Focus on the Future
Powertrain Strategies for the 21st Century

University of Michigan
July 12, 2011
“Focus on the Future Powertrain – are you auto-motivated?”

Agenda

Challenges in Future Mobility

Continental Powertrain - Solutions for Future Mobility
“Focus on the Future Powertrain – are you auto-motivated?”

Introduction

- Global population is growing up to 10 billion in 2050
- Growing prosperity leads to an increasing demand in individual mobility
- Growing urbanization requires new mobility concepts

Status Quo

- Usage of fossil energy resources
- Global Temperature
- Fossil Peak
- Global Warming
“Focus on the Future Powertrain – are you auto-motivated?”

Introduction

- Since its beginning, mankind used renewable resources to provide energy
- From a long-term perspective fossil energies are just a peak in history

Status Quo

- Usage of fossil energy resources
- Global Temperature
- Future City

How can we provide enough „Alternative Energy“?
“Focus on the Future Powertrain – are you auto-motivated?”

Introduction

- Limitation of temperature increase to +2°C till the end of the century, in comparison to the pre-industrial level (UN Conference Copenhagen 2009)

Global Climate Targets

Climate Neutrality

Which one is the best propulsion system/fuel?

What does this mean for the automotive industry?
“Focus on the Future Powertrain – are you auto-motivated?”
Worldwide automotive CO₂ regulations become more stringent

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>154</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>95</td>
</tr>
<tr>
<td>USA</td>
<td>240</td>
<td>228</td>
<td>205</td>
<td>198</td>
<td>191</td>
<td>181</td>
<td>172</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>152</td>
</tr>
<tr>
<td>Japan</td>
<td>141</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td>109</td>
</tr>
<tr>
<td>China</td>
<td>185</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>167</td>
<td></td>
<td></td>
<td></td>
<td>145</td>
</tr>
</tbody>
</table>

- Orange: Enacted (through legislation)
- Gray: Proposed
- Blue: Estimates based on current trends

Enacted (through legislation)
“Focus on the Future Powertrain – are you auto-motivated?”

Worldwide automotive CO₂ regulations become more stringent

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ g/km</th>
<th>NEDC Cycle</th>
<th>Enacted (through legislation)</th>
<th>Proposed</th>
<th>Estimates based on current trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>35.9</td>
<td>35.9</td>
<td>35.9</td>
<td>35.9</td>
<td>56.2 mpg by 2025</td>
</tr>
<tr>
<td>2011</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>23.9</td>
<td>23.9</td>
<td>23.9</td>
<td>23.9</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>26.6</td>
<td>26.6</td>
<td>26.6</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>27.6</td>
<td>27.6</td>
<td>27.6</td>
<td>27.6</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>30.2</td>
<td>30.2</td>
<td>30.2</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>31.7</td>
<td>31.7</td>
<td>31.7</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>35.9</td>
<td>35.9</td>
<td>35.9</td>
<td>35.9</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>43.7</td>
<td>43.7</td>
<td>43.7</td>
<td>43.7</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>50.1</td>
<td>50.1</td>
<td>50.1</td>
<td>50.1</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>37.6</td>
<td>37.6</td>
<td>37.6</td>
<td>37.6</td>
<td></td>
</tr>
</tbody>
</table>

Converted to mpg for gasoline
“Focus on the Future Powertrain – are you auto-motivated?”
e-Mobility today, what are the main Challenges

- Battery cost are expected to drop by almost 60% within the next 10 years
- Combustion engines remain the most affordable solution for the next 20 years
- Alternative Fuels to replace fossil fuels to make internal combustion CO₂ neutral
“Focus on the Future Powertrain – are you auto-motivated?”
Combustion/e-Mobility: Managing both Trends

- Combustion engines remain dominant for 20+ years
- Clear trend towards Electrification

Propulsion 2020+

Powertrain: Clean Power

Source: Aligned Continental Automotive view based on Key Account Organization, Powertrain BUs and P S&T under consideration of external sources; Status May 2011

*) Start/Stop, Micro Hybrid part of Combustion
“Focus on the Future Powertrain – are you auto-motivated?”
Agenda
“Focus on the Future Powertrain – are you auto-motivated?”

Solutions for Future Mobility

- Downsizing
- Downspeeding
- Turbo Charging
- Friction Reduction
- Weight Reduction
- Onboard Power Generation
- Demand driven aggregates

Energy Efficiency

Powertrain Balancing – Managing the System

Holistic approach to increase efficiency and reduce emissions & cost

Advanced Combustion

Advanced Aftertreatment

Drivetrain & Transmission Electrification
“Focus on the Future Powertrain – are you auto-motivated?”
Solutions for Future Mobility – EMS3: 3rd Generation Engine Management Systems

PowerSAR

Electrification

Scalability

Open Architecture

Flexibility
“Focus on the Future Powertrain – are you auto-motivated?”
EMS3: 3rd Generation Engine Management Systems – Platform for all kinds of Vehicles

Sensors & Actuators
- MAP, EGR, ...
- Inj, Pump
- 2-12 cyl.; MPI, SDI, PDI, Diesel, Gasoline, CV, Hybrid

EMS3 Platform - Building Blocks
- System Functions & Definition
- Control Functions
- OS, Services
- I/O Driver
- Chip Set
- HW Modules (schematic)

wet Components

Variety of Business

Affordable Cars, 2/3 Wheeler

Mainstream Cars

Premium

Mainstream: 3-6 Cylinder Engines

LCV

CV

Customized Design

Products / Product families

Flexibility

Division Powertrain

13 / P ES / Guenther Raab / July 2011 © Continental
“Focus on the Future Powertrain – are you auto-motivated?”
EMS3: 3rd Generation Engine Management Systems – Platform for all kinds of Drivetrains

PowerSAR Open Architecture

Vehicle | Powertrain
--- | ---
Motion | Powertrain Management
Body & Interior | 
Chassis | 

3rd party Solutions
OEM Solutions

Runtime Environment (RTE)

Support of New Powertrain Topologies

Re-use functions across vehicle platforms

*) based on AUTOSAR 4.0

Division Powertrain

14 / P ES / Guenther Raab / July 2011 © Continental
Focus on the Future Powertrain – are you auto-motivated?”

Next Generation Engine Management System EMS3 Platform

EMS3 Platform - Building Blocks
2-12cyl.; MPI, SDI, PDI, Diesel, Gasoline, CV, Hybrid

Sensors & Actuators
- MAP, EGR,...
- Inj, Pump
- wet Components

System Functions & Definition
- OS, Services
- I/O Driver
- Chip Set
- HW Modules (schematic)

Chip Set

EMS3 Platform - Building Blocks
2-12cyl.; MPI, SDI, PDI, Diesel, Gasoline, CV, Hybrid

Sensors & Actuators
- MAP, EGR, ...
- Inj, Pump
- wet Components

System Functions & Definition
- OS, Services
- I/O Driver
- Chip Set
- HW Modules (schematic)

Affordable
- PFI Deka 7/8
- Best Value Diesel
- Best Value GDI

Main stream
- Diesel Servo Piezo PCR5

Premium
- Diesel Direct Piezo

LCV
- Diesel Piezo Servo or Direct

CV Customized Design (ECU only)

Scalability

Variety of Business

System Families

Division Powertrain
15 / P ES / Guenther Raab / July 2011 © Continental
“Focus on the Future Powertrain – are you auto-motivated?”
Solutions for Future Mobility – Gasoline CO2 reduction

Our road to sustainable mobility
**Selective Catalytic Reduction Control System** - designed as a cost effective solution for controlling the Exhaust Gas After-treatment systems (SCR, Diesel Particulate Filter) in passenger cars and heavy duty trucks.

**Product characteristics**
- Convert NOx gases through a chemical reaction by usage of UREA into Nitrogen, Oxygen and Water
- UREA is known as Ad-BLUE

**Technology**
- The control unit acquires relevant sensor information from the exhaust line as well as from the after-treatment systems (e.g. temperatures, pressures, mass flows, urea tank level, emissions)
- The sensor values are then utilized to calculate and execute the set point values for the SCR dosing system and the diesel dosing system.
“Focus on the Future Powertrain – are you auto-motivated?”
Solutions for Future Mobility – Drivetrain & Transmission Electrification

Electro-mechanical Dry Double Clutch Transmission Control Module

**Benefits**
- Driving without torque converter slip and traction torque interruption
- Up to **15% better fuel efficiency** compared to a conventional automatic transmission
- Electro-mechanic actuators instead of a hydraulic system

**Features**
- Integration of the transmission control unit as well as two BLDC motors into one mechatronic module
- The mechatronic module supports “plug and play” functionality, i.e. transmission can be fully calibrated and programmed by the transmission supplier.
- Considerable weight and cost reduction through integration of shift drum actuators and minimized wiring harness.
- Ready for “Stop/Start” functionality
“Focus on the Future Powertrain – are you auto-motivated?”
Solutions for Future Mobility – Drivetrain & Transmission Electrification

Powertrain: Major Hybrid and Electric Vehicle Components

- First Lithium Ion battery supplied in 2008 to the S 400 HYBRID
- First series contract for a complete Electric Powertrain, i.e. Electric Motor (Synchronous Machine); Battery and power electronics
  - SOP 2011 with an European OEM
  - Location Gifhorn, Germany with an annual capacity of 60K units
  - Peak outputs of 65-75 kW
  - Weight: just 65 kg

First worldwide high efficient rare earth free electric powertrain
“Focus on the Future Powertrain – are you auto-motivated?”
Disruptive changes are leading to new business models

Pay on Demand
(e.g. Internet)

Pay as you Drive
(e.g. Insurance)

Pay per View
(e.g. Television)

New Business Models for EV

- Driving flat rate
- Car sharing
- New mobility concepts
- ...

www.betterplace.com
“Focus on the Future Powertrain – are you auto-motivated?”

„ Most people spend more time and energy going around problems than in trying to solve them. “

Henry Ford 1863 - 1947
140 Years Continental
1871 – 2011

Thank you for your attention!