Transmission Technology Trends – Competition fuels the future

Patrick Lindemann
Global Warming
CO₂ Legislation Worldwide

China: 117 g/km in 2020
EU: 95 g/km in 2020
Japan: 105 g/km in 2020
USA: 109 g/km in 2025

Source: icct 2013
CAFE vs. Footprint

CAFE Fuel Economy vs Model Year and Footprint

- MY2012
- MY2013
- MY2014
- MY2015

mpg

Footprint in Sq Ft (wheelbase * track)
Fuel economy chain of a combustion engine

- 100% Fuel energy
- 34% Exhaust gas heat
- 29% Heat loss
- 25% Charge cycle
- 3% Engine
- 8% Accessories
- 3% Transmission & driveline
- 17% Wheels

On the basis of Nizzola.
Damper is enabler for engine technology

Torque Converter Dampers – addressing the needs of the modern powertrain
Mike Swank
Transmission Technology Trends –
Competition fuels the future

Patrick Lindemann
Competition fuels the future

The Contestants
Competition fuels the future

The Contestants
Competition fuels the future
Competition fuels the future
Selection Criteria:

- Fuel Economy
- Start-stop Capability
- Ratio Spread
- Efficiency
- Regulation
- Environmental Laws
- Cost
- Comfort
- Durability
- Region:
  - Japan
  - Europe
  - US
  - China
  - Market
- Technology:
  - Image of a Technology
  - CAFE Standards
  - CAFE Credits
- Government Incentives
- Performance
- Weight
- Package Space
- Start-stop Capability

The Customer has to decide
Manual Transmission
Motivation for clutch automation

- Main driver in the past: Comfort and robustness
- Additional driver for today / future: Fuel efficiency
- MT with strong Disadvantage!
Fuel saving potential of Start/Stop and Sailing

Without automation, sailing potential can not be tapped!
### Options for clutch automation

<table>
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<tr>
<th>ECM</th>
<th>CbW</th>
<th>MTplus</th>
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<tbody>
<tr>
<td><img src="image1" alt="Diagram ECM" /></td>
<td><img src="image2" alt="Diagram CbW" /></td>
<td><img src="image3" alt="Diagram MTplus" /></td>
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</tbody>
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- **2-pedal** design
  - Actuator with **high** dynamic
  - Shift intention sensor
- **3-pedal** design
  - Actuator with **high** dynamic
  - Pedal load emulator
- **3-pedal** design
  - Actuator with **reduced** dynamic
Key activities for Clutch by Wire

Flexible actuator concept
- Tailored for upgrading manual transmission to CbW
- Modular with high add-on capability

Compact force emulator device
- Space neutral unit with integrated position sensor
- Optimal pedal load by new spring system
Key activities for MTplus

Demonstrator vehicle
- Study of operating handling and feedback on foot actuation
- Study of extended functionality (sailing, comfort, misuse protection)

Actuator unit design
- Detailing of final architecture
- Study cost-benefit ratio
Functionality of clutch automation

- **Drive w/o clutch pedal**
- **Optimal pedal load**
- **Slip control**
- **Anti judder**
- **Anti jerking**

**ECM**

- **Traction control**
- **Impact**
- **CbW**

**MTplus**

- **Longer gear ratios**
- **Sailing**
- **Recuperation**
- **Electric launch & creeping**
- **Automated launch and creeping**
- **Engine stall**
- **Resonance drive**

**CO₂ Potential**

- **Assistance**
- **Protection**
- **Comfort**
- **Safety**

**Driving w/o clutch pedal**

- **ECM**
- **CbW**

**Sailing**

- **Recuperation**
- **Hybrid capability**
- **Automated launch and creeping**
- **Pedal load assist**
- **Emergency break**

**CO₂ Potential**

- **Assistance**
- **Protection**
- **Comfort**
- **Safety**
Fuel saving potential of automated launch

Heat dissipation in clutch during vehicle launch (measurement)

Occurrence in %

Energy in kJ

0 50 100 150 >200

Manual launch
Fuel saving potential of automated launch

- Reduced energy level due to automated launch can be used to adjust gear ratios
- Reduction of gear ratios by 10 % can lead to fuel saving of 5.6 % (NEDC) / 2.5 % (WLTP)

Simulation result (2.0l Diesel)
Double Clutch Transmission
DCT as an Efficient Basis for a Full Hybrid System

- Excellent efficiency of the dry DCT!
- No disconnecting clutch necessary!
- No additional axial space required!

2004 mild hybrid-demonstrator ➔ 14 % improved fuel efficiency!

2006 full hybrid-study ➔ > 20 % improved fuel efficiency!

2014 Schaeffler Symposium • First production application!
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Test-ride report for Honda Fit hybrid: High quality drive feeling (Auto-Proof)

Honda unveiled the new FIT with magical fuel efficiency and drive feeling. In addition to universal utility, the 3rd generation offers good drive feeling. (Car watch)

Explanation of the structure of the i-DCD which achieved class number 1 fuel efficiency in the world. (MONOist)

Unveiled Honda Fit, 36.4km/l best in class fuel efficiency achieved.

Target sales: 15,000 unit/month (Nihon Keizai Shimbun evening)

HONDA Fit Hybrid will be awarded JAHFA (Japan Automotive Hall of Fame Association) car of the year in 2013-2014.

Source: "Internal Press research"
Modular Approach Clutch / Actuation

Hydrostatic clutch actuator HCA

Gear actuator

180 Nm

370 Nm
Wet Double Clutch System with CSC

370 Nm
"Dry or Wet" or "Dry and Wet"?

Transmission production in million per year


Modular and Efficient Actuator Technology

Clutch actuator

Gear actuator

Average power consumption in W

2007  2010  2011  2013

Dry DCT A

Dry DCT B

Dry DCT C

Wet DCT

Dry DCT

200 W

2007  2010  2011  2013

- Dry DCT A
- Dry DCT B
- Dry DCT C
- Wet DCT
- Dry DCT
... the Powertrain of Tomorrow - Requirements

- Efficiency ✓
- Ratio spread ✓
- Comfort ✗
- Performance ✓
- Weight ✓
- Space ✓
- Cost ✓
- Start-stop capability ✓
- Hybridization capability ✓

Graph:
- Y-axis: Speed in rpm
- X-axis: Time in s
- Engine line
- Input shaft line
Further Potential for Launch and Creeping

- Facing
  - Geometric optimization of parts and assembly
  - Compensation function
  - Anti-judder control system
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- Facing
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![Diagram showing cumulative frequency in % for different facings and excitations.](image)

- Optimized facings RCF10, B8040
- Next generation Double clutch facings e.g. B9000
- Standard facing

**Tribological system damping**
Further Potential for Launch and Creeping

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- Geometric optimization of parts and assembly
- Compensation function
- Anti-judder control system
Further Potential for Launch and Creeping

- Facing
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### Efficiency
- ✓

### Ratio spread
- ✓

### Comfort
- ✓

### Performance
- ✓

### Weight
- ✓

### Space
- ✓

### Cost
- ✓

### Start-stop capability
- ✓

### Hybridization capability
- ✓
The Planetary Automatic Transmission

Efficient Comfort --
Low drag wet clutches while maintaining performance

Matt Frary

ITC - Innovative Solutions
for Torque Converters Pave the Way into the Future

Markus Steinberger
The CVT

CVT – Always In The Right Gear
Allen Pervo
Customer acceptance

International Customer Clinic:
What is your favorite Transmission

- DCT  Sporty
- CVT  Smoooth
- Planetary AT Have to pull out Stumps
Transmission Production

Worldwide

Transmission production in million per year

2013  2017  2022

DCT
CVT
AT

Prediction is very hard, especially about the future

Yogi Berra
1925 –