Fiat-Chrysler
The Challenges of Global Powertrain Engineering

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Chrysler Group LLC
1920-1924: Walter P Chrysler teams with Fred Zeder, Owen Skelton and Carl Breer, to design a revolutionary new car. 1925 Chrysler founded. 1928 partners with the Dodge brothers.

What are we trying to achieve together?
- True global producer of passenger vehicles
- Full spectrum of vehicles (A-F class)
- Multiple Brand approach
- Existing and emerging markets
- Capitalize on synergies
- Combine/develop best practices e.g. WCM

What are the challenges?
- Global market regulatory/requirement differences
- Managing portfolio complexity without duplication
- Cultural differences
- Learn from previous collaborations/ownerships
Fiat-Chrysler Vehicle Brands

Differentiate via:

- Technology level
- Brand sound engineering
- Transient response/feel
- Underhood appearance
- Power/torque ratings
- Torque curve shaping
- Transmission type
- Shift strategy and feel

Need to achieve brand differentiation at the powertrain level without excessive part proliferation
CO₂ legislation is core driver in all regions for the foreseeable future – EU leads but absolute limits converging.

Note: The standards are not adjusted for footprint / weight, fleet size effect and other geographical differences.
Emissions legislation is core driver in all regions for the foreseeable future – US leads but absolute limits converging
Different test procedures have a huge cost/resource impact without tangible benefit to local air quality/global warming.

Average vehicle demand energy (Jeep Patriot - AWD)
- FTP Combined = 10.34 MJ
- NEDC Combined = 6.06 MJ
### Regional Differences in Fuel and Lubricants

- **Region**: NAFTA, EAEM, Western Europe, Eastern Europe, LATAM, APAC
- **Fuel**: 89-100 RON, 95-98 RON, 90-98 RON, 93-98 RON, 88-98 RON
- **Lubricant**: GF 4 or 5, ACEA or OEM Spec, ILSAC or OEM Spec, Usage Specific
- **Service Interval**: 5-10K miles, 12.5-18.6K miles, 6-9.3K miles

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*Regional differences in fuel and lubricants result in considerable additional work to implement global powertrains around the world.*

- **APAC***: 88-98 RON, ILSAC or OEM Spec, Usage Specific

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* Manganese and methanol added to increase octane adversely affecting aftertreatment robustness.
Fuel/Vehicle Pricing – Cost of Ownership

**US**
- $46,875
- 225 hp (168 kW), AWD
- 3.0L Turbo Diesel

**Europe**
- $72,502*
- 201 hp (150 kW), AWD
- 3.0L Turbo Diesel

* 19% VAT, duties, foreign exchange, distribution

**Cost of vehicle ownership is significantly higher outside the US resulting in different vehicle attribute preferences**

**Oil change in US**
- $30 Generic oil
- $80 Synthetic oil (higher at OEM)
- $160 High end (synthetic)

**Oil change in Europe**
- $60 Minimum generic oil
- $160 Typical cost (higher at OEM)
- $300 High end
EU vs US Market Differences

Market Quartiles: US vs EU

<table>
<thead>
<tr>
<th>Segment</th>
<th>CAPE Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/B/C</td>
<td>&gt; 31.8 mpg</td>
</tr>
<tr>
<td>D</td>
<td>27.1 – 31.8</td>
</tr>
<tr>
<td>E</td>
<td>23.7 – 27.0</td>
</tr>
<tr>
<td>F</td>
<td>&lt; 23.6 mpg</td>
</tr>
</tbody>
</table>

Vehicle footprint correlates to disposable income

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Powertrain Portfolio - Engines

Chrysler and Fiat Powertrain Power Distributions

Fiat Distribution (Italian Market)

Chrysler Distribution (US Market)

Percent of Sales 2012 Registrations

Power [kW]

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Powertrain Portfolio - Engines

**Fiat Sales Mix (Euro Market)**
- Gas: 65%
- Diesel: 35%

**Chrysler Sales Mix (US Market)**
- Gas: 94%
- Diesel: 6%

**Cummins RAM Truck**

**Maserati**

**Gasoline – Fiat** = small displacement/lower output

**Chrysler** = larger displacement

**Diesel – Fiat** = significant in-house portfolio

**Chrysler** = 100% purchased
FWD options similar for Fiat and Chrysler. AMT/DCT transmissions more prevalent outside the US. Chrysler has larger capacity RWD transmissions.
Design/Validation Boundary Conditions

Chrysler

- Coolant Temperature = 100 °C
- Oil Temperature = 100 °C
- Fuel Energy (LHV) = 43.05 MJ/kg
- Electrical Loads = None
- Accessory Drive = Fully equipped

Fiat

- Coolant Temperature = 90 °C
- Oil Temperature = Floats
- Fuel Energy (LHV) = 42.5 MJ/kg
- Electrical Loads = Loaded
- Accessory Drive = Various levels

Opportunity to rationalize future test procedures
World Class Manufacturing (WCM)

WCM is ….

A system based on the systematic reduction of all types of waste and loss through the contribution of everyone and the rigorous use of methods and standards.

Applies its’ principles to all aspects of the plant organization, from quality to maintenance, cost control to logistics, in a culture of continuous improvement.

Was born of the collaboration between Fiat and the best European and Japanese experts, with the aim to develop a recognized, world class production standard.

Goals:
- Zero Accidents, Zero Waste, Zero Breakdowns, Zero Inventories

Deliverables: Continuous improvement

Two result examples from Fiat:

Energy Efficiency Improvement
- 1,700 projects introduced in 2011
- 80% energy savings increment over 2010
- €38 million savings

Waste Reduction
- 1,900 projects introduced in 2011
- €50 million savings

Huge opportunities for efficiency improvements and waste reduction over very large global manufacturing footprint.
Key Technology/Powertrain Transfer Examples

- **MultiAir**
- **CNG**
- **DDCT**

**Small I4 Gas Engines**

**Cylinder Deactivation**

**V6 Gas Engines**

**Hybrid/Electric**

**Axle Disconnect (4wd)**

**Diesel Engines**

**Multispeed ATX**
Social/Cultural

Leisure time

Racing

Start early vs work late

“Football?”
Key Conclusions

- Minimal Overlap within Powertrain portfolios but still need rationalization
- CO$_2$ driving downsized engines in all regions
- Joint entity has key technical capabilities in all necessary technologies for future – diesel emissions, advanced valvetrain, high efficiency transmissions, cylinder de-activation, pressure charging, advanced fuel systems
- Lack of harmonization in worldwide legislation is a vast waste of money and effort – but little hope of change
- Fundamental differences in engineering practices, books of knowledge etc already narrowing – good opportunity to question the paradigms
- Customer requirements/perceptions around the world are widely different but MAY start to converge if fuel prices increase dramatically in the US
- World Class Manufacturing is a cultural change with huge savings opportunity
- Out of phase economy highs and lows (US and Europe) allow some resource opportunities
- Joint R & D offers significant technical and financial benefits
- Global purchasing leverage benefits considerable

Truly a Marriage of Equals???