SmartTruck Systems

A Look at Tractor Trailer Aerodynamics and Fuel Efficiency

ACEEE / ICCT
Workshop on Emerging Technologies for Heavy-Duty Vehicle Fuel Efficiency
Washington DC  July 22nd, 2014
SmartTruck Introduction

- Boeing and NASA Technology
- Aerion Super Sonic Business Jet
- Boeing MD 80 Winglet for aging aircraft
- Racing and Motorsports
  - Daytona Prototype development
  - Indy Car
  - NASCAR
- Ballistics
- Ford Hybrid Concept Car
- Bright Automotive Plug-In Hybrid Van
SmartTruck’s current focus is on advanced aerodynamics for trailers.
### Fuel Performance Perspective

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>FE Rating (miles/gallon)</th>
<th>Loaded Weight (lbs)</th>
<th>Vehicle Efficiency (ton-miles/gallon)</th>
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Which is the most fuel efficient vehicle on the road today?
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Which is the most fuel efficient vehicle on the road today?

The language of passenger cars and light trucks: miles/gallon
## Fuel Performance Perspective

The language of heavy-duty vehicles: **ton-miles/gallon**

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The language of heavy-duty vehicles: **ton-miles/gallon**
Fuel Performance Perspective
with Aerodynamic Perspective

**Class 8 Long Haul Vehicle**
Vehicle Efficiency: 228 ton-miles/gal  
MPG: 6.5 mpg  
Cd: ~0.60

**All Electric Compact**
Total Vehicle Efficiency: 192 ton-miles/gal_e  
MPG: 124 mpg_e  
Cd: 0.29

**Compact Gas Hybrid**
Total Vehicle Efficiency: 83 ton-miles/gal  
MPG: 50 mpg  
Cd: 0.25

**Gasoline Coupe**
Total Vehicle Efficiency: 53 ton-miles/gal  
MPG: 30 mpg  
Cd: 0.23
Class 8 Aerodynamic Potential
Impact on Highway Fuel Efficiency

- Due to the amount of highway miles driven, the tractor trailer would benefit more than any other vehicle on the road from advanced aerodynamic improvements.

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<th>Class 8 Long Haul Vehicle w/ Cd Similar to:</th>
<th>Drag Coefficient (Cd)</th>
<th>Highway MPG @ 65 mph (miles/gallon)</th>
<th>Highway Vehicle Efficiency (ton-miles/gallon)</th>
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<td>Today’s Class 8 tractor-trailer Design</td>
<td>.60</td>
<td>6.8</td>
<td>238</td>
</tr>
<tr>
<td>Passenger SUV</td>
<td>.45</td>
<td>~8</td>
<td>280</td>
</tr>
<tr>
<td>Aerodynamically advanced car</td>
<td>.29</td>
<td>~9.7</td>
<td>340</td>
</tr>
<tr>
<td>Best production passenger car</td>
<td>.23</td>
<td>~10.6</td>
<td>371</td>
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- If the tractor trailer had the aerodynamic performance of the top passenger cars it could achieve ~11 mpg at highway speed.
  - With no other technical advancements: same vehicle weight, engine efficiency, tire rolling resistance, etc.
  - 371 ton-miles/gallon is the equivalent of a compact passenger car achieving 225 MPG
Aerodynamics

Where is the Drag on Tractor Trailers?
Aerodynamics
The Low Pressure Wakes are Real

Low pressure hot spot causes high drag and low pressure creates snow and ice build up
UT System dramatically reduces low pressure hot spot and reduces drag. Significantly less snow and ice build up on the rear doors proves the point.
Aerodynamics
The Low Pressure Wakes are Real and can be Greatly Reduced

Standard Trailer

Trailer Equipped with UT System
Current Trailer Aerodynamic Strategies

- Side skirts
- Nose Fairings
- Boat tails
- Under Trailer Systems
Current and Emerging Aero Targets

- **EPA SmartWay**: 5% highway MPG improvement
  - Skirts, Boattails, Undertrailer systems
  - CARB requirements
- **EPA SmartWay Elite**: 9% MPG improvement
  - Combinations of skirts, boattails, undertrailer systems, nose
  - Undertrailer systems with inboard rear fairings
- **DOE SuperTruck Program**: ~10 mpg
- **EPA Phase I and II regulations**

**More sophisticated aero designs beyond the first wave:**
- Robust and durable (out of harms way, do more with less)
- Sophisticated system cooling strategies (tractor and trailer)
  - Intake and exhaust of cooling air flows
- Managed airflow over vehicle components
- Integrated aero packages: tractor/trailer
Tractor Trailer Concepts
Tractor Trailer Concepts

SmartTruck Aerodynamic Projections

- Drag Reduction Potential
- Fuel Efficiency @ 65 MPH

- Existing Tractor/Trailer: 0.58857
- Aggressive Tractor Upgrade: 0.35599
- Aggressive Tractor Upgrade w/ ST Phase 1 Trailer Components: 0.23733
Fixed Trailers vs. Multi-position Trailers

**Single 53’ Trailer**
- Single Trailer, Single gap
- Generally, one optimized trailer strategy

**28’ Pup Trailers**
- Double Trailer, Two gaps
- Trailer aero solution must be ubiquitous for interchangeable trailer positions #1 and #2

**Rocky Mountain Doubles**
- Double Trailer, Two gaps
- Generally, trailers remain in fixed positions: Can optimize for trailer #1 and trailer #2
Intelligent Transportation Creates Opportunities

- Platooning vehicles for safety and fuel performance
- Gap reduction at highway speeds
- Video rear vision systems
- GPS and vehicle awareness
- Vehicle learning to optimize aero (especially for trailer packages)
Factors to Consider

• Testing and validating fuel performance
  – Wind tunnel, Road and Track Tests, Coastdown, CFD

• Ensuring individual system improvements work with other system improvements

• CapX vs. ROI vs. NPV (value of investment)

• Trailer to tractor ratio: national average is 2.75

• Driver training and capability
  – Drivers impacts can be 30%

• Vehicle size and longer combination vehicles
Thank You

SmartTruck Systems
www.SmartTruckSystems.com

Mitchell Greenberg
mgreenberg@smarttrucksystems.com

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