Utilizing a Small Efficient DCT for the Chinese Market

Drivetrain Forum 2016, Untergruppenbach
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Utilizing a Small Efficient DCT for the Chinese Market

Agenda

1. Voice of the customer
2. 6DCT150 architecture
3. 6DCT150 matching development
4. Working together in a JV, localization in Wuhan
5. Future outlook
Voice of the customer

- Why choose DCT as strategic route?
- Why develop the first small torque capacity wet DCT in the world?

✓ Chinese government regulation
✓ Requirement of Chinese customer
✓ Chinese passenger vehicle market development estimation
CO₂ targets get stricter for all markets
Due to high transmission efficiency DCT contributes for vehicle fuel consumption reduction.

Average fuel consumption per 100km for a 1000kg:

- AT: 5.9l/100km / 1000kg
- CVT: 5.5l/100km / 1000kg
- DCT: 4.6l/100km / 1000kg

Snapshot of China made passenger cars 2011.
Voice of the customer

- Requirements of Chinese customer

**High performance** — fast & comfort launch and shifting performance advantage of DCT:

- Fast response
- High internal efficiency

**Low cost** — price & cost of usage advantage of DCT:

- Partly carry-over MT technology to reduce manufacturing cost.
- Good flexible gear & shaft structure to reduce development cost.
- **Customer benefits** from reduction of manufacturing cost and development cost
- **Low cost of usage** — DCT helps customer to reduce fuel cost.
Voice of the customer

- Volume distribution of Chinese cars by different level

A/A0 level occupy 70% of Chinese car market

- Price: 60k~160k RMB
- Engine: 1.0~2.0L naturally aspirated /1.0~1.4L, boost/maximum torque around 200Nm

A/A0 level request to DCT: lower price, more suitable for small engine.
Voice of the customer

- **Advantage of small torque capacity DCT:**
  - Smaller mass and inertia, suitable for small engines, better launch & acceleration response and lower fuel consumption.
  - Small size leads to better package in vehicle.
  - Lower price.

- **Advantage of wet dual clutch:**
  - Heavy traffic leads to frequent vehicle launch, clutch will be in slipping status by a long time. Wet clutch has better thermal capacity and reliability.
  - Smaller inertia compared to dry clutch, lead to better dynamic response.
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6DCT150 Architecture

- 6/1 speeds to be achieved
  - BUT: 7 speed transmissions don’t fit in small engine compartments of small vehicles such as sub-B

- Deliver world class efficiency
  - BUT: Small engines and high transmission inertia will not deliver that

- Transmission weight and cost do not support OEM vehicle cost strategy
  - BUT: All developed DCT architectures are too big and too expensive
6DCT150 Architecture

- GETRAG approach to 3rd generation DCT technology
  - Wet inhouse clutch
    Common TCU and software with 7DCT300
    Common on-demand actuation and sensor concept

- Reduce cost and weight
  - Single drum actuation
    Direct shift forks, no linkage, 3-shaft design

- Reduce size to package in small vehicle
  - Cascaded gears
    Six speed gears only
Smart modularity as GETRAG approach:
“Question everything, but not the technology”
Common technology used e.g. for shift actuation, but different design.

Common parts in 3rd generation DCT
- Clutch assy
- Clutch support
- Main bearings
- Electrical hardware, sensors, connectors, e-motors
- Synchronizer systems
- Oil, oil filters, oil pumps
- Shift drum drive mechanism
“Commonality to reduce D&D effort and manage product quality”

- Local content as project target (supplier selection)
- High inhouse content to foster product knowledge
- Localize proven manufacturing technologies
- Localize product testing to control product quality
- Consequent lean manufacturing layout and process
<table>
<thead>
<tr>
<th>Advantage</th>
<th>Benefit</th>
<th>Main Features contributing to the advantage</th>
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<tbody>
<tr>
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<td>OEM</td>
<td>Driver</td>
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<td>Best in Class Fuel Economy</td>
<td>✔️</td>
<td>✔️</td>
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<td></td>
<td>• On demand Electro-Hydraulic Clutch Actuation and Cooling, Start-stop compatible</td>
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<td>Competitive Piece Costs</td>
<td>✔️</td>
<td>(✔️)</td>
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<tr>
<td></td>
<td>• Direct Actuation</td>
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<td>• Gear Layout / Patented Gear Flow Path</td>
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<tr>
<td>Best in Class Drivability, Smooth Shifting</td>
<td>✔️</td>
<td>✔️</td>
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<td></td>
<td>• Powershift using Dual Wet Clutch</td>
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<td></td>
<td>• Shift System with pre-selection</td>
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<tr>
<td></td>
<td>• Launch Performance (1st gear ratio up to 18)</td>
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<tr>
<td>Small Packaging</td>
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<td></td>
<td>• Gear Layout</td>
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<td>• Shift Actuation</td>
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<td>Best in Class weight</td>
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<td></td>
<td>• Gear Layout</td>
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<td></td>
<td>• Electro-Hydraulic Clutch Actuation</td>
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<tr>
<td></td>
<td>• Electric Shift Actuation</td>
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The first vehicle with 6DCT150——Dongfeng Passenger Vehicle A60

- A level, with 1.5l/148Nm natural aspirated engine
- Market launch 2016
- NEDC fuel consumption 5.8L/100km, reduction by 12% and 17% compared to 5MT vehicle 6.6L/100km) and 4AT vehicle (7.0L/100km).
6DCT150 matching development on Dongfeng Vehicle

- Summer & winter tests
- Specific road test
- Chinese environment tests
- Specific Chinese area.
Summary:

- The first Dongfeng passenger car with a DCT150 transmission launched
- Continuation for further applications in the next month and years
- Strong partnership between GETRAG and Dongfeng for DCTs as hub for other customers
- Specific vehicle test procedures to prove technology readiness for China
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Working together in a JV, localization in Wuhan

Dongfeng GETRAG Transmissions - Company Development

- 2012.10.22: Dongfeng and GETRAG sign Joint Venture Agreement
- 2013.03: Company registered
- 2013.10: Start Construction
- 2014.10: Plant constructed
- 2015.04: First Transmission shipped (confirmation prototype)
- 2016.04: SOP 6DCT150
Working together in a JV, localization in Wuhan

DGT
Site Overview
“Establish a full capable Transmission Company as JV in Wuhan”

- Localize all manufacturing technologies for DCT technology
- Establish D&D department for full local development of DCTs
- Build test facilities for cold and hot transmission tests
- Close relationship to JV partner and lead customer
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Future outlook

Variable sDCT concept

Variable Diff drop

170 mm

183 mm

Variable Diff position

15 mm
Future outlook

Hybrid Transmission

Relevant Hybrid Modes
- electric driving
- extended sailing
- recuperation
- boosting
- generator-mode / load-shift
- charge@standstill
- restart of internal combustion engine with torque-split effect
- hybrid modes identical for 48V and Plug-In

Specific Functions
- impulse cranking support omit of conventional starter
- Torque–split effect
  - support dynamic and comfortable restart of ICE
  - higher CO2 potentials for high voltage solutions in load shift
Future outlook

- POEM design (Package Optimized E-Machine)
- one intermediate gear to sub-transmission two
- e-machine as power pack
- identical integration concept for all HDTs
- e-machine fixed connected to sub transmission two, 6th gear
THANK YOU
FOR YOUR ATTENTION
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