# **EMERGING ISSUES**

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# **THE FUTURE OF AUTO**

Google



#### **Driverless Cars / Autonomous Vehicles**











### May 18, 2017

### 44 Corporations Working On Autonomous Vehicles

Apple	Ford	Man	SoftBank Group
Audi	GM	Mercedes-Benz	TATA ELXSI
Autoliv	Honda	Microsoft	Tesla
Baidu	Huawei	Mobileye	Toyota
BMW	Hyundai	Nissan	Valeo
Bosch	Intel	Renault	Volkswagen
DAF	IVECO	Nvidia	Volvo
Daimler	Jaguar	PACCAR	Waymo
Delphi	Land Rover	PSA Groupe	Yutong
DiDi	Lyft	Samsung	
FCA	Magna	Scania	

Source: CBINSIGHTS



#### Notable Acquisitions in the Autonomous Vehicle Space

Company Name	Company Acquired	Deal Value	Closing Date
Intel	Mobileye	\$15.3 Billion	8/2017
Uber	Otto	\$680 Million	8/2016
Verizon	Telogis	\$900 Million	7/2016
Intel	ltseez	Undisclosed	5/2016
General Motors	Cruise Automation	\$581 Million	5/2016
Lear Corporation	Arada Systems	Undisclosed	11/2015
Freescale	CogniVue	Undisclosed	9/2015
Delphi	Ottomatika	\$35 Million	7/2015
Ambarella	VisLab	\$30 Million	7/2015
Delphi	Nutonomy	\$450 Million	10/2017

Source: KPMG, 6/2017



#### Where are driverless vehicles already on roads?





#### **Autonomous Vehicles Legislation**

According to the National Conference of State Legislatures, self-driving legislation has been adopted in 24 states and Washington, D.C.





#### New State Laws – 2017

- California DMV Officially Propose Autonomous Vehicles Regulations
  - Would allow deployment for public use as opposed to just for testing
  - No longer require a driver behind the wheel
  - Allow deployment of vehicles without steering wheel manual makes or other devices that would allow humans to take control
  - Makes and developers would have to obtain a permit and must meet liability insurance requirements
- Nevada Governor sings law:
  - Allowing operations, including commercial use, of fully autonomous vehicles



#### **Federal Legislation**

## 9/17 – U.S. passes the SELF-DRIVE Act

- Allows more driverless cars on roads
  - 25,000 per manufacturer first year after enactment
  - 100,000 per manufacturer three years after enactment
  - Makers required to develop cybersecurity plans
  - Makers required to develop privacy plan
  - One year after enactment, NHTSA required to issue rule on safety of autonomous vehicles

1/18 – Trump Administration to revisit federal regulations to remove barriers to self-driving vehicles



#### **Driverless Vehicles**

### Makers Taking Four Approaches

- 1. Incremental approach Favored by traditional auto manufacturers
- 2. Ground up to fully autonomous Favored by non-standard manufacturers – Google, Apple
- 3. Secondary market accessories *Turn newer models into driverless vehicles; currently very limited to certain models*
- 4. Consumer DIY



#### **Automated Vehicles**



Source: SAE International



**Driverless Vehicles – Elephant in the Room** 

#### **Tesla Motors**

- Upgraded Model S and Model X enabling autonomous driving on highways – Summer 2015
- Upgrades occurred over the web
- May 2016 Tesla auto pilot has accumulated 130 million miles
- May 2016 Tesla autopilot's first fatality

Some believed this accident would slow down the drive towards fully automated vehicles

According to the head of the NHTSA, "no one incident will derail the Department of Transportation and NHSTA from its mission to improve safety on the roads"



#### **Driverless Vehicles – Elephant in the Room**

#### **Tesla Motors**

- Six month investigation of fatal crash exonerates Tesla's Autopilot
- NHTSA no defect in system
- Autopilot repeatedly warned the human to put his hands on the steering wheel prior to crash
- NHTSA since the addition of Autopilot, crash rate for Tesla's have dropped 40%

#### Subsequently

- NHTSA Tesla system shares some blame
  - System requires driver to place a hand on the wheel periodically doesn't mean driver is actually paying attention
  - System allows driver to use it on roads where use isn't appropriate



#### Autonomous miles driven between disengagements



Source: DMV. Envercore ISI Research.

**Driverless Vehicles** 



# Roadblocks

Technological	Poor Roads	Regulatory Feds v. states
Cost	Acceptance	Liability?



Driverless Vehicles – WHY?

### Human Driving

- 2016 over 40,200 deaths in car accidents and 2.44M injuries
- 2015 35,092 fatalities and 2.34M injuries



### Driverless Vehicles – WHY?

### Driverless Vehicles Predicted to Reduce Frequency and Severity

- Fully autonomous vehicles expected to reduce frequency by 80%–90%
- Eno Center for Transportation
  - If 90% of vehicles were autonomous:
    - 4.2 million accidents would be avoided
    - 21,700 lives saved
  - If 10% of vehicles were autonomous:
    - 211,000 fewer accidents
    - 1,100 lives saved
- 7/17 CEO of Nauto U.S.-based autonomous vehicle tech startup – "some 70% of vehicle loss events will disappear in the course of 10 years"



### Driverless Vehicles – WHEN?

- Deloitte 2015: Transformation of vehicles to disrupt industries beginning in 5–15 years.
- January 2016 GM CEO: "I believe the auto industry will change more in the next 5 to 10 years than it has in the last 50."
- 2016 Fortune: "self-driving car technology is improving so quickly that experts believe that it will be mainstream in five years (by 2021)."



### Driverless Vehicles – WHEN?

- 2017 Garret Galland Research: 10M self-driving cars on roads by 2020. 1 in 4 will be self-driving by 2030; but, *These "estimates (especially the one for 2030) are too conservative..."* –Garret Galland Research
- Former vice chairman and head of product development at GM:

"Vehicles...will no longer be driven by humans because in 15 to 20 years – at the latest – human-driven vehicles will be legislated off the highways."

"Tipping point will come when 20% to 30% of vehicles are fully autonomous."

"The era of the human-driven automobile, its repair facilities its dealerships, the media surrounding it – all will be gone in 20 years."



## Driverless Vehicles – WHEN?

#### **Company Announcements**

- Tesla will be selling fully autonomous cars by 2018
- Audi to launch self-driving car in 2018 able to handle 80% of situations
- GM to launch thousands of driverless Chevy Bolts in 2018
- Apple will be selling fully autonomous cars by 2019
- Ford, Toyota, Alibaba, Baidu, LeEco and Renault-Nissan shooting for 2020
- Nissan to have 10 models with autonomous driving by 2020
- BMW fully autonomous cars available by 2021
- VW Group various level five fully autonomous cars in 2021
- Uber CEO: fully autonomous vehicles by 2028

"This is all coming much faster than people anticipate..." – GM's Exec Chief Engineer



### Driverless Vehicles – WHAT?

Predicted to Reduce Vehicle Ownership By 40%–99%

- University of Michigan's Transportation Research Institute
  - Driverless cars with an unoccupied "return home" feature could reduce vehicle ownership by 43%
- Google driverless cars can reduce the number of cars by 90%
- Barclays Plc driverless cars could reduce vehicle ownership by 40% by 2025
- University of Texas combine Uber with driverless cards and 90% of vehicles unnecessary
- KPMG predicts a reduction in vehicle ownership could be as high as 99%
- PwC predicts vehicle ownership will fall by 99%



**Driverless Cars Predicted to Reduce Vehicle Ownership** 

#### Transportation As A Service (TAAS)

- ABI Research: 400 million people will rely on robotic car sharing by 2030
- 2016 Uber starts driverless ride share in Pittsburgh, PA and Phoenix, AZ
- 2017 Waymo begins driverless ride share in Phoenix, Chandler and Tempe, AZ
- 2017 Lyft begins driverless ride share in Boston



### Driverless Vehicles – WHAT?

Driverless Vehicles Predicted to Reduce Vehicle Ownership Transportation as a Service (TaaS)

- GM to launch driverless ride share service in several U.S. cities in 2019
- Waymo purchase thousands of Chrysler Pacifica Minivans to launch its own ride-sharing service
- Car sharing businesses in addition to ride sharing businesses
  - ReachNow BMW

- Maven – GM

- Car2Go – Daimler

- Chariot Shuttle – Ford



### Driverless Vehicles – WHAT?

Driverless Vehicles Predicted to Reduce Vehicle Ownership Transportation as a Service (TaaS)

- Univ. of Calif. Berkeley 2010
  - Concluded that each shared vehicle replaces 9–13 privately owned vehicles
- Alix Partners 2014
  - Concluded that each car sharing vehicle resulted in 32 vehicle purchases avoided
- Lyft's president...car ownership in cities will "all but end" by 2025



**Driverless Vehicles – WHAT?** 

Predicted to Reduce Industry Auto Premium

- KPMG 2015 auto insurance sector to shrink by 71% (\$137B) by 2050
- KPMG 2015 "While a 50% reduction in premium may not be realistic in the near term, a major correction in premiums must eventually follow the fall in losses."
- Celent 2015 driverless cars could reduce auto premium by between 30%–60% in 5–10 years

"If I told you that the auto insurance industry would be cut in half in 20 years, that doesn't feel crazy – we're talking about almost \$100 billion in premium disappearing." – Brian Sullivan (Carrier Management – 1/16)



### Paradigm Shift in Liability





### Driverless Vehicles – WHAT?

### Paradigm Shift in Liability!

- Google, Mercedes-Benz, Volvo and Audi assume all liability for accidents caused by their driverless cars
- NHTSA encouraging auto makers to assume liability for accidents caused by their driverless cars
- Michigan 12/16 passes law holding makers liable for accidents when automated driving system is at fault
- Texas 6/17 passes law holding makers liable for accidents when automated driving system is at fault as long as the automated driving system hasn't been modified by anyone else



#### WHAT's Left?

### Paradigm Shift in Liability!

- Comprehensive
  - Flood
  - Hail
  - Etc.
- Collision likely covered under manufacturers' product liability



### Driverless Vehicles – WHAT?

## Paradigm Shift in Liability!

- Tesla selling car insurance with the purchase of the car in Asia – currently using an insurance company – soon to be doing the same in Australia
- Root Insurance (AZ, IN, OH, OK and expanding into six other states in 2018) offering discounts for self-driving cars
- UK insurance company offering a discount for Tesla if driver will activate Autopilot system



# Driverless Vehicles – WHAT?

# **Ripple Effects**

Employment	Municipalities	Body Shops
Gas Stations	Emergency Rooms	Parking Garages

### **Driverless Vehicles**

### But Insurers Don't Have To Wait For Driverless Cars...

- Lux Research
  - Within six years
    - 57% of cars on the road will have assisted driving innovations
    - 8% of cars will be as autonomous as today's Google car
- BI Intelligence
  - 10 million semi-autonomous and self-driving cars on the road by 2020





#### **Assisted Driving Innovations – Forward Collision Avoidance Systems**

- Insurance Institute for Highway Safety (2016):
  - Automatic braking technology reducing rear end crashes by 40%
  - Forward collision warning systems, reduced rear-end crashes by 23%
- Volvo XC60s with auto braking have seen a 33% reduction in injury claims
- Volkswagen Golf VI reduced personal injury claims by 45% Reduced rear-end crashes by 23%
- NTSB 2015 collision avoidance systems could reduce 80% of deaths caused by rear-end collisions and potentially prevent 93% of those injured in rear end crashes



#### **Assisted Driving Innovations**

### 2017 – Insurance Institute for Highway Safety Lane Keeping Systems

- Reduces sideswipe and head on crashes by 11%
- Reduces cashes in which there were injuries by 12%
- Could cut fatal crashes by 86%

### Front Lighting Innovations

- Mazda's equipped with its adaptive front lighting have seen a 10% reduction in the frequency of property claims
- Similar systems have also reduced the frequency of property claims
  - 9% in certain Volvo models
  - 5% in certain Mercedes models
  - 5% in Acura models



#### **Assisted Driving Innovations**

- Of course, all these innovations render vehicles more vulnerable to hackers
- 2014 and 2016: U.S. government is warning that manufacturers of driverless car technology need to prioritize cybersecurity standards or risk coming under attack from cybercriminals and hackers and terrorists



#### **Assisted Driving Innovations – Front Crash Avoidance Systems**

### Also Being Added to Commercial Vehicles

- Federal Express
  - Purchasing 2,600 tractors with front crash avoidance systems in 2015
- Freightliner 46% of Cascadias sold in 2015 had anti-collision system – up from 24% in 2014
- EU already requires new trucks to have front crash avoidance systems



#### **Assisted Driving Innovations**

### Front Crash Avoidance Systems Also Being Added to Commercial Vehicles

- Oakley Transport Inc., FL
  - 500 trucks 250 with collision avoidance systems 250 without
  - 2014 eight accidents for trucks without collision avoidance systems
  - One accident for trucks with collision avoidance systems
- NHTSA 6/16 Study
  - 150 tractor-trailers from seven companies
  - Collision avoidance systems reduced rear-end crashes by up to 87%
  - Reduced rear-end crash costs by nearly 89%

# The Future of Auto – Autonomous Trucks







#### **Driverless Commercial Vehicles**

- 10/16 Freight Shuttle International and Texas A&M to produce driverless tractor-trailer
- Uber (formerly Otto) to retrofit tech onto regular trucks
  - 10/16 Uber in talks with "thousands of owner-operator truck drivers" about using the company's drivers technology
  - Cost of self-driving systems being added to trucks is from \$23,400-\$30,000
- 2/17 Embark launches driverless trucks for highway driving testing on Nevada roads
- 8/17 Tesla making a driverless, electric, long haul semi-truck capable of platooning; to reveal prototype 9/17
- 2017 other companies producing driverless trucks
  - Waymo, Daimler, Starsky Robotics, Dirve.ai, Einride (Swedish Firm) and TuSimple (Chinese Firm)



TechCrunch.com

Conservative

2032

scenario

**Baseline** 

2036



### Scenarios For Roll-Out And Adoption Of Driverless Trucks On Long-distance Routes And In Urban Areas

Long Distance

Regulated scenario



Source: International Transport Forum – 2017

2024

2028

Disruptive scenario

2020

%

90

80

70

60

50

40

30

20

10

0

2016



- 9/17 CEO of Alphabet's Waymo division (Google)
  - Self-driving trucks may arrive before self-driving taxis
- Currently, some 3.4 million truck drivers
  - Another 10 million that hold commercial drivers' licenses



**Driverless Vehicles** 

# Why driverless trucks?

- There is currently a shortage of some 50,000 truck drivers in the U.S.
- "There's no industry on Earth that wouldn't jump at the chance to cut 34% of its operating costs through automation."
- "The drive to reduce costs and increase efficiency will quickly outpace concerns about any possible consequences."

– digitaltrends.com, 2016 – Jeff Zwschmeide

• "Self-driving trucks could cut logistics cost by 40% in the U.S."

– Bloomberg, 2017

# The Most Common Job In Every State





Source: NPR

# The Future of Auto — Chinese Ehang





#### Source: EHANG

Emerging Issues | Charlie Kingdollar





Source: A<sup>3</sup> by Airbus

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More than a dozen companies – from large to small – are now in various stages of creating flying vehicles.

- Terrafugia
- Kitty Hawk
- Airbus Group
- Moller International
- Xplorair
- PAL-V
- Joby Aviation
- EHANG

- Volocopter
- Uber
- Haynes Aero
- Samson Motorworks
- AeroMobil
- Parajet
- Lilium

# Impact of Driverless Vehicles on Colleges and Universities



#### **Universities Begin to Provide Autonomous Shuttles**

### Some Higher Education Institutions at the Forefront

- 2016
  - University of Waterloo makes autonomous electric shuttles (golf cars) available to students
  - Santa Clara University makes autonomous electric shuttles (golf carts) available to students
- 2017
  - Michigan University makes 15-passenger autonomous electric shuttles available to students



#### **Other College and University Impacts**

- Academics
- More colleges and universities providing courses / majors in subjects pertinent to artificial intelligence and robotics including:
  - Programming and coding
  - Mechanical, electrical and industrial engineering
  - Computer science and robotics

Colleges and Universities may also see an increased interest in:

- Marketing, communications, advertising
- Political science (at least in the early stages of adoption)

Could see more interest in advanced degrees



#### Other College and University Impacts

# Parking

- Some now putting off construction of new parking structures
- Others designing mixed / flex-use parking structures
  - Using level rather than sloped floors
  - Higher floor-to-ceiling heights
  - For easier retrofitting
- Northwestern University has built two mixed use parking structures
  - One contains an entrepreneurship incubator and a speech and hearing clinic
  - One contains a visitor center



#### Maybe Less State / Municipal Funding Available For Higher Education

- State and municipal revenue reductions arising from driverless vehicles could impact higher Ed funding
  - Traffic violations can account for 5%–30% of revenue for some municipalities
  - Taxi medallion fees
  - Parking meter income
  - Vehicle registration fees
  - Issuing driver's license fees
  - Personal property taxes
  - Fuel taxes as more driverless vehicles are EV

# ARTIFICIAL INTELLIGENCE (AI) AND ROBOTICS



Higher Education Will Have A Bigger Role To Play

Artificial Intelligence and Robotics will impact far more than just vehicles creating job displacement

- Up to 3.5 million truck drivers
- Some 279,000 taxi and limo drivers (2016)
- Some 175,000 city and transit bus drivers (2016)
- Several hundred thousands ride-share drivers
- Other municipal fleet drivers



#### Job at Risk of Automation



#### Source: U.S. Bureau of Labor Statistics, McKinsey Global Institute analysis

# •

#### Jobs at Risk of Automation

Loan officers			
Receptionists/clerks			
Paralegals/legal assistants			
Retail salespersons			
Taxi drivers/chauffeurs			
Security guards			
Cooks/fast food			
Bartenders			
Personal financial advisors			
Computer programmers			
Reporters/correspondents			
Musicians/singers			
Lawyers			
Elementary school teachers			
Physicians/surgeons			
0% 20% 40%	60%	80%	1009

Source: CBC News; Bloomberg

#### Jobs at Risk of Automation

### January 2017 McKinsey report

- 45%–47% of job activities in the U.S. could be automated by adopting *currently demonstrated technologies*
- 73% of jobs in the accommodation / food industries
- 60% of manufacturing jobs
- 58% of agricultural jobs
- 57% of transportation jobs
- 53% of retail jobs
- 51% of mining jobs
- 47% of construction jobs

Will colleges and universities see more or fewer students?

- Mass job displacement would result in less spending power and possibly fewer students
- Mass job displacement could result in higher enrollment as a percentage of those displaced – possibly older – go back to school



# Thank You

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