Improving Road Safety Through Autonomy: Challenges and Opportunities

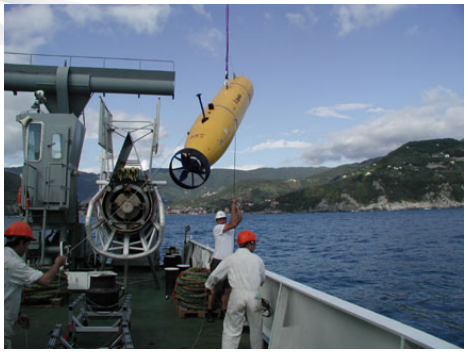
John Leonard

Toyota Research Institute

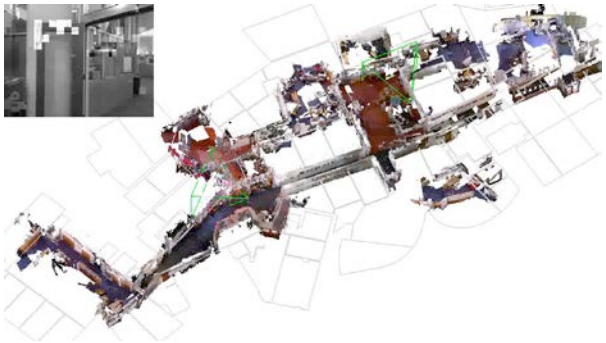
Massachusetts Institute of Technology

The Road to Zero Coalition, January 26th, 2017

My Background



Autonomous Underwater Vehicles



Mapping and Localization

Self-Driving Vehicles

Education:

- University of Pennsylvania, BSEE (1987)
- University of Oxford, DPhil (1991)

History of MIT Positions:

- MIT Sea Grant AUV Lab (1991-1996)
- Dept. of Ocean Engineering (1996-2004)
- Dept of Mechanical Engineering 2005-present
- Artificial Intelligence Laboratory (2002-2004) and CSAIL (2005-present)

Mapping and Localization

Current Positions:

- Samuel C. Collins Professor, MIT MechE & MIT CSAIL
- **Director of Autonomous Driving Research, Toyota Research Institute**

Research Interests:

- Self-Driving Vehicles; Mapping and Localization; Marine Robotics

MIT DARPA Urban Challenge Team (2006-2007)

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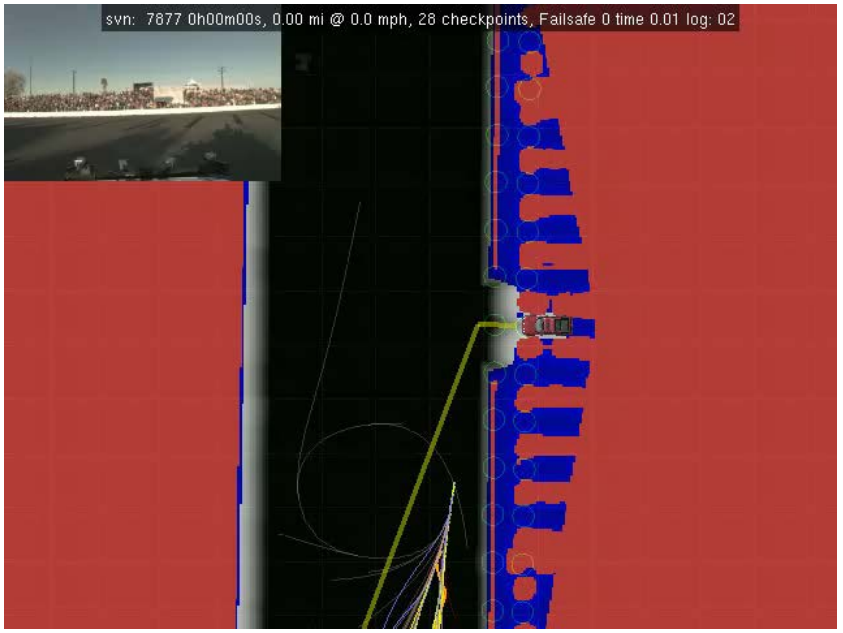
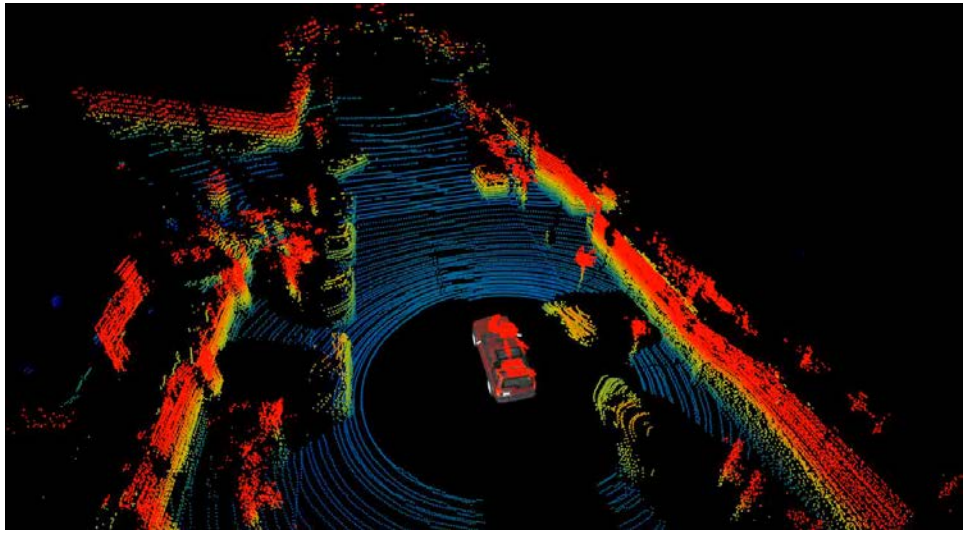


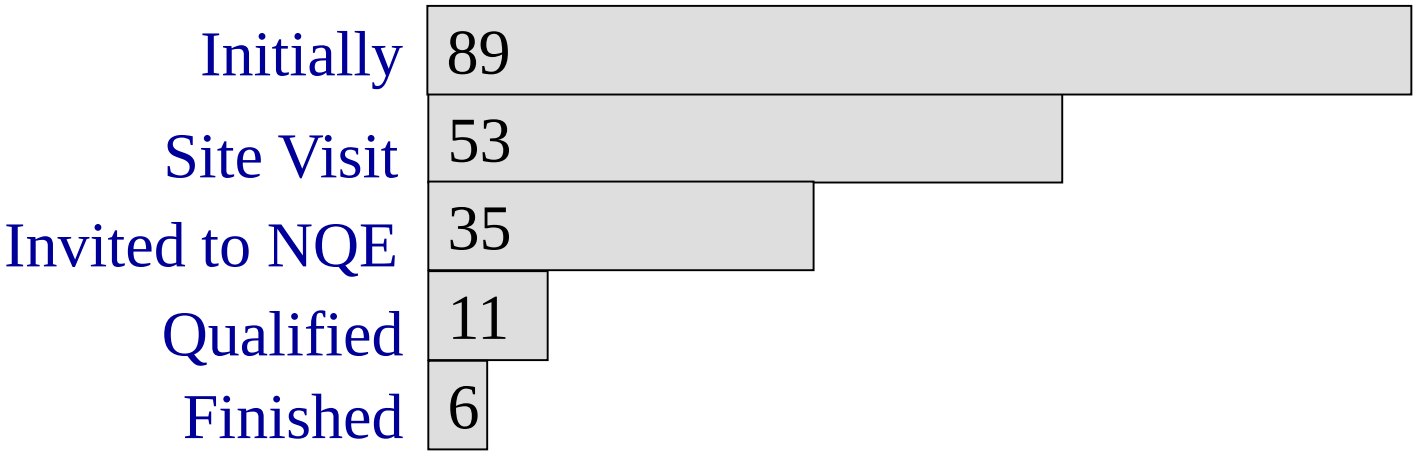


Leonard et al., JFR 2008 ; Karaman and Frazzoli, IJRR 2011; Huang et al., AR 2009

MIT Land Rover LR3 (Talos)

- Blade cluster
  - 10 blades each with two 2.33GHz dual-core processors ➔ 40 cores
- A **lot** of sensors
  - Applanix IMU/GPS
  - 12 SICK Lidars
  - Velodyne (~64 Lidars)
  - 15 radars
  - 5 cameras
- 6 kW generator

2007 Urban Challenge Results

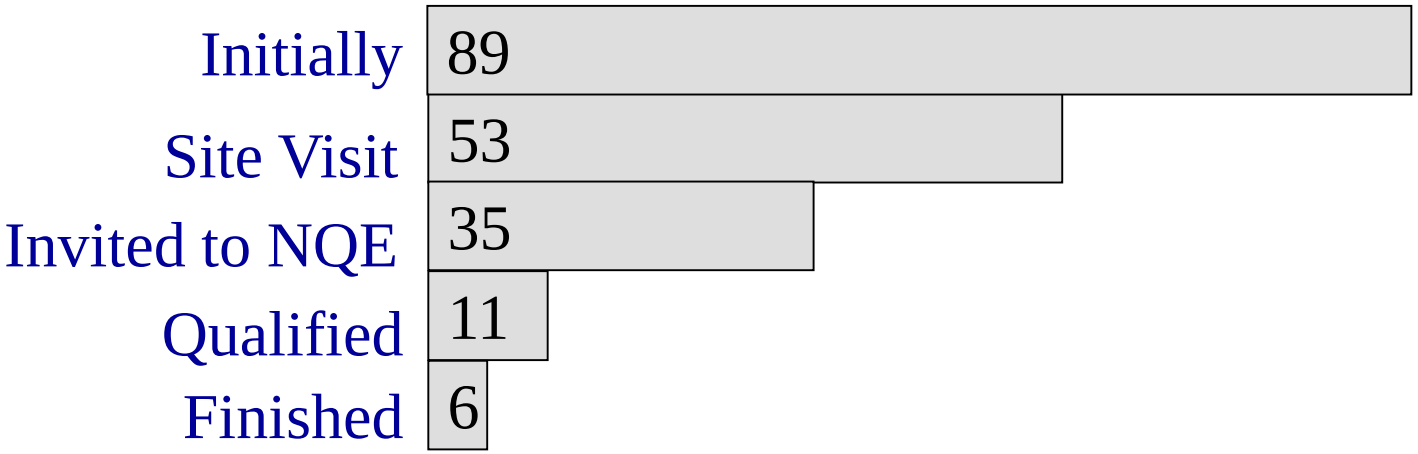


CMU
1st place

Stanford
2nd place

Virginia Tech
3rd place

2007 Urban Challenge Results



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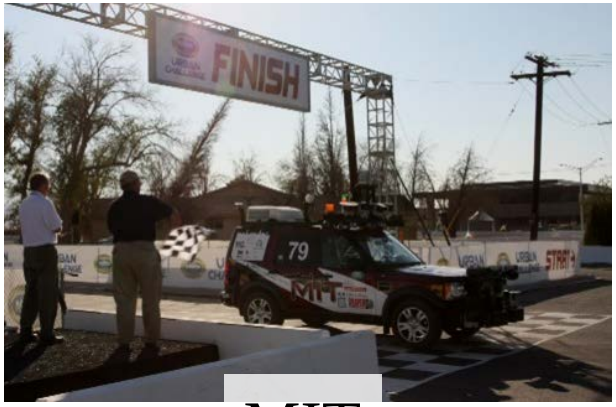

Virginia Tech
3rd place

MIT
4th place

2007 DARPA Urban Challenge – Collision between MIT and Cornell

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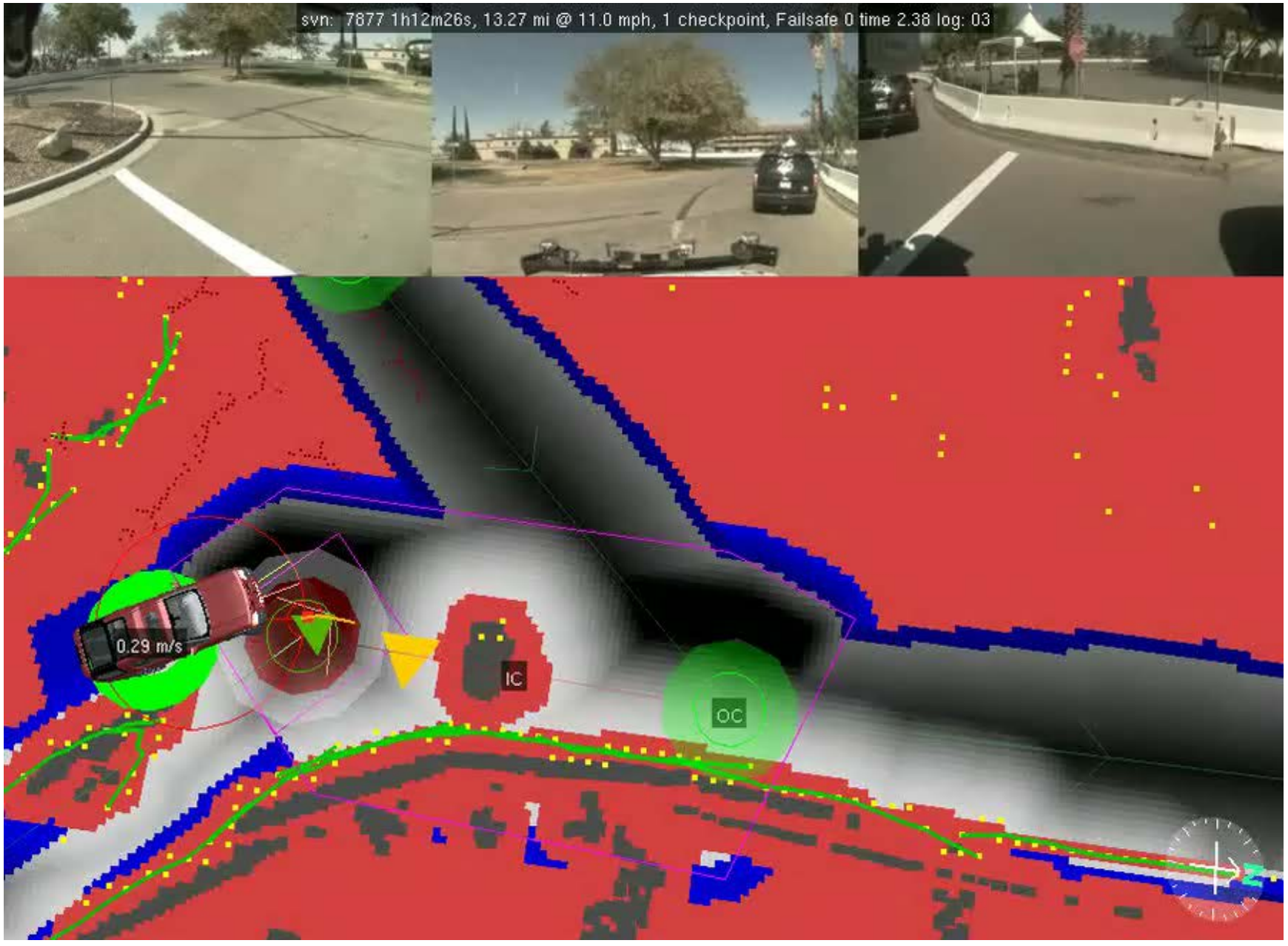
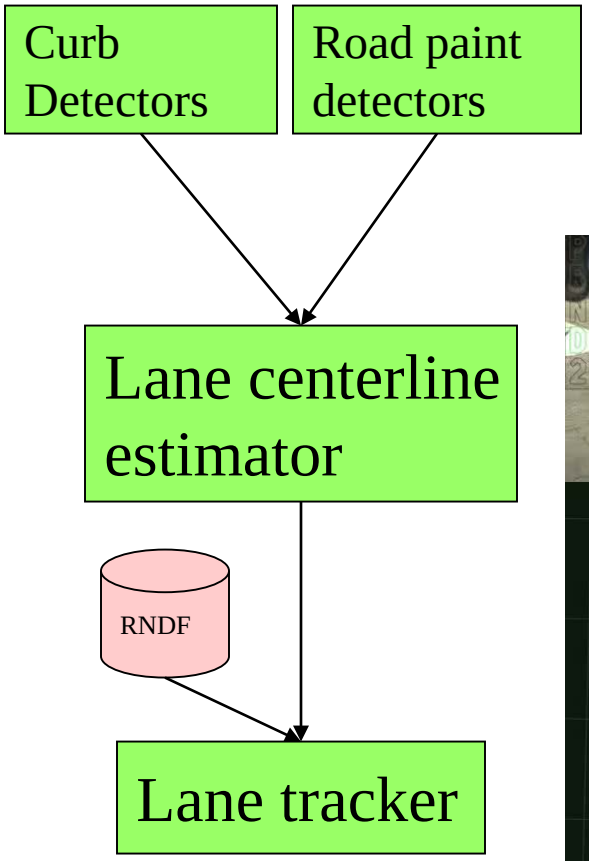
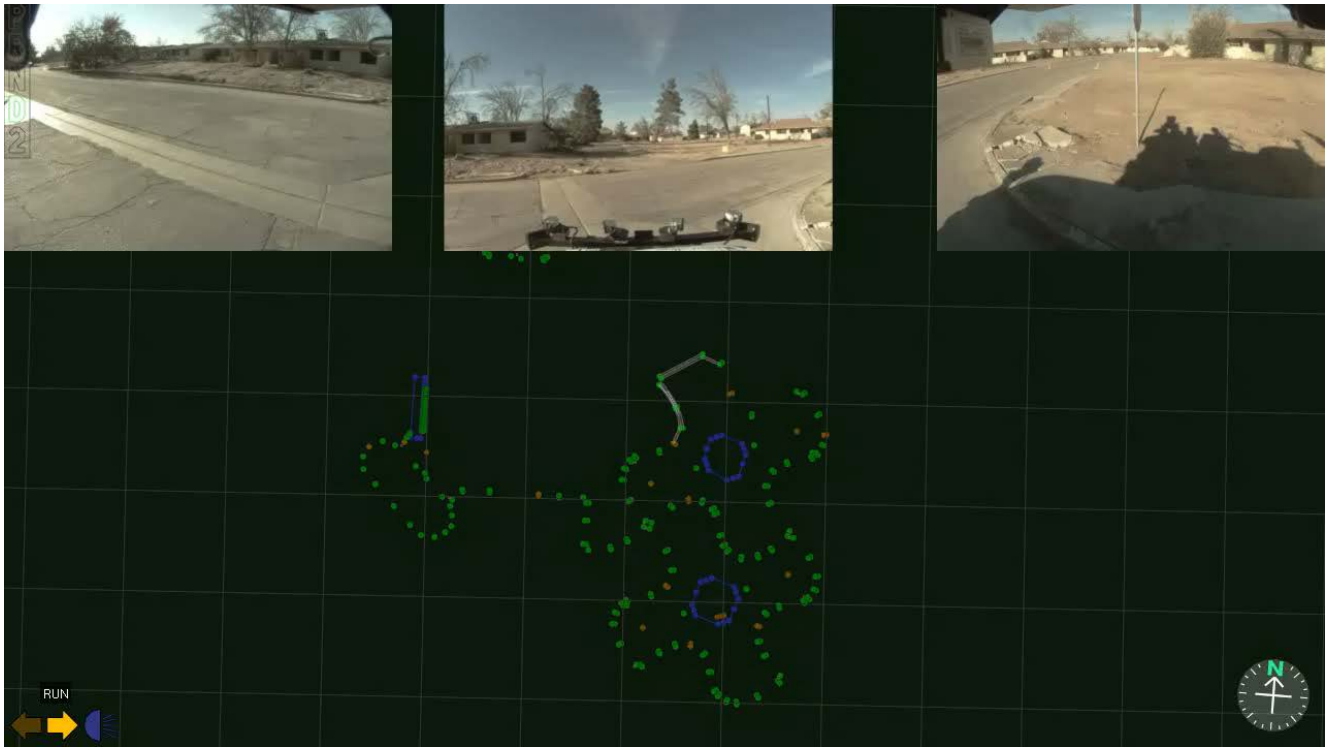


2007 DARPA Urban Challenge – Collision between MIT and Cornell

L. Fletcher, S. Teller, E. Olson, D. Moore, Y. Kuwata, J. How, J. Leonard, I. Miller, M. Campbell, D. Huttenlocher, and others, "The MIT–Cornell collision and why it happened." In Journal of Field Robotics, 25(10), pages 775-807. 2008.

Perception-based Navigation (Albert Huang & Seth Teller)





Team MIT qualifying event run with sparse waypoints / online road estimation

SMARTER THAN YOU THINK

New York Times Oct 9th, 2010

Google Cars Drive Themselves, in Traffic

Ramin Rahimian for The New York Times

Dmitri Dolgov, a Google engineer, in a self-driving car parked in Silicon Valley after a road test.

By JOHN MARKOFF
Published: October 9, 2010

MOUNTAIN VIEW, Calif. — Anyone driving the twists of Highway 1 between San Francisco and Los Angeles recently may have glimpsed a Toyota Prius with a curious funnel-like cylinder on the roof. Harder to notice was that the person at the wheel was not actually driving.

Potential Benefits of Self-Driving Vehicles

- Safety
  - Over 5 Million vehicle crashes per year in the US
  - 93% of accidents have human error as a primary factor
  - Over 30,000 fatalities in the US due to traffic accidents per year
- Increased Road Network Efficiency
- Recovery of Time Lost due to Commuting
- Reduced Need for Parking in Cities
- Radically New Models for Personal Mobility and the Distribution of Goods and Services

"Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations" Daniel J. Fagnant and Kara M. Kockelman, Eno Center for Transportation, October 2013

Questions for Self-Driving Vehicles

- Technological
- Economic
- Employment
- Ethical
- Legal
- Security
- Energy and the environment