

Robots on Our Roads: *The Coming Revolution in Moving Freight*

Wharton School: Program on Vehicle and Mobility Innovation

Connected Truck Day

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Automated Driving: A Powerful New Wave

Myths!

The roads need to be changed
to make automated driving possible.

WRONG!

Myths!

All vehicles need to be connected to enable automation.

WRONG!

Myths!

Automated vehicles
are prohibitively expensive.

WRONG!

Myths!

New laws / regulations are needed
to enable automated vehicles.

...not necessarily

Myths!

Automated vehicle development started a few years ago.

...more like decades ago.



**PROMOTE
CHAUFFEUR**

**Electronic
Tow Bar
A potential
solution**



DaimlerChrysler

**PROMOTE
CHAUFFEUR**

**Comparison
CHAUFFEUR
1 and 2
(contd.)**



DaimlerChrysler



The Promise of Automated Trucks

What Factors Affect Trucking Today?

- Driver shortage
- Hours of Service
- Fuel cost
- Crashes
- Congestion
- Sustainability
- Trailer Length / Longer Combination Vehicles
- Increasing home-delivery parcel volumes



The Promise of Automated Trucks

- Driver shortage
 - job evolves to high-tech “logistics managers”
 - high tech aids reduce level of technical driving skills needed
 - will the day come when driver’s are not needed at all?



The Promise of Automated Trucks

- Hours of Service

- drivers spent 728M hours in congested traffic in 2014
- regulations for “not driving” will adapt ... in the long term.



The Promise of Automated Trucks

- Fuel cost
 - long-haul fleets spend 40% of operating expenses on fuel
 - reduced usage!



The Promise of Automated Trucks

- Crashes greatly reduced
- for trucks AND cars
- ...reducing congestion overall





AV Use Cases for Heavy Trucks

On-Road

- Fuel Economy
 - Driver Assistive Truck Platooning
- Driver Productivity
 - Traffic Jam Assist
 - Highway Pilot
 - Automated Movement in Queue
 - Automated Trailer Backing
 - Parcel Delivery Automation

Constrained Environments

- Trailer Switching
- Mine Hauling
- Drayage
- Dispersed Local Sites
 - manufacturing
 - distribution

from crash avoidance to
automated driving

Doing Things Right!

- Automated driving is different from crash avoidance.
- Crash avoidance technology intervenes when things go wrong
- Automated driving technology automates the things we do RIGHT.

The Levels of Vehicle Automation: SAE Standard J3016

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>	System	System	Human driver	Some driving modes
4	High Automation	the <i>driving mode</i> -specific performance by an automated driving system of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>	System	System	System	Some driving modes
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes

Levels of Automation: Simplified

- Level 0: hands and feet ON
- Level 1: hands or feet OFF
- Level 2: hands and feet OFF, eyes ON
- Level 3: hands, feet, eyes OFF, brain on
- Level 4: hands, feet, eyes, brain OFF
 - constrained environments
- Level 5: hands, feet, eyes, brain OFF
 - unconstrained

Tech Developers

Freightliner "Inspiration:" Highway Pilot (Level 3)



Uber Advanced Technology Group: Exit-to-Exit Driverless Operation



EMBARK:

Exit-to-Exit Driverless Operation



Starsky Robotics: Remote Driving



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Driver Assistive Truck Platooning





Near Term: Driver Assistive Truck Platooning



- Two trucks following safely at close following distances (~ 50-80 feet)
- Significant fuel savings due to aerodynamics
 - 5% for front truck and 10% for rear truck in two truck platoon
- Braking by front truck occurs simultaneously on follower truck
 - ...combining vehicle-vehicle communications with radar
- Level One system: follower truck driver still responsible for steering
- Gaps variable in real-time based on conditions

What Starts Must Align?

What Stars Must Align for AV to Happen?

- Public Acceptance
- State Regulations
- National Regulations
- Cybersecurity
- Liability
- Insurance

What Stars Must Align?

State Regulations for Truck Platooning

- Low level of automation eases the way
- State-level following distance laws are key
- Testing and demonstration of close following distance technologies approved:
 - California
 - Arizona
 - Colorado
 - Florida
 - Nevada
 - Oregon
 - Utah
- **Deployment** of platooning approved:
 - Michigan
 - Arkansas
 - Tennessee
- Significant activity in other states.

Evolution of Truck Platooning

- Product introduction 2017 (USA)
- Within Fleet >> Inter-fleet
- Driver Role in Follower Truck
 - steering
 - fully automated, driver supervises
 - no driver

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JaxPort: Use Cases of Interest



Truck Signal Priority

- FSP for trucks on Heckscher Dr. used to reach I-295
- assess improvements to traffic flow and emissions
- with or without automated throttle control
- Low hanging fruit, can be implemented with an aftermarket device on truck.

Platooning

- Work with tech providers, shippers, and fleets to implement two-truck platooning
- Low Speed
 - low speed platooning on the surface streets leading to I295
- High Speed
 - highway platooning on I295

Georgia Pacific
 Fanatics
 JanPak
 VW
 UniFirst
 Michaels
 Dynarex Corp.
 Johnstone Supply
 King Provision
 Allstates World Cargo
 BMW of North America
 Falken Tire
 Balfour Beatty Rail Systems
 Invacare Supply Group
 Revere Supply Company
 SCP Pools
 Arvco
 UPS
 Southeastern Aluminum
 D&H Distributing
 AAR Parts Trading

Dr. Pepper / Snapple
 Kraft Foods
 HJ Heinz
 Interline
 Pilot Pen
 Pratt & Whitney
 Prime Source Building Products
 International Granite & Marble
 Marcone
 Henry Schein
 Physician Sales & Service Medical
 Edgepark Medial Supplies
 Simpson Strong Tie
 Tri Star Freight Systems
 Owens & Minor
 NFI / National Dist. Centers
 ORS Nasco

Coach Leather
 Mercedes Benz
 Kraft Foods
 CEVA Logistics
 Keefe Supply
 TAP Worldwide
 Air Van
 Enkei Florida
 Sally Beauty Supplies
 CNF Worldwide
 Swisher International
 Magic Transport
 National Dist. Center
 Spirit Delivery
 Jackson Shaw
 Healthcare Supplies
 H.C. Shau
 Union Supply

General Electric
 W&O Supply
 Body Central Corp.
 Malnove Packing
 Elliott Company
 Bacardi
 OshKosh Defense
 National Distribution
 Outsource Logistics
 Kaman Aerospace
 Wasserstrom Co.
 Samsonite
 Sears Logistics
 Seaoonus
 Millard Refrigerated Services

Crowley
 Sears
 The Hillman Group
 Tweeter Home Entertainment
 Nivel Parts
 CHEP, USA
 MBX Logistics
 APT Engineering
 Southeast Paper
 APR Energy
 T&C Metals
 Premier Sydel

AJC Logistics
 Sam's Club
 Spectrum Logistics
 Survitec

Preferred Freezer Services
 Publix
 Winn-Dixie
 ABC Supply
 SanMar
 Burris Logistics
 Laney and Duke
 Southeast Toyota
 Samsung
 BJ's
 Unilever
 U.S. Cold Storage
 Johnson Development
 PenserSC
 ProLogis Park

Bedrosians
 JA-RU

Bridgestone Firestone
 Saft
 FedEx
 GE Oil & Gas
 Alenia North America
 Boeing
 Flightstar
 Jet Turbine Services
 Logistic Services Inat'l
 Northop Grumman



JaxPort: Use Cases of Interest

Full Automation Within Immediate Port Area

- Assess shipper and drayage fleet interest in automating trucks operating the really short drays (less than $\frac{1}{4}$ mile) as a real world testbed.



Port of Palm Beach Gate Congestion (adds up to 90 minutes to trip)



Resources

Resources

- ATA Technology and Maintenance Council, Future Truck
 - Automated Driving & Platooning: Issues & Opportunities (TMC IR 2015-2)
<http://www.atabusinesssolutions.com/Default.aspx?TabID=1415&productId=3095480>
 - Recommendations Regarding Automated Driving and Platooning Systems (TMC Future Truck Position Paper 2015-03)
http://www.trucking.org/ATA%20Docs/About/Organization/TMC/Documents/Position%20Papers/Future%20Truck%20Position%20Papers/FT_PP_2015_3.pdf
- Lessons Learnt: European Truck Platooning Challenge 2016
 - Dutch Rijkswaterstaat, Netherlands Ministry of Infrastructure and Environment
 - www.eutruckplatooning.com/
- Heavy Truck Cooperative Adaptive Cruise Control: Evaluation, Testing, and Stakeholder Engagement for Near Term Deployment
 - Auburn U., Peloton, Peterbilt Trucks, Meritor-Wabco, ATRI, Bishop Consulting
 - Phase Two Final Report
 - http://eng.auburn.edu/~dmbevly/FHWA_AU_TRUCK_EAR/
- Managing the Transition to Driverless Road Freight Transport (labor issues)
 - OECD International Transport Forum
 - <https://www.iru.org/resources/newsroom/driverless-trucks-new-report-maps-out-global-action-driver-jobs-and-legal-issues>
- Florida DOT
 - Driver Assistive Truck Platooning: Considerations for Florida State Agencies
 - Study underway by University of Florida
 - Report to be published later this year

Automated Vehicles Symposium

- AVS: the biggest and most significant annual event for Automated Vehicles worldwide.
 - July 11-13, San Francisco
 - 2017 will be the 4th meeting.
- Sponsors
 - Transportation Research Board
 - Association for Unmanned Vehicle Systems International
- Blending commercial interests with government and academia
- Expecting 1500 attendees this year
- <http://www.automatedvehiclessymposium.org/home>

Wrap-up

*No other technology ever offered in vehicles allows drivers to do something else with their **brain**.*

THIS IS NEW TERRITORY!

Thank You

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