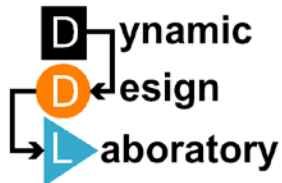

Automated Driving Research Activities at Stanford University

J. Christian Gerdes

Department of Mechanical Engineering

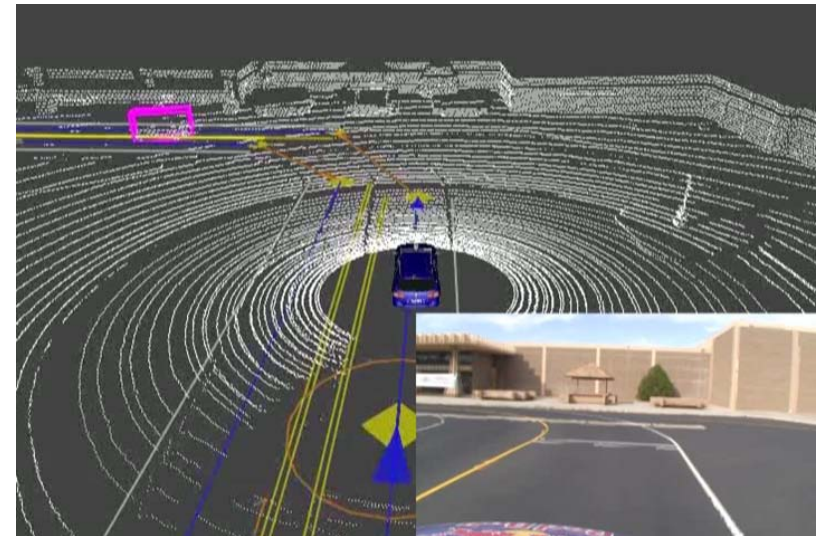
Stanford University

July 25, 2012



Stanford Racing Team

- Led by Sebastian Thrun
 - Won DARPA Grand Challenge
 - Second place in DARPA Urban Challenge



Clifford Nass

- Professor of Communication
 - Expertise in HMI, multitasking



- Three waves of vehicle intelligence:
 - First wave: Purely mechanical
 - Power steering
 - Second wave: Hidden intelligence
 - Anti-lock brakes, engine control
 - Third wave: Intelligent vehicles

Toyota Unintended Acceleration

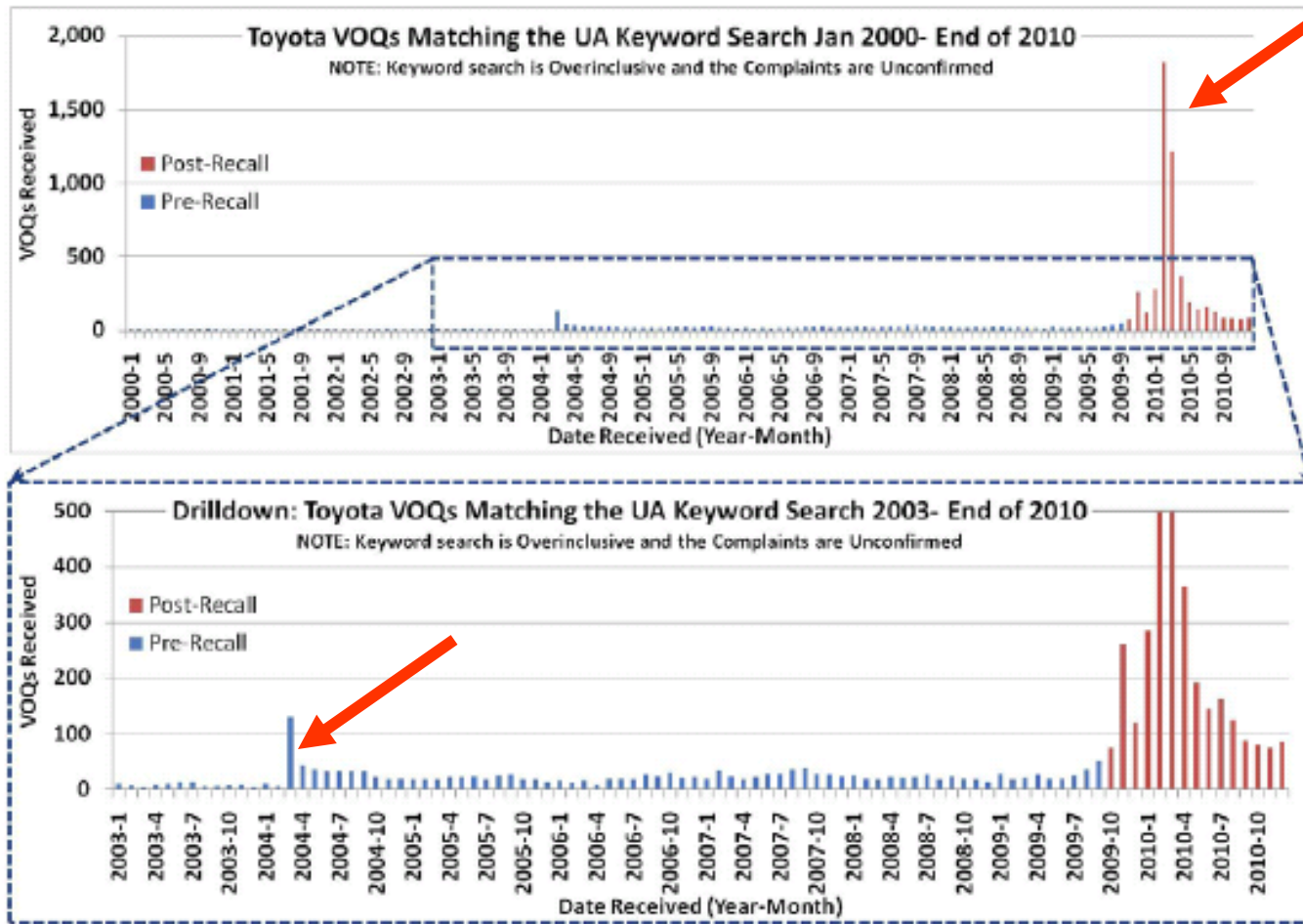


Figure 1: Consumer Complaints to NHTSA Alleging Unintended Acceleration in MY 1998-2010 Toyota Vehicles

The Driver as Passenger

- Lessons learned?
 - People do not understand their cars
 - Cars offer little interpretation of their actions
 - This can lead to tremendous fear
- Interaction with driver is key
 - Even if the vehicle is fully automated
 - Need to gain (and keep) trust
 - HMI needed for more than just transition

The Driver as Role Model

- Human beings can be amazing drivers



- Can we learn from the best drivers?

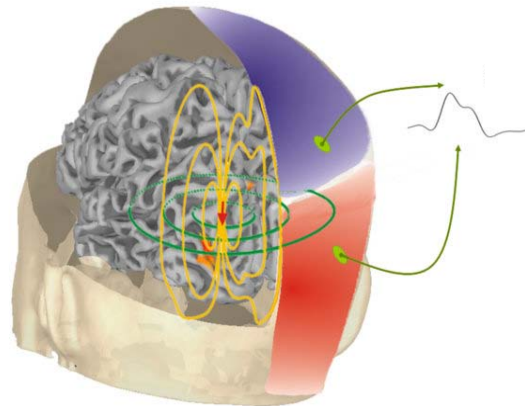
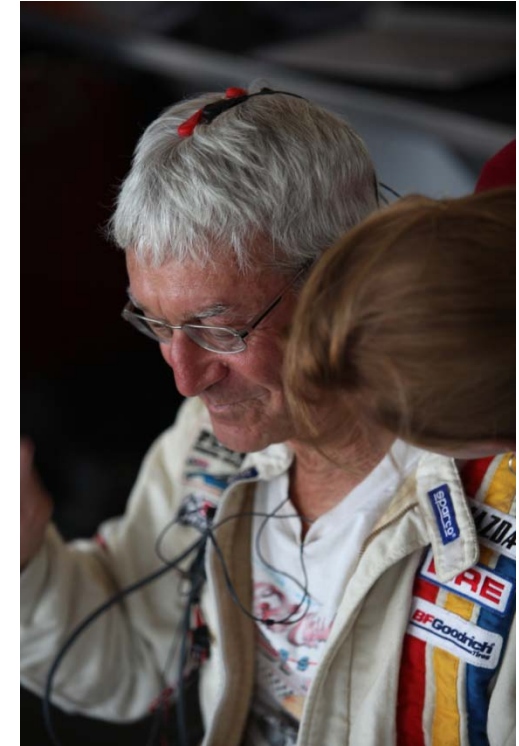
Revs Program at Stanford

- Instrumenting vintage race cars
- Vehicle data and driver physiology



EEG Data Analysis

- Meaningful frequency bands:
 - Theta waves: 4-8 Hz (“cognitive activity“)
 - Alpha waves: 8-13 Hz (“relaxation“)
 - Key figure for mental workload (MWL):
Power ratio: Average Theta/Alpha waves
- Results suggest car control is instinctive



John Morton at Laguna Seca



Automation at the Limits

- Can we operate cars at the very limits of their physical capabilities?
 - Racing is an inspiration
 - Safety is the motivation



Thunderhill Raceway Park



Automated Drifting

- Trade stability for controllability



What Have We Learned?

- Robotic cars can be great at car control
 - So are humans, but with a different approach
- Both cars and robots find the fastest line
- Humans adapt
 - Feel the car
 - Apply experience



Looking Ahead

- Should automated cars learn and adapt?
 - If so, how do we test them?
 - What happens if they learn bad habits?
- How good do automated cars have to be?
 - Better than the best human drivers?
 - Better than the average human driver?
 - Better than a distracted driver?
- Technological, human and legal questions