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METRIC ENGINEERING

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PLATINUM SPONSORS

CUTR

UBER
AVs ARE HERE IF YOU SQUINT
MISSION

Support the entrepreneurs building the future of transportation
TRUCKS PORTFOLIO

AEYE
Aurora LABS
NAUTO
QUADRIC
ROADSTER
WISE SYSTEMS
APERIA TECHNOLOGIES
BEAR FLAG ROBOTICS
NuTonomy
ORYX VISION
STARSKY ROBOTICS
ARRIVO
MAY MOBILITY
DIATOM ROBOTICS
POLYSYNC
SKYRYSE
ZENDRIVE
WHERE ARE AVs?
WHERE ARE AVs?

R&D
| R&D | ADVANCED ENGINEERING | WHERE ARE AVs? |
WHERE ARE AVs?

R&D

ADVANCED ENGINEERING

PRODUCTION
GLOBAL FLEET

Source: McKinsey 2017 DT report, Trucks research
Source: McKinsey 2017 DT report, Trucks research
GLOBAL FLEET

Source: McKinsey 2017 DT report, Trucks research
WHAT SERVICE?
WHAT SERVICE?

UN-STRUCTURED
WHAT SERVICE?

UN-STRUCTURED

STRUCTURED
WHAT SERVICE?

UN-STRUCTURED

- Takes longer to get right
- FMVSS vehicles
- More exp

STRUCTURED

- Smaller coverage
- Faster leadership
- Lighter, cheaper vehicles
- Less exp
WHAT SERVICE?

UN-STRUCTURED

STRUCTURED
WHAT SERVICE?
WHAT SERVICE?

TELE-OPERATION
RIDE-HAILING, THEN AV

37% CITE PARKING AS TOP REASON FOR USING RIDE-HAILING

Source: UC Davis Institute of Transportation Studies, Oct 2017
RIDE-HAILING, THEN AV 49% OF TRIPS WOULD NOT HAVE BEEN MADE AT ALL, OR BIKE/TRANSIT

Source: UC Davis Institute of Transportation Studies, Oct 2017
RIDE-HAILING, THEN AV

9% USERS ELIMINATED A PERSONAL VEHICLE

Source: UC Davis Institute of Transportation Studies, Oct 2017
RIDE-HAILING, THEN AV 5700 TNC VEHICLES
AT PEAK 20% OF ALL SF VMT
THEREFORE 25% OF ALL SF TRIPS

Source: SFMTA TNC Network Activity Report 6-20-17
Advanced Technologies Group

Florida AV Conference
Alden Woodrow, Self-Driving Trucks Product Lead
November 14, 2017
Save lives
Save time and money
Improve livelihoods
“Self-Driving Trucks Are Going to Kill Jobs, And Not Just for Drivers”

“End of the Road: Will Automation Put and End to the American Trucker?”

“Truck Driving Jobs Could Be The First Casualty of Self-Driving Cars”

“Self-Driving Trucks: Are Truckers Out of a Job?”

“Robots Could Replace 1.7 Million American Truckers in the Next Decade”

“Self-Driving Trucks Are Going to Hit Us Like a Human-Driven Truck”
Thank you
The Trustworthy Automated Driving Provider

Bryant Walker Smith
Assistant Professor
University of South Carolina School of Law
and (by courtesy) School of Engineering
Affiliate Scholar
Center for Internet and Society at Stanford Law School
Adjunct Clinical Professor
University of Michigan Law School

law of the
newly
Possible
newlypossible.org
The Victor "Flyer" of 1893.
Facebook said in a comment to *The Verge*: ‘People often use Facebook to make plans with friends. So, we’re running a very small test in the Facebook app to make that easier. We look forward to hearing people’s feedback.’ The test appears to be running in New Zealand and Toronto.”
Elon Musk
@elonmusk

Thanks. Point of calling it "beta" was to emphasize to those who chose to use it that it wasn't perfect.

10:44 AM - 10 Jul 2016

"Wenn mit der Bezeichnung ,Beta-Version’ ein ,unfertiger’ Stand der Software gemeint ist, würde das KBA eine Funktionalität mit einer derartigen Software nicht genehmigen“

"Contrary to what Tesla represented to them, buyers of affected vehicles have become beta testers of half-baked software that renders Tesla vehicles dangerous if engaged.”

https://twitter.com/elonmusk/status/752196881871040512
The trustworthy company

• Markets only what it believes reasonably safe
• Bases its belief on compelling evidence
• Updates that evidence over entire lifecycle
• Acts in response to those updates
• Mitigates harm in the case of failure
• Communicates candidly with the public
The challenge

- **Product characteristics**
  - Diverse, complex, dynamic, part of larger systems, and service-oriented

- **Regulatory capacity**
  - Limited resources, legacy expertise, slow processes

- **Public expectations**
  - Fickle and misinformed....
Why do we regulate?

To correct market failures

- Safety: System developers lack incentives to act reasonably safely
- Trust: Public lacks resources to decide if something is reasonably safe
Regulation is imperfect

<table>
<thead>
<tr>
<th>Imperfection advantages innovation</th>
<th>Imperfection disadvantages innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation ameliorates imperfection</td>
<td>Innovation exacerbates imperfection</td>
</tr>
</tbody>
</table>
How safe?

• We don’t actually know – and this is normal
• No system is absolutely safe
• No system that encompasses a human user is functionally deterministic
• We expect a product to be safer than the one that just caused harm
Space for *technical* innovation

- Technologies, applications, business cases
- Governments don’t design motor vehicles
- Governments shouldn’t pick technological winners and losers
Space for regulatory innovation

- Safety assessment is also a subject of innovation!
- Empirics may not resolve philosophical debates
- Cost of safety assessment offers economic incentives for innovation
- Not as sexy as innovation in consumer products – but as important and potentially as diverse
How do we get there?

- **Goal: Deserved trust!**
- My public safety case
- NHTSA’s exemption process
- NHTSA’s safety assessment letters
- Congress’s safety evaluation reports
- What about the states?
Toward a model state law

• Necessary? Useful? Timely?
• Do something / Do nothing / Do only this
• Be thoughtful!
• Uniform Law Commission’s Highly Automated Vehicle Drafting Committee: Meeting on December 1-2, 2017 in Chicago
Automated driving provider

• The legal subject of the vehicle code
• Self-identifies as a condition of vehicle registration
• Could be the manufacturer, developer, retrofitter, owner, operator, insurer....
• The person that expressly warrants the automated operation of an automated vehicle to be reasonably safe
The promise

Registration of an automated vehicle may be granted, maintained, and renewed only if, by means of a current electronic record automatically retrievable by any participating agency, an automated driving provider:

• describes the capabilities and limitations of the vehicle’s automated driving system;
• provides proof of automated operation insurance for the vehicle;
• represents to each participating agency that it believes the automated operation of such vehicle to be reasonably safe;
• represents to each participating agency that clear and convincing evidence supports such belief;
• warrants to the public that the automated operation of such vehicle is reasonably safe....
The trustworthy company

- Markets only what it believes reasonably safe
- Bases its belief on compelling evidence
- Updates that evidence over entire lifecycle
- Acts in response to those updates
- Mitigates harm in the case of failure
- Communicates candidly with the public
Florida AV Summit

November 14, 2017

Mike Scrudato, CPCU, ARe
SVP, Strategic Innovation Leader - Mobility Domain
Munich Reinsurance America, Inc.
Insurance is not a barrier
Why Munich Re cares about autonomous vehicles
In 2016 in the US

Over 90% of vehicle accidents are attributed to human error

- $432.5* billion crashes (12% increase)
- 4.6 million injuries (7% increase)
- 40,200 fatalities (6% increase)
- 4,067** fatalities involving trucks

*cost of motor-vehicle deaths, injuries and property damage
**2015 statistic

Mobility

- 31% of disabled people report insufficient access to transportation
- Underserved markets such as disabled or low-income persons – unprecedented access to transportation
- Aging baby-boomer population able to keep independence
- Disabled advocates major voice in passing legislation to allow autonomous vehicles
Environment

- Increase in comfort with shared mobility (pooling), and electrification of cars has the potential to dramatically reduce emissions
- AV could accelerate the adoption of electric vehicles
- Does charging time matter when a vehicle self-charges?
- Cars could be programmed for optimal fuel efficiency – 10% improvement expected

Source: The Fuse, Autonomous vehicles to bring sweeping energy, environmental impacts, 06/15/16, Scientific American, Driverless cars may slow pollution, 01/19/16, Carnegie Mellon, Fuel economy testing of autonomous vehicles, December 2015,
Societal impact

Many jobs and industries will need to pivot and some will cease to exist.

New revenue opportunities will favor those companies that pivot to meet customer demand.

New industries and jobs will be created.

Driving Related Jobs by Industry

Insurance impacts of autonomous vehicles
### Potential shifts in liabilities and premiums

<table>
<thead>
<tr>
<th>Category</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto liability</td>
<td>Likely to shrink</td>
</tr>
<tr>
<td>Cyber risk tech E&amp;O/IoT</td>
<td>Likely to increase</td>
</tr>
<tr>
<td>Products liability</td>
<td>Likely to increase</td>
</tr>
<tr>
<td>Auto physical damage</td>
<td>Likely no material change</td>
</tr>
<tr>
<td>Equipment breakdown/warranty</td>
<td>Likely to increase</td>
</tr>
<tr>
<td>Product recall</td>
<td>Likely to increase</td>
</tr>
</tbody>
</table>

**Transition to full vehicle autonomy**

Varying degrees of impact over time
Looking ahead

- Liability shifts from driver to manufacturers and technology companies
- Auto physical damage, cyber, products warranty may grow
- Exposures will be more complex – cyber/software, car manufacturer, driver
- Coverage issues will emerge and take time to evolve and stabilize
- Telematics use will grow – continue the progress towards individual ratemaking
- Insurance industry should understand the issues; be prepared to adjust and innovate
Impact - risk or opportunity?

“If I had asked people what they wanted, they would have said faster horses.” – Henry Ford
Summary

Our journey
I see. I think. I drive. (I learn).

How Deep Learning is revolutionizing the way we interact with our cars.
The Ecosystem is evolving with new power players

Who are the key players?
- Intel Capital
- Andreessen Horwitz
- Kleiner Perkins
- NVIDIA
- Intel/Mobileye
- Google
- Qualcomm
- Microsoft
- Amazon/Alexa
- IBM/Watson
- National Labs
- MIT
- Stanford
- Carnegie Mellon
- Univ of Mich
- VocalZoom
- Proterra
- nuTonomy
- Eyeris
- Bosch
- Visteon
- Delphi
- Magna
- Denso
- Continental
- DOE
- NHTSA, CARB, DOT, FHWA
- EU – CO2
- Japan
- China
- GM ventures
- BMW ventures
- Nissan
- Renault
- Hyundai
- EU
- China
- Japan
- HK
- A

How will the balance of power shift amongst the players?

How and when will investments be made?

What are the competitive strategies?

I see. I think. I drive. I learn.
Understanding Personal Mobility is Critical to Forecasting Change

U.S. personal miles traveled (PMT) per capita 2014–2050 (Kmiles)

Parents can be everywhere at the same time
82% of people asked in focus groups would want mobility options for kids

Safe independence for the kids
Convenience of “my time”
Independence for seniors

“I do not have to take keys away from dad”
79% of people asked in focus groups would want mobility options for seniors

Note: (a) Discounted 25 percent from U.S. Bureau of Transportation Statistics (BTS) total Vehicle-miles traveled (VMT) for 1995, 2001, 2009, 2014 (assumed to be commercial miles), (b) multiplied by NHTS occupancy rates applied 2009 rate to 2014 numbers. Source: U.S. BTS data, NHTS data, U.S. Census data, KPMG Analysis
Personal miles will soar due to the impacts of autonomy

U.S. Personal Miles Traveled (PMT) and Vehicle Miles Traveled (VMT)
1950 – 2040, trillion of miles traveled

Scenario
- PMT grows due to increased mobility at all ages
- PMT grows with the population
- AV AOR is 40% lower than manually driven cars
- AV AOR is 20% lower than manually driven cars
- AV AOR is the same as manually driven cars
- AV AOR is 20% higher than manually driven cars

Insights
1. AV AOR is expected to decrease due to miles travelled without passengers
2. Carpooling and ridesharing trends may put upward pressure on AOR
Islands of Autonomy
Where every mile matters and has revenue potential

Vehicle Miles Traveled by Ownership Type & Mode

- AV MaaS: 20% of the total, with an estimated 2.8 trillion VMTs in 2015, increasing to 4.0 trillion VMTs in 2030.
- AV Personal: 40% of the total, with an estimated 3.2 trillion VMTs in 2015, increasing to 4.0 trillion VMTs in 2030.
- Non-AV Personal Vehicles: 33% of the total, with an estimated 3.0 trillion VMTs in 2015, increasing to 4.3 trillion VMTs in 2030.
- Other(a): 86% of the total, with an estimated 2.8 trillion VMTs in 2015, increasing to 4.0 trillion VMTs in 2030.

Value of Mobility & Connected Services

- Mobility Services: $86 in 2015, $199 in 2020, $537 in 2025, $981 in 2030.
Islands of Autonomy

Sales in the US have likely peaked as a result

VMT grows more rapidly than PMT due to a drop in average occupancy per vehicle

Growth in the car parc declines as AV MaaS vehicles eliminate the need for a portion of personally owned vehicles

Non-autonomous vehicle sales fall, but are replaced by autonomous personal and MaaS vehicles

Source: KPMG Analysis
Note: Passenger vehicle VMT analysis excludes non-MaaS commercial POV

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The future of the automotive industry is bright - but there will be clear winners and losers

Stunning innovation

Complete reshaping of the automotive ecosystem

Great reason for optimism

There has never been a more exciting time to be part of the automotive industry. The future is full of possibilities – and it’s up for grabs!
Conclusion

I see. I think. I drive. I learn.

Deep learning enabled cars only