

Automotive Autonomy State-of-the-Art

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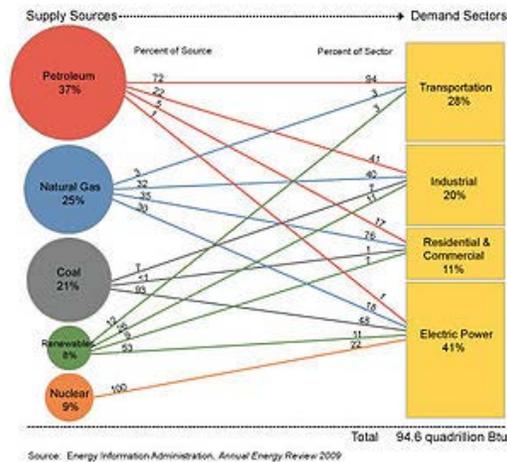
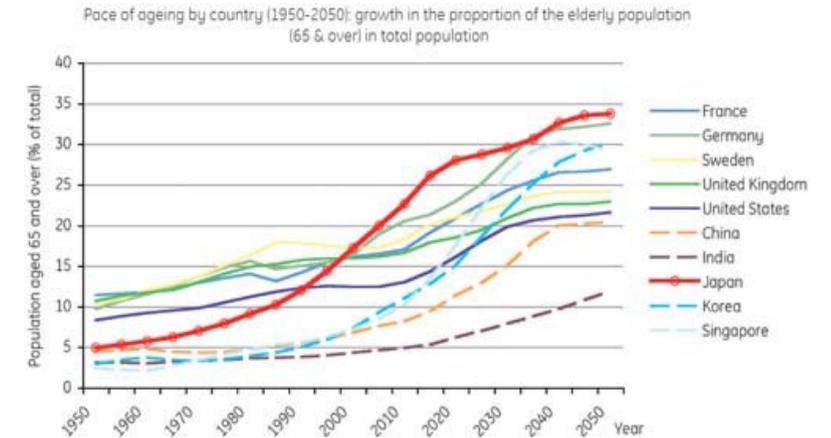




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Why Vehicle Automation?

- Safety
- Aging Society
- Energy Consumption
- Congestion

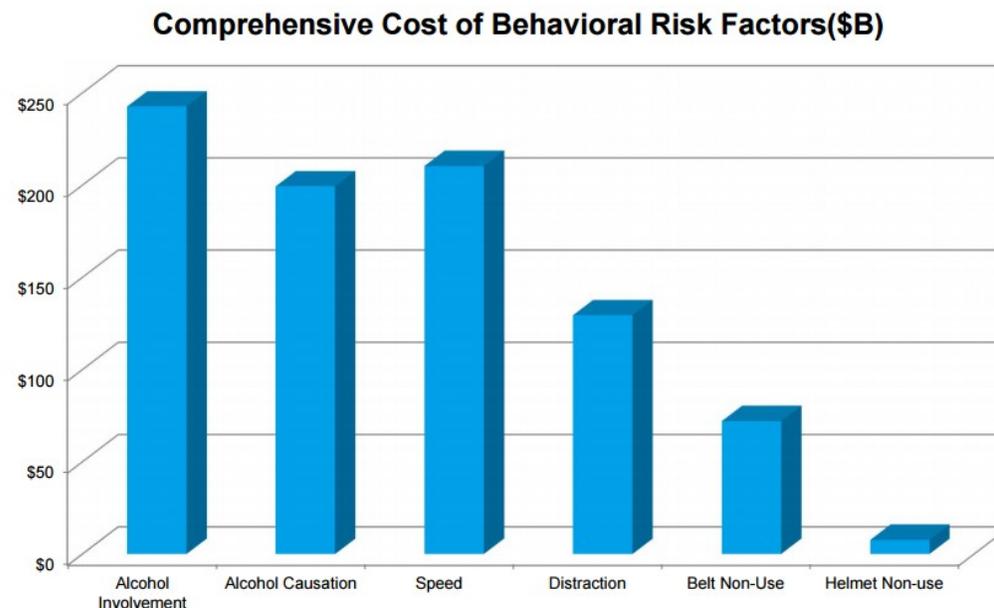


What Do Vehicle Crashes Cost?

- 2015 Data₁

Fatalities	35,092
Injuries	2,443,000
Economic Cost	\$242 Billion
Societal Harm Cost	\$836 Billion

- Underlying Cause is the Human!₂



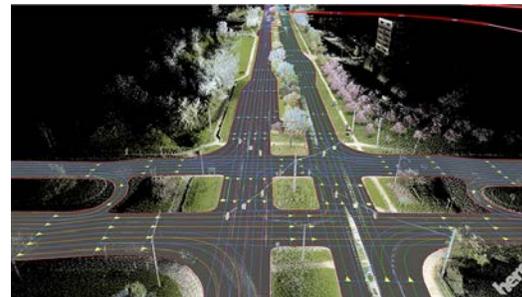
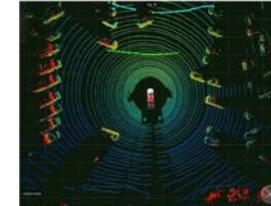
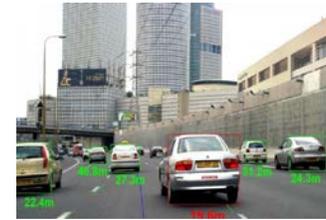
1. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812348>
2. [http://www.nhtsa.gov/DOT/NHTSA/NVS/Public Meetings/SAE/2015/2015SAE-Blincoe-Costs_of_crashes2010.pdf](http://www.nhtsa.gov/DOT/NHTSA/NVS/Public%20Meetings/SAE/2015/2015SAE-Blincoe-Costs_of_crashes2010.pdf)

Approach - SAE J3016

Levels	Event Detection	Control	Fallback	Automated Modes
0 (not automated)				None
1 (driver assistance)				Some
2 (Partial automation)				Some
3 (Conditional automation)				Some
4 (High automation)				Some
5 (Full automation)				All

Sensor/Systems Suite

- Cameras
- LIDAR
- RADAR
- IMU
- GPS
- HD Maps
- Connectivity



Sensor/System Limitations

- Cameras – Low and bright lighting, adverse weather
- LIDAR – Traffic signal phase, lane lines, adverse weather, relative speed
- RADAR – Pedestrians and cyclists, traffic signals, lane lines, reflections from stationary objects
- IMU – Cost/accuracy trade-off
- GPS – Availability in urban areas
- HD Maps – Continuous need for updates
- Connectivity – Most effective with widespread deployment

Technical Challenges

- Handling vast amounts of data
- Deep learning from vast amounts of data
- Computationally intense processing on-board
- Accuracy/reliability
 - Do we only need to be “as good as a human”?
- Corner cases are extremely challenging
 - How to extrapolate the mundane to the extreme?

Non-Technical Challenges

- User acceptance – do they want it, will they pay for it?
- Human-machine interface – how information is conveyed
- Security and privacy
- Legal, liability and insurance issues – current focus on the driver
- Standardization – 70 years of standards revised in 8 - 10 years?
- Unknown societal impacts (congestion, miles travelled, etc.)
- Workforce – vehicle-based (engineers and technicians), infrastructure, data
- Broader societal changes

The greatest remaining challenges to vehicle automation are not technical

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Thank You

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