Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles

Michael Schmitt
Institute of Vehicle Concepts
michael.schmitt@dlr.de
Agenda

- Aerospace and transport vehicles?
- Introduction
- Research issue
- Approach
- Outlook
### German Aerospace Center Research Topics

<table>
<thead>
<tr>
<th>German Aerospace Center</th>
<th>Research Topics</th>
<th>Program Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aeronautics</td>
<td>Terrestrial Vehicles</td>
</tr>
<tr>
<td></td>
<td>Space</td>
<td>Traffic Management</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
<td>Transport System</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td></td>
</tr>
</tbody>
</table>

**Aerospace and transport vehicles?**

Line-up of German Aerospace Center in transport vehicle research?

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Introduction
How can we develop more efficient commercial vehicles?

Goal:

- Special driving and load cycle for unique CVs
  based on real driving cycle and real load cycle

necessary to:

- Creating individual thermal and energy management
Introduction
Overview of different purposes of heavy duty commercial vehicles

• Driving Cycle on road
• Load Cycle
e.g.: garbage collection truck
basket crane truck

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Introduction – state of the art

Emission standard test for truck

European Transient Cycle (ETC) and Stationary Transient Cycle (ESC) used for emission certification of HD diesel engines

Two alternatives for verification:
1) whole vehicle chassis dynamometer test (Vehicle Speed )
2) only engine dynamometer test (Engine Speed and Torque)
Literature research – state of the art

Methods for creating driving cycles used in other studies

- Own record of route (speed and gradient profile)
- Scaling of standard driving cycle e.g. NEDC or ARTEMIS
  - over speed: reducing of $v_{\text{max}}$ and $a_{\text{max}}$
  - over time: reducing $a_{\text{max}}$
- Merging of existing cycles to a new individual cycle
- Combination of the previous points
Research issue – Example
Fuel consumption variation for real driving

<table>
<thead>
<tr>
<th>Rural</th>
<th>Motorway</th>
</tr>
</thead>
<tbody>
<tr>
<td>velocity: 50-90 km/h</td>
<td>velocity: constant 90 km/h</td>
</tr>
<tr>
<td>about 20 stops</td>
<td>no stops</td>
</tr>
<tr>
<td>elevation: 112m – 273m</td>
<td>elevation: 99m – 460m</td>
</tr>
<tr>
<td>6.5t – 11t</td>
<td>9.5 t</td>
</tr>
</tbody>
</table>

Fuel consumption [l/100km]

Boundary conditions:
- same Vehicle (MAN TGL 210 151kW / 2400 min\(^{-1}\))
- same driver
- different routes

Conclusion:
detailed analysis is necessary!
Approach

Generation of special reference load/driving profiles out of real load/driving cycles

1. Collecting Real drive/load cycle
2. Analyzing Methodology
3. Assembling special load/driving cycle
4. Measurement data processing
5. Database

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Approach – Example of real drive

Real drive of a tank truck from Simmozheim to Karlsruhe and back

- Length 153 km
- Time 4 h

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Methodology for analyzing driving cycles
Analyzing of real driving cycles and its components for filling up the database

Analyzing Information

- Working and driving load case
- Distribution of speed over vehicle speed
- Distribution of slope over vehicle slope
- Stop-and-go behavior
- Length and duration of acceleration and barking
- Qualitative characteristic of purpose
- … will be continued
Preliminary Results

Percentage distribution of speed over vehicle speed

Conclusion:
ETC provide good distribution of velocity, but most in the three areas of urban, rural and motorway

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Preliminary Results

Distribution of slope over vehicle slope

Conclusion:

The slope of the track is one of the most important information, that is missing in the standard driving cycle.

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Preliminary Results
Analyzing Start-and-Stop for a real and the standard driving cycle

Legend
- Urban
- Rural
- Motorway
- Working

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Preliminary Results

Rural: Influence of intersections for a real and the standard driving cycle

Conclusion:

ETC: 600 sec without stopping. In Germany a lot of traffic lights and intersections commit to stop or brake.

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Preliminary Results

Motorway: Influence of traffic for a real and the standard driving cycle

Legend
- Urban
- Rural
- Motorway
- Working

ETC Example

The motorway part of ETC is like the real driving cycle but it covers no traffic disruptions

Conclusion:
Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Outlook – Final assembling of load and driving cycles

Build a special reference load/driving cycle with the deposited fraction of the database

Database
Include fraction of real load/driving cycle with characteristic parameters

Customer survey
• Classification of load/driving profile
• Type of Vehicle
• Tour information

Fitting fractions from database
• How many fractions?
• Which fractions?
• What sequence?

Final assembling
• Combination of blocks
• Generation load/driving profile

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Outlook
How can we develop more efficient commercial vehicles?

Special Load Case for unique purposes of CVs

Energy Management
• Powertrain
• Electric components
• Control strategy

Thermal Management
• Climatisation
• Exhaust
• Heat losing

Developmental methodology for generic compilation of load cases for conceptual design of commercial vehicles
Thanks for your attention!

Questions?

Michael Schmitt
Institute of Vehicle Concepts
michael.schmitt@dlr.de