Parking: Are we overbuilding for the future?
May 4, 2015

Self-Driving Cars:
A primer on current knowledge

Urban Land Institute
Indiana
It’s 2015…..what does Doc Brown actually see?

Lots of talk about autonomous cars and the impact on parking
What’s a self driving or autonomous car?

Five levels of vehicle automation per National Highway Traffic Safety Administration (NHTSA)

0 - No-Automation: Driver in complete and sole control.

1 - Function-Specific Automation: One or more specific control functions.

2 - Combined Function Automation: At least two control functions work in unison to take over those functions.

3 - Limited Self-Driving Automation: Driver cedes full control but is expected to be available for occasional control. The Google car is currently level 3.

4 - Full Self-Driving Automation: Vehicle performs all driving functions and monitor roadway conditions for an entire trip. Driver provides destination or navigation input, but is not in control at any time during the trip. Can be occupied or unoccupied.

Source:
http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development
Mercedes Concept Car Shown at Consumer Electronics Show 1/2015

Photo by Associated Press
Industry Consensus...Right Now

- Self-Driving Cars will be safer than human drivers
- Level 3 Self-driving cars will be available for purchase by 2020.
- Eventually all cars will be capable of level 4, 100% self-driving
  - Most aggressive: all new cars sold in 2030
  - Most conservative: by 2040
- One of the biggest impacts will be on parking
  - Shoup¹: average car is parked 95% of the time
  - British Study²: parked 96.5% of the time

¹ Donald Shoup, The High Cost of Free Parking. Based on USDOT 1995 Nationwide Personal Travel Survey but with some assumptions to convert person trips to cars moving or parked

² http://www.racfoundation.org/research/mobility/spaced-out-perspectives-on-parking#sthash.uLEQRCTk.dpuf Based on similar personal transportation data in UK.
Safer than human drivers?

The absolute consensus of safety experts is autonomous cars WILL be safer, save lives, prevent injuries and significantly reduce property damage.

- **2013¹:**
  - 31% of crashes with fatalities: at least one driver legally DUI
    - 61% of those crashes involved BAC > 0.15

- **Causative factors in detailed study of 2005-7 crash data²:**
  - “Most” critical factor in 94% was driver error
    - Recognition errors 41%
    - Decision errors 33%
    - Performance errors 11%

So.....audience poll: autonomous cars will be better at

- Recognition errors
- Decision errors
- Performance errors
Potential users of autonomous cars

✓ Young urban dwellers... okay, all urban dwellers... can text and drive safely!
✓ Commuters: Similar to rail but door to door
✓ Aging baby boomers and disabled: able to retain independence and mobility, again door to door
✓ In fact, transit systems can use for cost-effective dial a ride service for these groups

Image courtesy KPMG
There certainly is a lot yet to do:

- **Technology:**
  - Biggest problems are construction (not on gps/maps), and weather issues, especially snow
  - Expected to be good enough for 100% self-driving for individual trips by 2020 (but not optimum until infrastructure catches up)

- **Insurance:**
  - In early years, who is at fault for accidents? Manufacturer?

- **Security:** hackers, terrorists

- **Legal:** The biggest question, really
  - When will US allow cars to be driving around without any occupants?
Two studies that it can have a big impact without making predictions of realistic penetration or when

Both using National Household Travel Survey data:

- University of Michigan’s Transportation Research Institute
  - Focused on potential for households to reduce auto ownership
- Columbia University’s Earth Institute
  - Focused on potential for subscription driverless cars aka Uber married to google car*
University of Michigan

- One car can shuttle for all daily family trips
- **Most** optimistic ultimate scenario: decline in cars per household from 2.1 today to 1.2, a reduction of 43%
  - Not a prediction, but calculation of lowest possible based on household trip data
  - Nationwide; lower urban, higher rural

*impacts residential parking as well as commuter and other parking*

1 [http://www.umtri.umich.edu/what-were-doing/news/driverless-vehicles-fewer-cars-more-miles](http://www.umtri.umich.edu/what-were-doing/news/driverless-vehicles-fewer-cars-more-miles)
Ann Arbor MI can support fleet of 18,000 subscription cars to replace cars used…and parked… by 120,000 people (1:15) that’s an 85% reduction in cars, with big impact on all parking.

Ann Arbor Case Study

Personal travel costs can be dramatically reduced using shared, driverless fleets

- A shared, driverless vehicle fleet can provide the same mobility as personally owned vehicles at far less cost
- Cost/trip-mile could be reduced by 80% compared to a personally owned vehicle driven 10,000 miles/yr
- Reduced parking costs and the value of time not spent driving would further increase these benefits

Top ten consulting firms have weighed in: and nearly all mention parking (√) as particularly affected

<table>
<thead>
<tr>
<th>1</th>
<th>McKinsey</th>
<th>Space needed for parking will be reduced by 25%, largely because cars can be parked even tighter than valet.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>The Boston Consulting Group</td>
<td>“.. improving urban land use as parking infrastructure is repurposed or replaced.”</td>
</tr>
<tr>
<td>3</td>
<td>Bain &amp; Company</td>
<td>First sentence: Intelligent cars that drive and park themselves.</td>
</tr>
<tr>
<td>4</td>
<td>Deloitte Consulting</td>
<td>2014 global consumer survey: positive opinion on benefits today 41% of Gen Y vs 31% of rest.</td>
</tr>
<tr>
<td>5</td>
<td>Strategy&amp;</td>
<td>Market potential of connected and driverless cars to quadruple by 2020</td>
</tr>
<tr>
<td>6</td>
<td>Booz &amp; Hamilton</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Price Waterhouse Coopers</td>
<td>Up to 90% reduction in auto fleet, parking, accidents, etc.</td>
</tr>
<tr>
<td>8</td>
<td>Ernst and Young</td>
<td>Parking is the first area where 100% self-driving facilities will be deployed</td>
</tr>
<tr>
<td>9</td>
<td>Accenture</td>
<td>Subscription cars will have big impact on parking demand</td>
</tr>
<tr>
<td>10</td>
<td>KPMG</td>
<td>Subscription cars will be the game changer</td>
</tr>
</tbody>
</table>
Per Ernst and Young... the first deployment that will happen

Deployment scenarios that support increasing automation of driving

As the benefits outweigh the costs, and liability, safety and security concerns are addressed, these controlled scenarios will expand and merge across vast urban areas and eventually integrating inter-city mobility as well.

Evolving levels of driver control, vehicle autonomy and connectivity

BCG: another study of cost per mile:

Source: https://www.bcgperspectives.com/content/articles/automotive_consumer_insight_robo-taxis_new_mobility/
The big question: Not if but when?

Stages per KPMG (paraphrased):
1 – Technology Advances from level 3 to level 4
2 – Early adopters purchase and use at level 4 (if permitted)
3 – Mainstream adoption
4 – Ultimate penetration

One extreme: destruction of auto industry as we know it

- Most new cars fully autonomous by 2025, all new 2030
- Shift to subscription driverless cars
- Auto sales in US will plummet from 16 million today to 3 million a year (by 2025!)
- Will result in loss of 10 million jobs

Okay so he is an anti-car blogger, but he is getting quoted!

Most of that blogger’s opinion appears to be based on Price Waterhouse Coopers\(^1\)

### 90% estimated ultimate benefit of autonomous cars

Source: Google, NHTSA, 2012 TTA Urban Transportation Mobility Report, US DOT

<table>
<thead>
<tr>
<th>Category</th>
<th>Reduction</th>
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</thead>
<tbody>
<tr>
<td>Traffic Accidents</td>
<td>1.8 million</td>
</tr>
<tr>
<td>Commute time and energy</td>
<td>1.9 billion gallons</td>
</tr>
<tr>
<td>Vehicle Fleet</td>
<td>2.4 million</td>
</tr>
</tbody>
</table>

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<th>Traffic Accidents</th>
<th>10.8 million</th>
<th>Commute time and energy</th>
<th>1.9 billion gallons</th>
<th>Vehicle Fleet</th>
<th>245 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>But reportedly it was presented at Detroit Chamber of Commerce as wake up call to industry to not let google, Tesla etc get too far ahead</td>
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<td></td>
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<td></td>
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</table>

\(^1\)“Look Mom, no hands” Autofacts, a Price Waterhouse Coopers auto industry newsletter, February 2013
The opposite opinion: Won’t happen fast and not fully

Problems:
• Too many legal, technical, insurance issues.
• New car costs too much until at least 2040 and maybe 2060
• Subscription model won’t happen because it will cost too much
• Full benefit in early years requires prohibiting other cars in lanes, similar to SOV.
• It takes 30-50 years for new “proven” technology in auto industry to be widely accepted, so not until after 2040
• Allowing completely passenger-less cars adds rather than reduces traffic (empty trips home, between trips, etc)

Advantages:
• Could help “last mile trips” between home/destination and transit
• Beneficial impact on parking

Okay so this guy (Todd Littman) could be considered pro-transit, but he is widely quoted and respected in transportation circles!

1 Todd Litman Victoria Transport Policy Institute http://www.vtpi.org/avip.pdf
More Concerns:

• With subscription model
  – Difficulty cleaning cars between use
  – Need to go to home base to recharge batteries
  – Cars require more frequent maintenance and replacement

• In general
  – Americans love their cars and won’t give them up
  – What happens when it can’t figure out what to do?
  – Will it have to be nearly flawless to be widely accepted?

• People are much more forgiving of human errors than technology errors (per Bill Gurley, Uber board member)
Uber and Lyft are proving that change can happen fast

- Uber X in Chicago is now 90 cents/mile…with paid driver
  - vs 57.5 cents/mile per IRS business use of private vehicle
- SF reports average monthly trips per taxi dropped from 1424 in 2012 to 504 in July 2014, a drop of 63%.¹
- As of November 2014, average price of taxi medallion in New York City has declined 20% from June 2013.²
  - Companies that specialize in financing medallions are turning to other markets because this one is risky NOW

¹ http://time.com/money/3397919/uber-taxis-san-francisco/
² http://www.nytimes.com/2014/12/03/upshot/new-york-taxi-medallion-prices-fall-again.html?_r=0&abt=0002&abg=1
Morgan Stanley analyst note to investors:

• 1 year ago: Uber/Lyft will move to subscription driverless car model in 15 to 20 years
  – Would supplant private ownership of cars
  – Significantly disrupt auto industry
• In February 2015, Uber endowed chairs to support autonomous research at Carnegie Melon (Pittsburgh)
• MS analyst then issued note: Uber-CMU collaboration happened five years earlier than expected.¹
• Before announcement, Pennsylvania regulators gave Uber provisional license to operate anywhere in PA except Philly

¹http://www.huffingtonpost.com/2015/02/03/uber-driverless-cars_n_6602782.html
Car sales can also change fast and have huge impact on auto industry

Recession of 2007-8: 37.5% decrease in 2 years... nearly bankrupted US auto industry

Percent of “small car” sales jumped from 20% to 50% in 2 years after Arab Oil Embargo, and caused substantial shift to foreign imports.

While only 15 to 20 % changes, other shifts occurred over 3 to 5 years
Will it impact Indy Connect?

<table>
<thead>
<tr>
<th>Miles 1 way (1)</th>
<th>Cost per Mile</th>
<th>Cost 2025 @ 2% inflation</th>
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<tbody>
<tr>
<td>Airport to Circle</td>
<td>14 $</td>
<td>17.69 $</td>
</tr>
<tr>
<td>Fishers to Circle</td>
<td>16.5 $</td>
<td>10.03 $</td>
</tr>
<tr>
<td>Carmel to Circle</td>
<td>15.5 $</td>
<td>3.01 $</td>
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<table>
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<tr>
<th>Miles 1 way (2)</th>
<th>Cost per Mile</th>
<th>Cost 2025 @ 2% inflation</th>
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<tr>
<td>Airport to Circle</td>
<td>12.60 $</td>
<td>10.03 $</td>
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<tr>
<td>Fishers to Circle</td>
<td>14.85 $</td>
<td>3.01 $</td>
</tr>
<tr>
<td>Carmel to Circle</td>
<td>13.95 $</td>
<td>3.01 $</td>
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<table>
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<tr>
<th>Miles 1 way (3)</th>
<th>Cost per Mile</th>
<th>Cost 2025 @ 2% inflation</th>
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<tbody>
<tr>
<td>Airport to Circle</td>
<td>7.00 $</td>
<td>17.69 $</td>
</tr>
<tr>
<td>Fishers to Circle</td>
<td>8.25 $</td>
<td>10.03 $</td>
</tr>
<tr>
<td>Carmel to Circle</td>
<td>7.75 $</td>
<td>3.01 $</td>
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<table>
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<tr>
<th>Miles 1 way (4)</th>
<th>Cost per Mile</th>
<th>Cost 2025 @ 2% inflation</th>
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</thead>
<tbody>
<tr>
<td>Airport to Circle</td>
<td>2.10 $</td>
<td>17.69 $</td>
</tr>
<tr>
<td>Fishers to Circle</td>
<td>2.48 $</td>
<td>10.03 $</td>
</tr>
<tr>
<td>Carmel to Circle</td>
<td>2.33 $</td>
<td>3.01 $</td>
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Trips per day with average 5 mile trip:

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<tr>
<th>Operating cost(5)</th>
<th>72,000</th>
<th>127,100</th>
<th>423,600</th>
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<tbody>
<tr>
<td>Excludes 1.3 billion capital cost</td>
<td></td>
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</tbody>
</table>

1 Per Mapquest
2 Uber X Chicago, 2014
3 Columbia Study, 2012 dollars, Shared Driverless Vehicles todays vehicles
4 Columbia Study, 2012 dollars, Shared Driverless Vehicles specialty vehicle
5 [http://www.indyconnect.org/pages/Plan-Funding/](http://www.indyconnect.org/pages/Plan-Funding/)
To conclude:

Any one scenario is probably not 100% right or wrong

but clearly change is coming

So let’s talk about parking....
And... in honor of Star Wars Day

MAY THE FOURTH BE WITH YOU