

Robocars

Where will they take you?

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(Not speaking for Google)



Five giant changes

- Massive saving of lives and injuries
- Enabling of efficient personal transport
- Many times more people on existing infrastructure
- Vast reductions in parking need
- Fast, cheap delivery turns retailing, dining and more upside-down



Numbers on Human Drivers

- Human drivers kill 34,000 per year in the USA - #3 in years of life lost
- 1.2 million die worldwide
- 12 million accidents, 1.8 million with injuries
- 230 billion cost of accidents: 2.5% of GDP (8 cents/mile)
- 50 billion hours spent driving: 8% of GDP



Those pesky humans...

- 40% fatalities due to drinking
- 80% of accidents due to inattention
- 41 hours/year per person lost to congestion
- 3 parking spaces per car, up to 60% of land in LA is for cars
- Over 25% of our energy budget, and more of CO2 output



Robocars are real

- DARPA contests
- ... Play Video ...
- Real "garage" innovators
- This is "Artificial Horse Intelligence"





They are coming

- Cars galore with:
 - Self parking
 - Lane keeping warning/assist
 - Automatic Cruise Control
 - Pedestrian and collision detection/warning/braking
- Now announced or demonstrated:
 - Mercedes 2013 S-Class with slow autopilot
 - Volkswagen Temporary Autopilot (2016?)
 - GM EV-N, Nissan Pivo 3, Toyota Prius w/AVOS
 - Valet Park, limited autopilot, accident management



The huge consequences

- Hundreds of thousands of lives every year
- Saving energy and ending U.S. Oil imports
- 200 million tons of CO2 per year
- A \$trillion of human productivity
- Land reclaimed from parking
- Freedom from congestion
- Delivery of anything



Programmers can save the world



What might it be like?

- Push a button on your cell
- A car comes in seconds
- You ride in a pleasant work environment or face-to-face
- You arrive at the elevator at your destination
- No central control, no new infrastructure



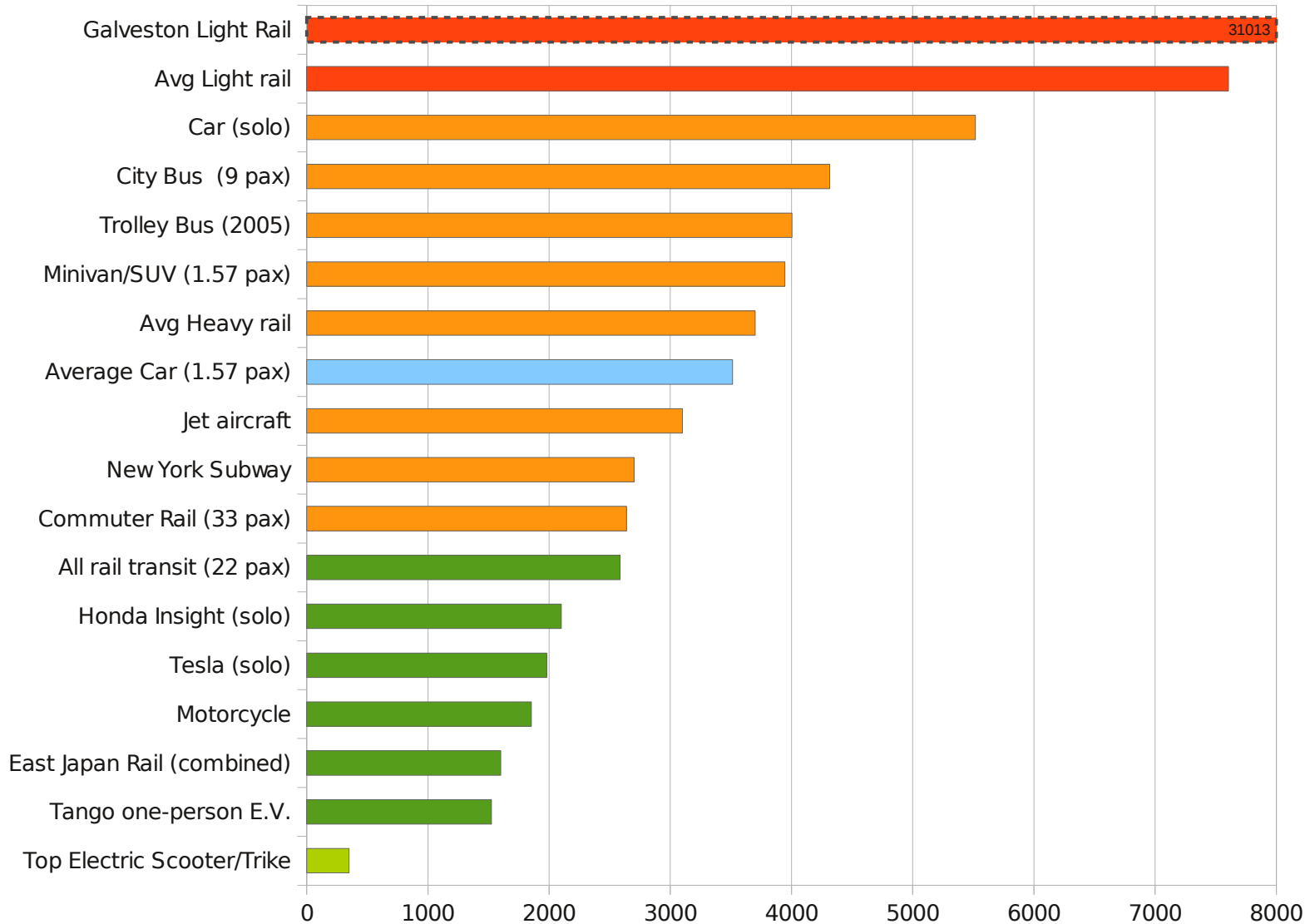
The right vehicle for the trip

- Mostly an ultralight
- Buy what you use, not what you might need
- Your car rents itself out
- Or don't buy at all
- Greener than transit...



USA Transportation Energy Use

BTUs per passenger-mile



Who killed the electric car?

- The battery killed the electric car
- People won't tolerate:
 - Cost
 - Limited Range
 - Long recharge time
 - Poor availability of fast recharge
- We can make an efficient short-range electric, but few will buy it.
- It's all about marketing!



Robots don't care how convenient it is to refuel

- They don't care about waiting.
- They don't park (they can wait anywhere)
- Enables all alternative fuels
- We know how to make this car, not how to sell it
- Robocars save the electric car



Moore's law to Transportation

- Competing innovators vs. 19th century
- Compare:
 - Early Adopters vs. municipal government administrators
 - Big infrastructure vs bottom-up growth with almost no new infrastructure



Whistlecar

- Some speed is slow enough to be safe
- Some special roads with decent speed
- Slow on the last mile
- Brings all the energy, parking and convenience benefits
- Does not bring working while riding, or service for those who can't drive.



Political issues

- Must be made legal
- Must not be over-regulated
- Jurisdictions will compete
- Possibly Singapore, China, India, Israel, Japan
- Children, the aged, the Drunk, some Jews



Downsides

- Less walking
- Longer trips, Robo-RV, super-sprawl
- Computer Intrusion, Bugs
- Sourcing electricity
- Disruption
- Empty cars
- Killbots



Privacy

- Cameras and sensors everywhere, in and out of the car
- Always recording, if only for test suite
- Your own technology should not betray you
- Yes, our cell phones already do this
- Rental vehicles will invade more than owned ones
- Rentals want to track damage, billing and trip records
- We can decide what architecture is in place – Anonymous taxi is possible.



Freedom

- Can we order our robocar to do something illegal?
- Will police have the power to redirect it?
- Will the police ever have grounds to pull you over?
- Will you have freedom to tinker?
- New traffic code:
 - Be safe
 - Don't unfairly impede others



Barriers

- Law
- Fear
- Liability
- Regulators
- Terrorists – will drive-by-wire be banned?
- S.M.O.P.
- Software recalls



Engineering Changes

- Range not a factor
- Acceleration and speed not a factor
- Comfort much more of a factor, soft ride.
- Want to be sharable
- Different safety constraints
- Small width, single passenger or face-to-face, sleepers, RVs



Deliverbots

- In military, then on back streets
- Anything in 30 minutes, not just pizza
- No need to own expensive, rarely used goods – “room of requirement”
- Vast alteration of the nature of retail
- Also changes airports, farms etc.



Parking

- They don't park they stand.
- Can stand in driveways, in front of hydrants, double and triple parked
- Cars can “move the gap”
- The more cars on road, the more road capacity
- Turn parking lots into parks



Congestion

- Regular, rational behaviour
- Half-width vehicles
- Emptying streets of parked cars
- Few accidents
- Redirection of streets one-way at rush hour
- Metering of reservations to be on a block
- Closer spacing
- On-demand full jitneys and buses



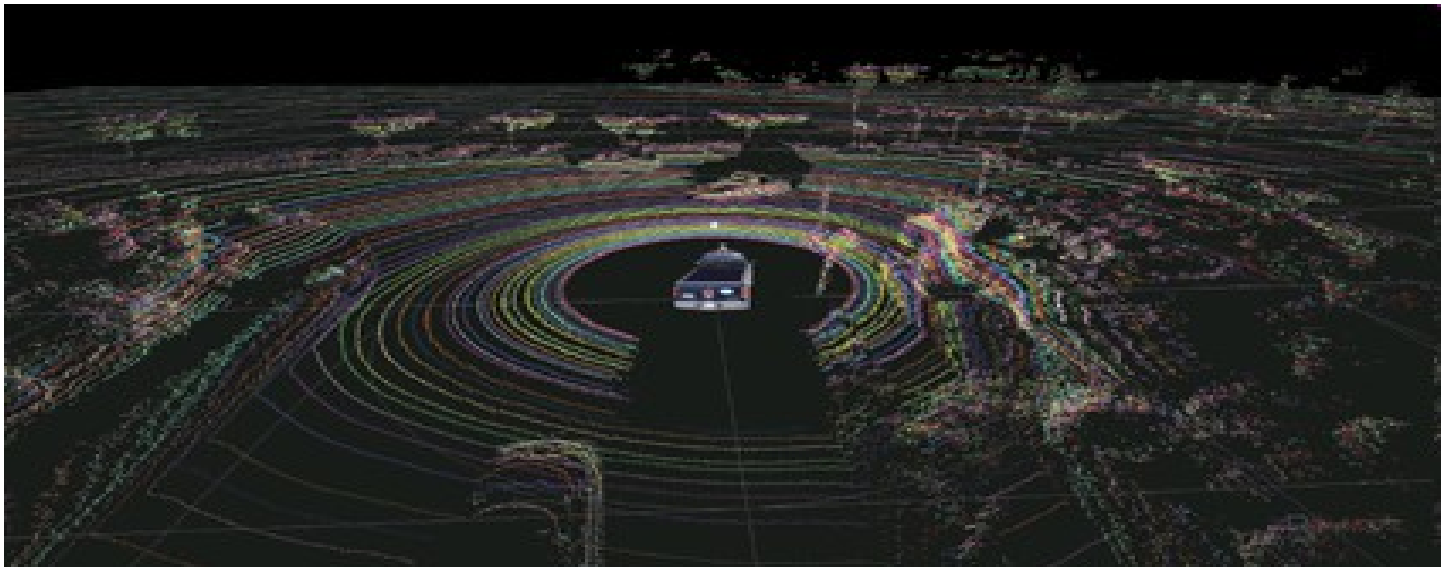
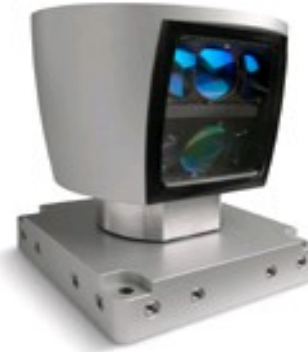
Who could make it happen

- Companies wanting to sell it
- Accident victims, M.A.D.D.
- Alcohol vendors!
- Soccer moms and other parents
- Global warming fighters



Lidar

- 64 lines, 50m pavement, 120m cars
- 1.3m points/.sec
- 1cm accurate
- \$75K today, \$300 later



Open Source Projects

Simulator:

- Base on TORCS or Rigs of Rods

- Simulate sensors, scenarios

- Allow contests

Udacity Course

Source code to Junior is on sourceforge

<http://sourceforge.net/projects/stanforddriving/>



More topics

- Poor man's Teleporter
- Redesign of the City
- Electric vehicles entering buildings
- <http://robocars.com>



Time for Apollo-like resolve

- Do it not because it's easy, but because it's hard
- “achieving the goal, before the next decade is out, of a computer driving a man to lunch at noon, and returning him safely to work”
- Few other projects offer so much for so little.

