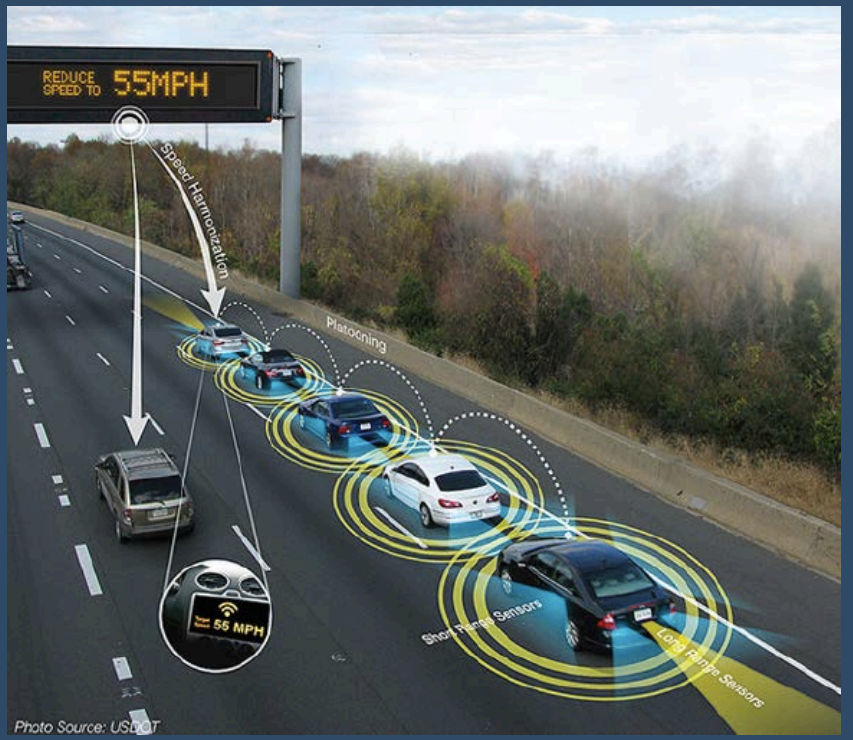

Image Source: USDOT
http://www.its.dot.gov/communications/image_gallery/image36.htm/

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Increase Freeway Capacity

MWCOG TESTING

- **Test** – increase freeway capacity to 3,300 vphpl
- **Expectation** – longer trips; some mode shift to auto

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	4.5%	5.8%	-0.5%	3.6%	2.0%	3.6%	3.6%
Vehicle Trip Growth	0.0%	0.4%	0.0%	0.5%	1.0%	2.4%	0.8%
Transit Trip Growth	-3.6%	-0.7%	0.0%	-1.6%	1.0%	3.8%	-1.1%

Increase Non-work Trips

MWCOG TESTING

- **Test** – increase non-work trip making by 25%
- **Method** – multiply motorized non-work productions and attractions by 1.25

Image Source: Taxi Intelligence
http://www.taxiintelligence.com/google-thinks-self-driving-cars-will-be-great-for-stranded-seniors-baby-boomers-want-mobility/

Image Source: DVZ
http://www.dvz.de/rubriken/logistik-verlader/single-view/nachricht/automobilwelt-erlebt-umbruch.html

Increase Nonwork Trips

MWCOG TESTING

- Test – increase non-work trip making by 25%
- Expectation – more auto and transit trips

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	5.2%	7.5%	8.7%	15.5%	10.0%	-	-
Vehicle Trip Growth	13.2%	12.3%	15.1%	20.8%	15.0%	-	-
Transit Trip Growth	6.2%	9.2%	10.3%	10.1%	5.0%	-	-

Increase Auto Occupancies

MWCOG TESTING

- **Test** – double average vehicle occupancy rate
- **Method** –Convert half of drive-alone vehicle trips to HOV 2 vehicle trips. Produce trip table inputs that are used for the assignment process.

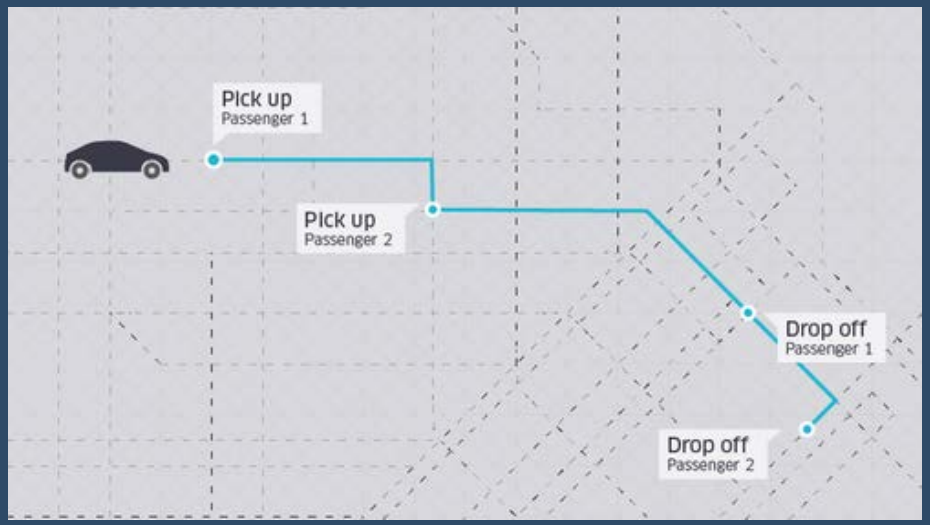

Image Source: uber
http://ubermovement.com/uberpool/

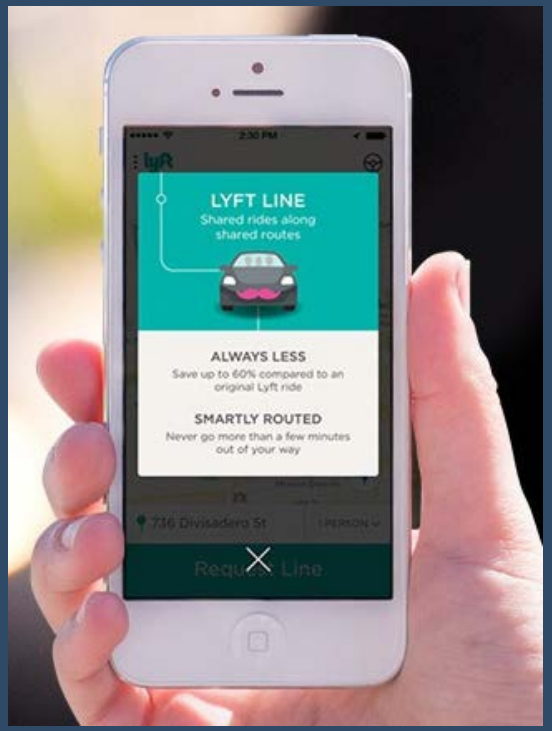

Image Source: Tech Crunch
https://techcrunch.com/2014/08/06/lyft-line/

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Increase Auto Occupancies

MWCOG TESTING

- Test – double average vehicle occupancy rate
- Expectation – fewer vehicles and less VMT

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	-6.2%	-10.7%	-21.5%	-14.5%	-	-	-
Vehicle Trip Growth	-13.1%	-11.8%	-21.9%	-22.3%	-	-	-
Transit Trip Growth	-4.7%	0.0%	0.0%	0.0%	-	-	-

Cumulative Effect (Private)

MWCOG TESTING

- Test – run 6 sensitivity tests together, no auto occupancy test
- Expectation – big increase to auto trips and VMT; transit mode shift

PRIVATE OWNERSHIP TESTING RESULTS

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	46.9%	16.5%	45.8%	67.6%	12.0%	19.6%	23.9%
Vehicle Trip Growth	24.6%	15.0%	19.4%	26.4%	16.0%	2.5%	2.6%
Transit Trip Growth	-26.0%	-38.9%	15.8%	-42.9%	5.0%	-7.7%	-42.4%

Cumulative Effect (Shared)

MWCOG TESTING

- Test – run all 7 sensitivity tests together
- Expectation – less increase in VMT and auto trips compared to 6 test run

SUBSCRIPTION/SHARED TESTING RESULTS

Measure	MWCOG	Mountain State Regional Model	Bay Area Model	California Central Valley Model	Southern California Model	Puget Sound Regional Council AB Model	Atlanta Regional Commission Model
VMT	26.7%	3.6%	16.3%	42.6%	-	-	-
Vehicle Trip Growth	5.2%	0.9%	-6.6%	-1.7%	-	-	-
Transit Trip Growth	-19.8%	-38.9%	15.8%	-42.9%	-	-	-

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