CHAPTA: COLLABORATIVE HUMAN-AUTONOMOUS PLATOONED TRUCKS ALLIANCE

AN OUTLINE FOR AN INDUSTRY-SPONSORED RESEARCH CENTER

PRESENTERS:
DR. CRAIG SHANKWITZ
DR. NIC WARD
APRIL 26, 2017
Presenters

Craig Shankwitz
Nic Ward

Introducing CHAPTA
Collaborative Human – Automated Platooned Truck Alliance
Presenter & Institutional Qualifications

• Technical Expertise:
  – Nic Ward, Human Factors, Health and Safety Culture (>20 years)
  – Craig Shankwitz, Autonomous and Connected Vehicles (> 20 years)

• Facilities
  – Driving simulators
    • Supports workload, information, cueing, personality studies
  – TRANSCEND test facility
    • Supports controlled testing of actual vehicles
    • In-situ testing on adjacent roads.

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Collaborative Human – Automated Platooned Truck Alliance
What are we proposing?

• Multi-disciplinary, pre-competitive, industry-sponsored research alliance for **Collaborative Human – Autonomous Platooned Trucks**

• The alliance? (CHAPTA).
  – **Collaborative Human – Autonomous Platooned Trucks Alliance** (CHAPTA)
What is the CHAPTA goal?

• Bring together stakeholders to **cooperatively** and **quickly** bring hybrid driver – autonomous truck platoons to U.S. highways

• **Cooperatively**: Fleets, manufacturers, regulators, law enforcement, customers
Why is this needed? Background

- ~$117 BILLION industry moving freight 100-500 miles.
- 65% of cost is fuel and driver salary/benefits
  - That’s $75.7B!

<table>
<thead>
<tr>
<th>Motor Carrier Costs</th>
<th>Per vehicle, per mile, 2015</th>
<th>ATRI Annual Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Costs</td>
<td>$0.45</td>
<td>$29,190,113,280.00</td>
</tr>
<tr>
<td>Truck/Trailer Lease or Purchase Payments</td>
<td>$0.27</td>
<td>$17,506,304,640.00</td>
</tr>
<tr>
<td>Repair &amp; Maintenance</td>
<td>$0.18</td>
<td>$11,321,520,000.00</td>
</tr>
<tr>
<td>Truck Insurance Premiums</td>
<td>$0.09</td>
<td>$5,770,740,480.00</td>
</tr>
<tr>
<td>Permits and Licenses</td>
<td>$0.02</td>
<td>$1,591,482,240.00</td>
</tr>
<tr>
<td>Tires</td>
<td>$0.05</td>
<td>$3,182,964,480.00</td>
</tr>
<tr>
<td>Tolls</td>
<td>$0.03</td>
<td>$1,772,626,560.00</td>
</tr>
<tr>
<td>Driver Wages</td>
<td>$0.58</td>
<td>$37,548,629,760.00</td>
</tr>
<tr>
<td>Driver Benefits</td>
<td>$0.14</td>
<td>$9,005,460,480.00</td>
</tr>
<tr>
<td>Totals</td>
<td>$1.81</td>
<td>$116,889,841,920.00</td>
</tr>
</tbody>
</table>

Drivers

- Shortages
- Turnover
- Expense

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Savings: Hybrid human-autonomous platoon

Number of humans in the 5-vehicle platoon.

<table>
<thead>
<tr>
<th>Cooperative Human - Truck Platooning:</th>
<th>Assumed Aerodynamic</th>
<th>Number of Humans in the Platoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Vehicle Platoon</td>
<td>Lead Truck</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Followers</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Percentage of total operating costs saved - fuel economy and labor savings</td>
<td>5%</td>
<td>10% / 20%</td>
</tr>
<tr>
<td></td>
<td>2.2% / 4.2%</td>
<td>9.0% / 11.0%</td>
</tr>
<tr>
<td></td>
<td>15.8% / 17.8%</td>
<td>22.6% / 24.6%</td>
</tr>
</tbody>
</table>

Substantial financial incentive to operate the hybrid truck platoon.

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What are CHAPTA goals?

- Member-directed research
  - Human Factors
  - Workforce Development
- Ensure existing highway traffic compatibility
- Promote U.S. competitiveness
SARTRE project (SAfe Road TRains for the Environment)
- 2009 – 2012 €6.4M

Driver Supervised.

The European Truck Platooning Challenge, organized by Rijkswaterstaat this spring, involved trucks from DAF Trucks, Daimler Trucks, Iveco, MAN Truck & Bus, Scania and Volvo, in the first ever truck platooning across national borders.
Singapore to trial truck platooning with Scania and Toyota

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U.S. platoon programs: U Cal Berkeley

Three Trucks Equipped for CACC

- ACC + DSRC + modified vehicle following control
- Supplementary Information Display for driver

Technology Focus:
All three human occupied.


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U.S. platoon programs: Auburn University

Phase I Results

- Business case analysis
  - ATRI survey; finding platoon partners
- Vehicle and aerodynamics simulation/analysis
  - Following vehicle sees large drag reduction, even at larger distances
- Traffic modeling
  - No delays, improvement at headways <1.25 / 60% penetration
  
  http://eng.auburn.edu/~dmbavly/FHWA_AU_TRUCK_EAR/FHWA_AuburnDATP_Phase1FinalReport

Phase Two (Underway; Early 2016 Complete)

- Testing
  - Track, on-road, wireless performance
- Aerodynamics
  - Model refinement based on track test results
  - Effects of lateral offset by rear truck
  - Collecting data via "coast down" testing to further refine model
- Platoon Formation
  - Taking into account different fuel economy benefits for leader vs. follower
  - Examining protocols for platoon formation based on braking ability
- Traffic Impacts
  - Addressing entry/exit factors and non-interstate highways via simulation


Technology Focus:
Both trucks human occupied.

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U.S. platoon programs: TTI

Sponsor
TxDOT through funding from FHWA

Research Team
• TTI
• Ricardo
• Texas A&M Department of Mechanical Engineering

In-Kind Partners
• Navistar
• Bendix
• ZF-TRW
• Denso International Americas
• Great Dane Trailers
• Lytx
• ARGONNE National Labs
• US Army TARDEC

Technology Focus:
Both trucks human occupied.

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Disruption

• Autonomy IS going to happen
  – Most prognosticators: within next decade

• Competitive forces from Asia and Europe
  – Technology gap – U.S. less competitive

• Present-day driver shortages
  – Will be worse in the future

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CHAPTA Research Foci

• **Human Factors**
  – How does the human operator interact with and within the platoon?

• **Operations**
  – How does the platoon interact with other traffic on public roads?
CHAPTA Research Foci

• **Workforce Development**
  – How to find and retain the “right” driver?

• **Institutional Issues**
  – Job loss versus job shortage: public and employee perception

*Introducing CHAPTA*

Collaborative Human – Automated Platooned Truck Alliance
Q & A: Direct Your Questions via the Chat

1. Chat pod is on left side of screen

2. Type your question or comment here

3. Answers will appear here unless addressed verbally

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Plant question: Do you think that the cart is in front of the horse? You’re talking about hybrid platoons before we even have “simple” platoons.
Poll Question

- What do you see as the greatest challenge?
  - Human factors
  - Operations
  - Workforce development
  - Institutional questions
CHAPTA Research Focus

• Important to note
  – vehicle guidance and control R&D is not the focus of the IUCRC
    • Work of other academics (Univ. Minnesota, Auburn, UC Berkeley) and private companies (OTTO, Peloton Technology)
Human Factors: Nic Ward

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The Need for Human Factors Research

• Until now, platooning has been a technological exercise

• Consider the Uber/Otto model:

  Ognen Stojanovski, part of Uber’s advanced technologies group: “He said no changes to existing training or safety regulations are needed if someone is required in the driver’s seat when in autonomous mode.”

FleetOwner, “Road to driverless trucks clogged with unanswered questions,” Neil Abt, 24 April 2017
(m.fleetowner.com: http://m.fleetowner.com/regulations/road-driverless-trucks-clogged-unanswered-questions)

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The Need for Human Factors Research

• Until now, platooning has been a technological exercise
• Consider the Peloton model:

“With our system, the drivers are still steering. The drivers' feet are just off the gas and brake pedals.”

“...we are reducing that potential safe following distance very considerably. That's how we get it down to 30-50 ft.”

FleetOwner, “And just like that, platooning is here,” Aaron March, 07 April 2017, interview with Josh Switkes (m.fleetowner.com: http://fleetowner.com/technology/and-just-platooning-here)
The Need for Human Factors Research

• Literature disagrees with Uber and Peloton

Concept of “out-of-the-loop”

“...because they are not actively monitoring, making decisions or providing input to the driving task”

Schematic representation of the out-of-the-loop phenomenon (Louw et al., 2015)

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Tyron Louw
PhD Candidate at University of Leeds
Human Factors - Example Research Questions

• Personality suited for platoons.
  – What personalities are well-suited for platoon operations?
    • Determination of personality type.
    • How to recruit that personality?
    • How to screen?

• Cueing to promote trust.
  – How should the autonomous trucks “behave” in the platoon to make humans comfortable?

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Human Factors - Example Research Questions

• Information
  – How should that information be distributed amongst the human drivers?
  – How much information can be handled by a human driver?
  – How frequently should information be provided?
  – What modalities should be used?
PLANT QUESTION

• In the 2 driver, 5 vehicle model, do you have an idea of how to distribute tasks between the two drivers?
Operations, Workforce Development, Institutional Issues: Craig Shankwitz

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Operations: Example Research Questions

• Size / Ratio
  – What is the minimum ratio of humans to autonomous vehicles for an operational human-robotic platoon?
  – How large can a platoon be?

How to pre-trip electronic systems?

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Operations – Example Research Questions

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Operations – Example Research Questions

• In what position within the platoon should the human drivers be located?

• How does the size of the platoon affect non-platooned traffic WRT efficiency and safety?
  – Size limitations on platoons
  – Specific behavior at entrance and exit ramps

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PLANT QUESTION

• How will trucks with varying horsepower, braking capability, and loading be “lined up” in the platoon?
Workforce Development – Example Research Questions

• Driver training and retention
  – How to (re)train existing drivers?
  – How to attract and retain well-suited drivers?
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Poll Question

Do you think that this technological change will make commercial trucking more attractive to the millennial generation?

• Yes
• No

I think that we can blow this off.

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Institutional Issues – Example Research Questions

• Perception that jobs are being “eliminated”
  – Shortage vs. elimination

• Insurance and Liability

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Membership and Governance

<table>
<thead>
<tr>
<th>Participant Level</th>
<th>Annual Fees</th>
<th>Number of Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platinum</td>
<td>$50,000</td>
<td>4</td>
</tr>
<tr>
<td>Gold</td>
<td>$40,000</td>
<td>3</td>
</tr>
<tr>
<td>Silver</td>
<td>$30,000</td>
<td>2</td>
</tr>
<tr>
<td>Bronze</td>
<td>$20,000</td>
<td>1</td>
</tr>
</tbody>
</table>

Project Selection:
Process Flow
Q & A: Direct Your Questions via the Chat

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Plant questions: If a company has different divisions, can each division be treated as a separate entity (e.g., 2 memberships, one at a bronze level, and one at a silver?)
(Partial) List of Relevant Driving Simulator Studies:
— Personality evaluation
— Safe/comfortable distance to vehicle ahead
— Information Studies
  • Modality studies
  • Frequency of information
  • Content of information
  • Distribution of information amongst drivers

Operational Studies
  • Where should humans be located in the platoon?
  • How large of a platoon can a human operator handle?

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Validation studies
— Controlled Traffic Environment
  • High Speeds
  • Low Speeds
— Atmospheric conditions
  • Snow makers
  • Rain Makers
  • Mist Makers
— Pavement conditions
  • Dry
  • Wet
  • Snow covered
  • Ice covered

Operational Studies
— Size of platoon
— Platoon vehicle performance requirements
— Non-platoon vehicle interaction with the platoon
Poll Questions

• How Likely are you to join CHAPTA?
  – Very
  – Moderately
  – Not Likely
  – Need more time/information

• At which level will you likely join?
  – Platinum
  – Gold
  – Silver
  – Bronze

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Contacts

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To keep in touch with CHAPTA updates, please visit http://wti-truckplatoon.org/

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