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The ‘Autonomes’ are Coming – This Will Fundamentally Change How We ‘Do’ Road Transportation

ITE – NAS Luncheon

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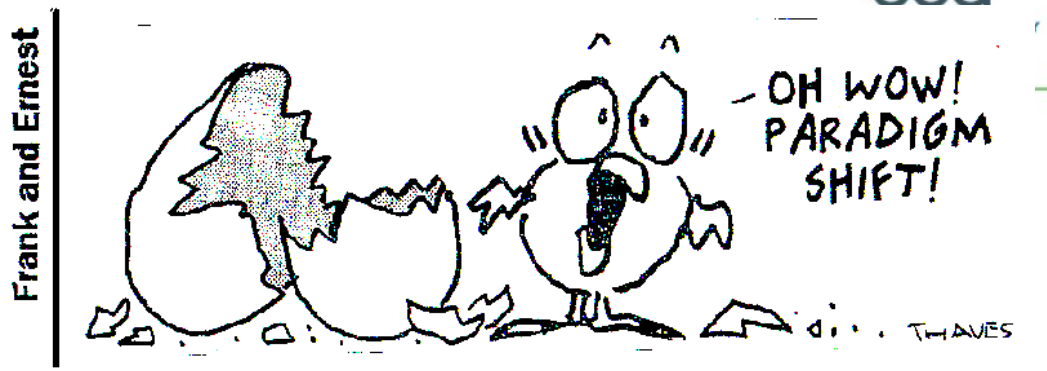
creating & delivering | BETTER SOLUTIONS

Background



My belief (glass half full!):

We are on the cusp of two technological tidal waves that will result in a paradigm shift in how we do road transportation.* *(*a radical change in underlying beliefs or theory.)*

- The challenges are immense, the potential benefits are transformative.

We need to:

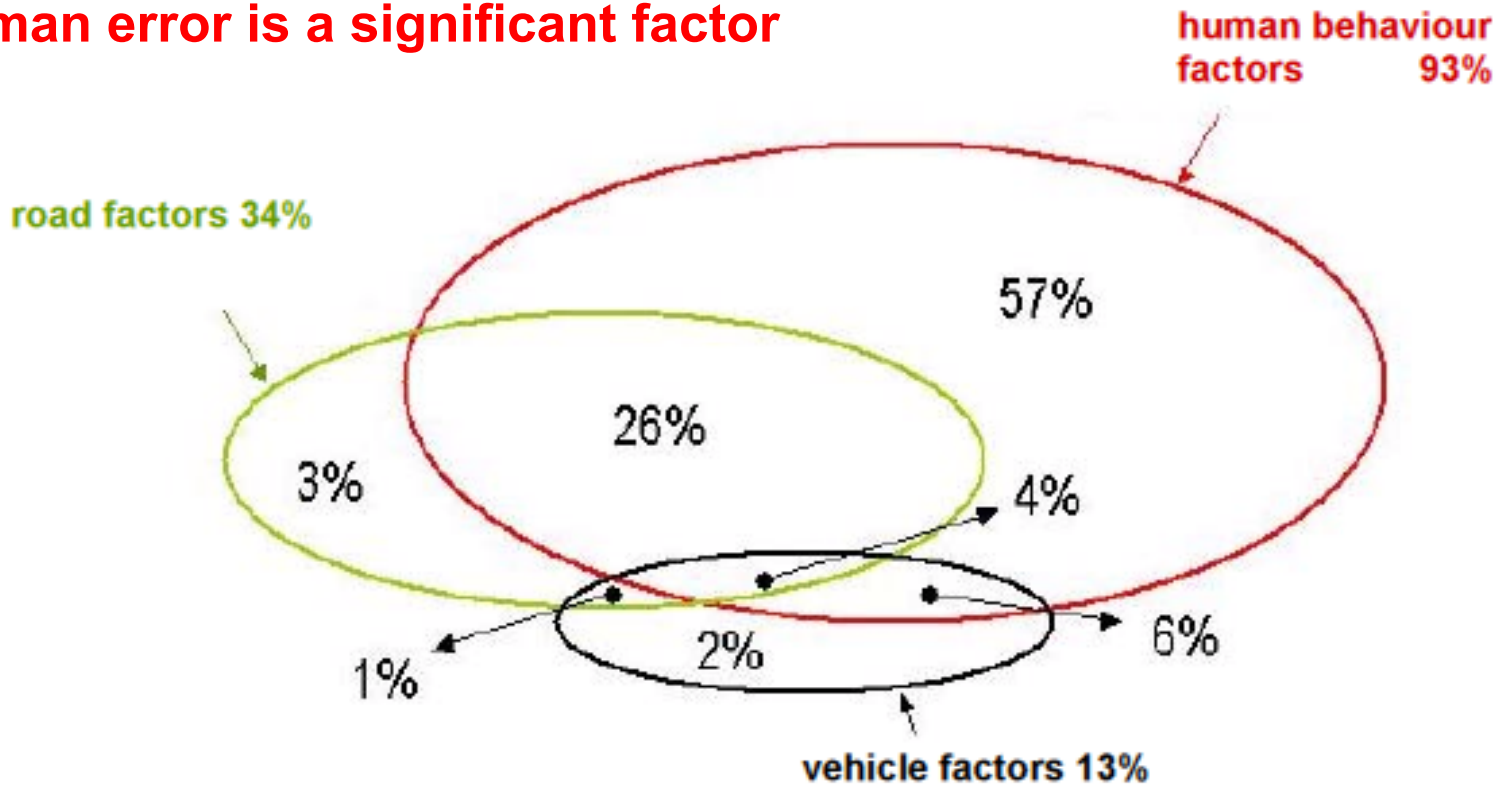
- Make ourselves aware
- Decide if we need to make a response
- Act on our convictions (limited research and experience to guide us)

Agenda

- The Problem
- The Technology ‘waves’
- What autonomes are
- Ultimate Autonome Vision
- Opportunities
- Challenges
- When might this all happen?
- Implementation Scenario
- Watch/wait or respond?

Big Problems - need a Big Solution

- Every year approximately **1.2million people are killed** on the world's roads. (2009: USA = 30,797 – Canada = 2,011)
- It is estimated that in approximately **93% of collisions (accidents) human error is a significant factor**



(Source: PIARC Road Safety Manual, 2003)

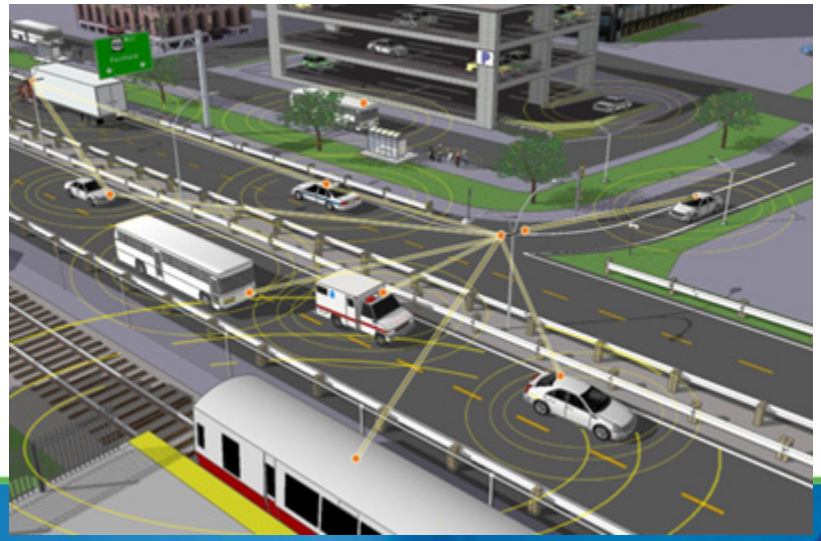
Big Problems - need a Big Solution

- **Congestion / 'lost time'** is a major problem – average US commuter ≈50mins in the car/day (US cost = $1tn?)
- Road vehicles are a significant contributor to **pollution** particularly in urban centers. (GHGs and particulates)
- The technology that will allow us to **virtually eliminate human error from the road system and significantly reduce road congestion and pollution** is already moving from 'science fiction' to 'science fact'.

1st Wave - Connected Vehicles (CV)

Electronic modules in vehicles and infrastructure:

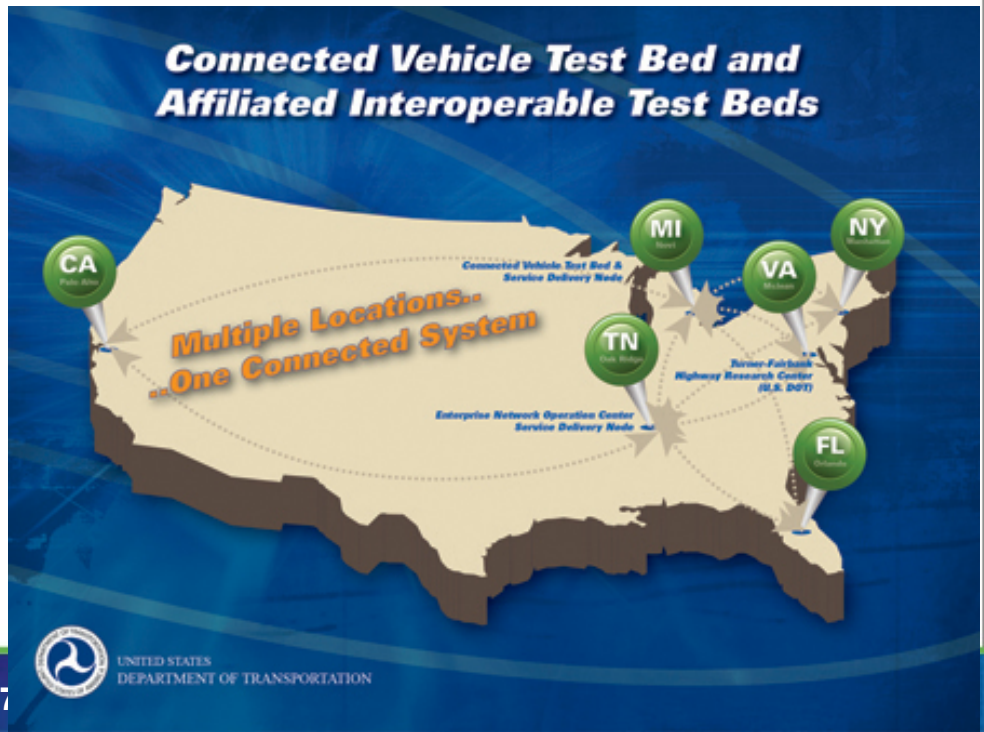
- Speed adaptation
- Collision avoidance
- Extended or revised traffic signal timing or phasing
- Emergency vehicle warnings
- Warning of red light runners
- Dynamic route selection or adjustment
- Platooning (SARTRE – Safe Road Trains for the Environment)



1st Wave - Connected Vehicles (CV)

NHTSA (US) will make a decision on CV tech in 2012 for 2013 – **estimated to remove up to 48% of all collisions**

- RITA ITS pilot project, 3k cars –underway – 2018/19?
- EXPECT MASSIVE CONGESTION/SAFETY BENEFITS
- (Dr. Tony Qui to present to ITE-NAS in the New Year)



1st Wave - Connected Vehicles (CV)

Some thoughts further to the TRB Workshop on 'The Future of Road Vehicle Automation', July 2012:

- ADAS to Semi-Autonomous = driver distraction = safe?
- Platooning has operational safety issues to address – getting vehicles in/out of dedicated high volume lanes efficiently is very challenging – could easily create the very congestion that it is meant to remove.
- If platoons are in in the RHS lane then they are a potential hazard – 13 vehicles sneaked through 10m gaps in European test at off-ramps.
- Platooning cars behind a truck get 'grit-blasted' – one way to make this work is if the autonomes are train carriage-like in shape with squared ends.

2nd Wave - Autonomes

- Autonomous Vehicles (‘Autonome’ for ease)
- Nevada Law (1st Mar 2012)
  - "artificial intelligence" means the use of computers and related equipment to enable a machine to duplicate or mimic the behavior of human beings.
  - "autonomous vehicle" means a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator.
- Catalyst: DARPA Grand Challenge/Urban Challenge
- Key proponents joined Google Self-Driving Car Team
- Automakers: Continental, Mercedes, BMW, AutoNOMOS, VisLabs, Audi, GM, Ford, Volvo etc.

Examples

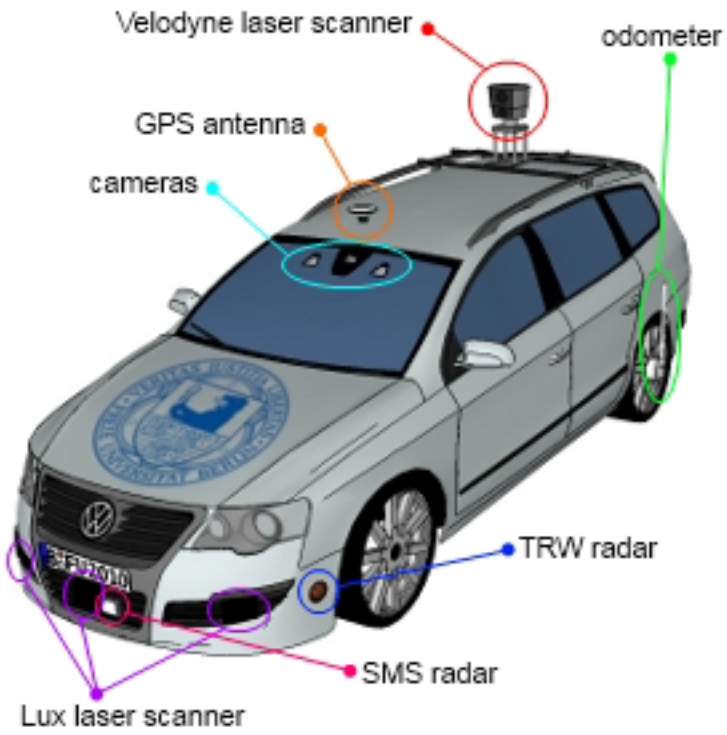
The Google Self-Driving Car

- Probably the most advanced civil autonome
- Key: Software-to-Hardware (traditional vehicle manufacturers Hardware-to-Software)
- Aims: 1 million miles unaided and Save 1 million lives
- Greater than 300k miles (Aug 2012) in self-drive mode – 50k miles without intervention… and counting?…
- Need 725k miles for 99% confidence crash less frequently, but 300milionl miles that cause less fatals
- PG calc – Google can do 1mil miles in 13 months…..
- Passenger No.1, Steve Mahan, San Jose, CA – 95% blind (well worth a watch on YouTube. Did you know 20% USA disabled, 12% severe – this tech should be transformative)

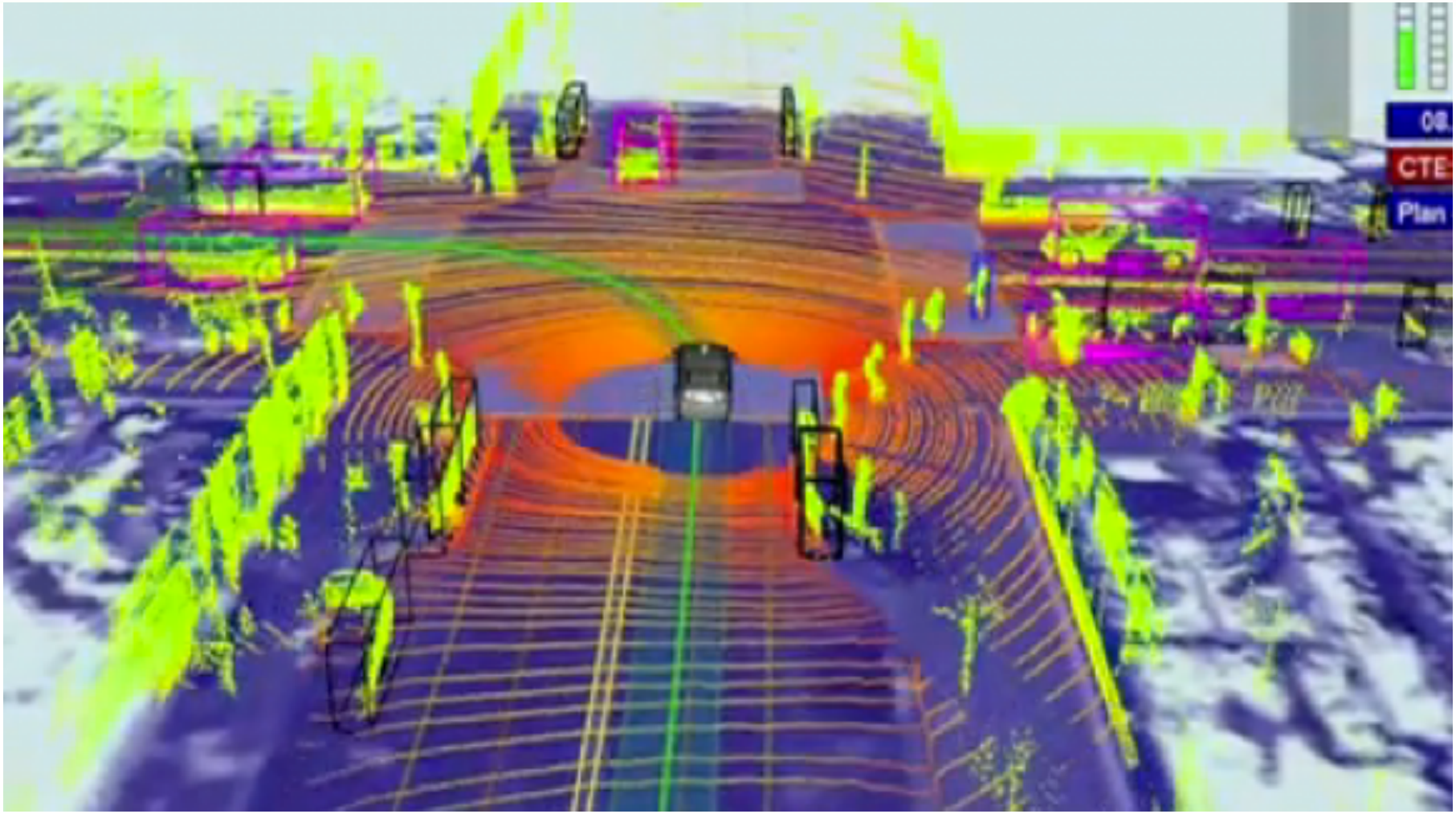
The Google Self-Driving Car

Autonome Characteristics

- Sensors typically:
  - OPTICAL – includes stereo vision for 3D image
  - RADAR – may be an advantage with rain, dust, snow, foliage
  - LIDAR – 360 degree 'point cloud' tracks movement
  - INFRARED CAMERAS – night driving
  - GPS / INERTIAL MEASUREMENT – macro view/location
  - WHEEL ENCODER – precise distance
- COMBINATION = 360°view, improved sensing when visual obscuration. Monitors real time movements at ≈10-20 Hz



The Point Cloud



Autonome Characteristics

DATA ANALYSIS / CONNECTIVITY

- Artificial Intelligence (AI)
- Develops algorithms to cope with new situations
- Connected – one ‘learns’, all ‘learn’, knowledge and experience dissemination
- Hive mind (CV) - platooning, intersections

CONCLUSION

Combination of superior sensory info, real time hazard analysis, AI and rapid reactions = potentially the safest & most efficient road transportation today? (on **existing** infrastructure).

Google Car Video Will Follow Shortly…..

- Presented at TED conference March 2011
- Google car travelled 140k miles at time of video
- August 2012 Google confirmed 300k – they want to do more snow/winter testing…..

Just a thought, but…… Edmonton is the largest northernmost North American city with nearly 1mil people and up to 7 months winter per year…..

Summary of the 2 Technologies

Connected Vehicle

- Congestion Busting
- Reduce Collisions by up to 48%
- Full implementation approx. 2018-2019

Autonome

- Reduce Collisions by up to 93%
- Minor Congestion benefits
- Major benefits to businesses and environment
- Full implementation approx. 2017

GOAL: Convergence = Ultimate Road Transportation (?)

The Ultimate Autonome Vision

Opportunities:

- Reduction (virtual elimination?) in collisions as it removes the human factor (i.e. error!)
- Maximizes road capacity by reducing spaces and improving flows
- Driver is now a passenger - free to use travel time productively
- Environmental – reduced emissions, fewer vehicles
- Business efficiencies – improvements to logistics, time, fuel, insurances, etc.
- Revolutionizes public transport

The Ultimate Autonome Vision

Additional Opportunities:

- Minimizes the road geometry and structures (narrow lanes, compact intersections, no grade separation etc.)
- Removes the need for lighting, signing/lining, furniture
- Roads cost less to construct and maintain
- Driver's licenses no longer required?
- Law enforcement no longer required?
- Vehicle Insurance reduced/eliminated?
- Environmental/real estate benefits – reclamation of excess paved areas (NY Times Jan 2012 – approx. 8 spaces/car in US, Houston approx. 30 spaces/car!)

Quantifying Opportunities (long term)

- SAFETY – Canada societal cost of road collisions = ($62bn 2007) 4.1% of GDP. Reduce 50% **Saving >2% GDP?**
- BUSINESS EFFICIENCY – improves logistics, 'lost time', fuel etc. 50min commute value ≈ $60bn **Saving >4% GDP?**
- PUBLIC TRANSPORT – improves service, logistics, time, fuel, insurances. **Saving >0.5% GDP?**
- ENVIRONMENTAL – reduced emissions, less vehicles yet better level of service. **Saving >0.5% GDP?**
- SOCIETAL – Like the phone, landline cell to smart and the social media revolution….. The possibilities are immense.

Long Term Total Saving >7.0% GDP?

The Ultimate Autonome Vision

Challenges:

- SECURITY – ‘missiles’ in a malicious entities hands
- LEGAL / REGULATORY – laws cover non-human driver. Policies, Rules and Standards
- SYSTEM RELIABILITY - MTBF

Challenges

- INSURANCE/LIABILTY – define responsibilities and liabilities
- USERS – overcome trust issues/acceptance
- UNIONS / TEAMSTERS – jobs threatened: long haul drivers, taxi drivers, road safety experts, trauma surgeons etc. (reduction in organ donations)
- STANDARDIZATION – systems, protocols, inter-connectivity, cross-borders, integration etc.

BUT……

…… this ‘vision’ assumes that virtually all vehicles on the road are autonomes.

- There will be a (probably decades long) **transition period**, where man, Connected Vehicles and autonomes share the road space and learn to get along.
- Will we share the roads harmoniously (drivers taking advantage)?
- Will/should drivers and autonomes be treated equally (Societal and legal viewpoint)?
- Can rules, regulations, standards and legislation be flexible enough to cope?
- Are we ready for the transition?

When will Autonomes arrive?

- Under development now in at least 8 countries
- March 2011 (onwards) - State of Nevada passed laws permitting autonomous vehicles in certain circumstances
- Sept 2011 - *MadeInGermany* vehicle test drives in Berlin
- General Motors predict they could have autonomous vehicles on the road by **2018**, Volvo by **2020**.
- Bruce Breslow (DMV, Nevada) '*… thinks autonomous vehicles will be operating on the state's roads in three to five years.*' (Bloomberg BusinessWeek, 1 March, 2012) – **2015 to 2017**
- – SCAG (Southern California Association of Govts.) event Sept 2012 "**Industry experts predict fully autonomous vehicles may be commercially available as soon as five years from now**."

When will Autonomes arrive?

Once Google have completed 1,000,000 miles, then:

*"Google could make an announcement **as early as next year** on when it might offer the self-driving technology, he [Levandowski] said."* Quote from SAE (Society of Automotive Engineers) World Congress 2012 dated 26 April 2012.

"*He [Levandowski] said the car and hardware cost about $100,000, but Google has just a handful of them. When they go into mass production, he estimated an ordinary car could be retrofitted for a couple of thousand dollars. Some cars already have many of the sensors the Google car uses, so the cost of retrofitting such cars would be much lower."* Cato@Liberty "Googling around DC", 17 May 2012.

When will Autonomes arrive?

- 25 Sept 2012 California became the 3rd US State after Nevada and Florida to sign an Autonomous Vehicle Bill into law.

Sergey Brin (co-founder Google) said **"You can count on one hand the number of years it will take before ordinary people can experience this."**

Possible Implementation Scenario

Assume ‘body-out’ legally acceptable:

1. Taxi industry disrupts
2. Early-adopter Entrepreneurs hire out autonomes
3. Transport as a Service (TaaS) develops
4. Bus service disrupts
5. Trucking industry disrupts
6. Public Transit (LRT, BRT, Trams etc.) impacted
7. ‘Accidents’/Collisions significantly reduced
8. Vehicle size/weight reduces
9. Catalyst for Alternative Propulsion systems – Electric!
10. Easier dedicated lanes and urban road-space optimization
11. Reduced urban parking – streets reclaimed

Mmmm…..

Watch and Wait or Respond?

Ensure we are prepared for this **paradigm shift** in how we 'do' road transportation. **Disruptive tech does not work to a fixed program and is unpredictable!**

We cannot un-invent this tech; it is a matter of 'when' and not 'if'.

Public Sector Suggestions:

- Prepare a roadmap for implementation
- Modify policies, prepare laws, regulations,

  standards etc.
- Be aware of impact on public transport plans
- Assist/sponsor research


CANADA 2020

The Canada
We Want in 2020

A Strategic Policy Roadmap
for the Federal Government

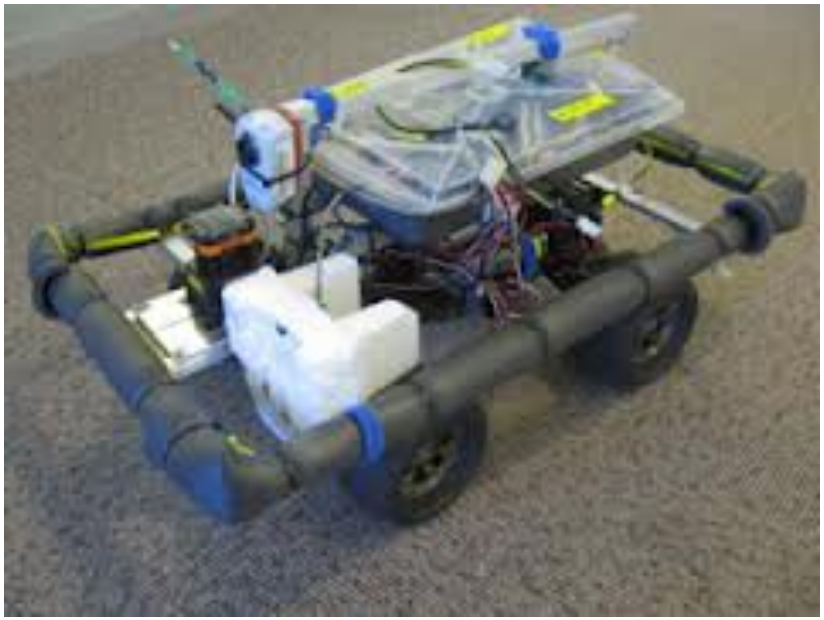
September 2011

About Canada 2020 – Canada's Progressive Centre

Watch and Wait or Respond?

Transportation Professionals Suggestions:

- Plan for a very different future starting in ≈5 years
- Consider review of forecasts (traffic flows, costs etc.)
- Consider impacts on public transport projects
- Get trained-up in this new tech.



Watch and Wait or Respond?

Suggestions for Businesses:

- Examine your business model
- Consider implications to vehicle fleet/development plans
- Note: "Incumbent players rarely do well when industries disrupt." – Larry burns, Co-Author of Reinventing the Automobile: Personal Urban Mobility for the 21st Century.
- Consider: Google are a $230bn company with $50bn cash. GM are a $36bn company…… you do the math.

All to Ponder

This is but the Dawn of the Robot Revolution – it will not only revolutionize our roads, but transform society (think cell-phone to smartphone to social media revolution, but bigger).

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The Autonomes are Coming
SOON!
This Will Fundamentally Change How We ‘Do’ Road Transportation

Thank You!

Science Fiction? Or, Science Fact?

Tongue-in-cheek view of the evolution of road transport:

1. Walking
2. Riding Horses
3. Horse and Carriage
4. Horseless Carriages
5. **Apeless Carriages**
6. Flying Cars?

Progress Update:

Google has been issued a test license for public roads in Nevada. Florida and California have passed laws. Oklahoma and New Jersey are next?

They have also been driving around Washington D.C.