High-Efficiency Engine Technologies Session
Introduction

Detroit, Sept. 29th 2010
Derek Rotz, Rakesh Aneja, Mark Groeneweg,
David Kayes, Alan Pearson, Sandeep Singh, Kevin Sisken
Changed priorities - Transition from emission regulations to $\text{CO}_2$ footprint & fuel economy
Predictive Technologies

2 Enables the truck to “see” the road that lies ahead

2 Uses on-board GPS and 3D digital maps

2 ‘Sees’ upcoming hills in advance

• Enables vehicle systems to be optimized for fuel economy

• Where can Predictive Technologies be used?
• Evaluates 2 kilometers of upcoming road grade
• Optimizes desired cruise speed to save fuel
• Maximum of 6% deviation from set speed
3D Digital Map Database

- High precision positioning and terrain data
  - Longitude, Latitude
  - Heading, Slope
- Covers over 200,000 highway miles in the continental 48 US states
Scoping Plans for 50% Improvement in Class 8 Freight Efficiency

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Department of Energy Super Truck Project Overview

Project objectives

Develop and demonstrate vehicle and advanced engine technology for Heavy-Duty Class 8 Trucks as follows:

- Demonstrate 50% improvement in Freight Efficiency (65,000 lbs CVW)
- Including 50% Engine Brake Thermal Efficiency
- Modeling and analysis for pathway to 55%

Funding

• Federal awards: $39.6M (+ $40M Daimler matching) over 5 years
• Pairing with partners or subcontractors encouraged
Determinants of Freight Efficiency

- Driving
- Idling
- Fuel Economy
- Power Distribution
- Hybrid Propulsion
- Energy Capture / Regeneration
- Efficient Operations
- Driving Behavior
- Route / Fleet Management
- Weight Reduction
- Freight Efficiency (ton–miles/ gallon)
Criteria to Guide Test Cycle Definition

### Traffic Density

- **SuperTruck Requirements**
  - ≥ 75% Highway / Freeway Cycle
  - ≤ 25% City Cycle
  - Idling: 5/12 total test cycle duration

### Terrain

#### Speed Limits

<table>
<thead>
<tr>
<th>Gradient (%)</th>
<th>-5 ... -3</th>
<th>-3 ... -1</th>
<th>-1 ... +1</th>
<th>+1 ... +3</th>
<th>+3 ... +5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>3%</td>
<td>11%</td>
<td>68%</td>
<td>10%</td>
<td>3%</td>
</tr>
</tbody>
</table>

### Hours of Service

- **11-Hour Driving Limit**
  - May drive a maximum of 11 hours after 10 consecutive hours off duty.

- **14-Hour Limit**
  - May not drive beyond the 14th consecutive hour after coming on duty. Following 10 consecutive hours off duty. Off-duty time does not extend the 14-hour period.

- **60/70-Hour On Duty Limit**
  - May not drive after 60/70 hours on duty in 7/8 consecutive days. A driver may restart a 7/8 consecutive day period after taking 34 or more consecutive hours off duty.

- **Sleeper Berth Provision**
  - Drivers using the sleeper berth provision must take at least 8 consecutive hours in the sleeper berth, plus a separate 2 consecutive hours either in the sleeper berth, off duty, or any combination of the two.

### DTNA / DDC Super Truck Team

Public Information
Target Setting Process

Component, System & Vehicle Measurements

Energy Balance Framework (simulation)

SuperTruck Targets
Technology Assessment

- Freight Efficiency
- Vehicle Integration
- Boundary Conditions
- Economics
- SuperTruck
- Safety / Regulatory
- Reliability / Durability
- Market
- Manufacturability / Serviceability
- Maturity

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Public Information 11
8 Cross-Functional SuperTruck Workstreams

- Engine Downsizing & Hybrid
- Powertrain Integration
- Energy Management
- Parasitic Losses
- Weight Reduction
- Aerodynamics
- Waste heat Recovery
- Packaging, drivability, weight distribution

Predictive Technologies

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Engine Technology & Integration

Exhaust Heat Recovery

Optimized Combustion

APCRS

Optimized Aftertreatment

Engine Downsizing

Next Generation Controller

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Tractor & Trailer Aerodynamics

Aerodynamics Competencies

Full Scale Wind Tunnel

Scale Wind Tunnel

Computational Fluid Dynamics

Fuel Economy Testing
Tractor-Trailer drag development: significant trailer contribution
Hybrid Electric Technology

Determinants Class 8 Hybrid Performance:

- Hybrid layout dependant
- Varies by drive cycle, terrain
- Maximized by broad feature set (regen., start/stop, WHR)
- ...

DTNA / DDC Super Truck Team
Acknowledgements

2 Department of Energy Headquarters
   2 Gurpreet Singh
   2 Roland Gravel

2 National Energy Technology Laboratory
   2 Carl Maronde
   2 Jeffrey Kooser

This material is based upon work supported by the Department of Energy National Energy Technology Lab under Award Numbers 409000-A-N8, DE-FC26-00-OR22805, and DE-EE-0003348.

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