The Outlook for Automotive Transmission Technologies in China

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Presentation Outline

- Background
- Market Development of Transmissions in China
- Technology Assessment of Automated Transmissions
- Outlook for Automated Transmissions in China
- Conclusions
Definition of Terminologies

- **MT** Manual transmission
- **AMT** Automated manual transmission
- **AT** Automated transmission including AMT, AUTOE, CVTE, DCT and other non-manual transmissions
- **AUTOE** Planetary automatic transmission
- **CAR** Passenger cars
- **CVTE** Continuous variable transmission
- **DCT** Double clutch transmission
- **ICE** Internal combustion engine
- **LCV** Light commercial vehicles
- **LV** Light vehicles (including cars and LCVs)
Background: Why Transmission?

Manufacturing Cost Breakdown for a LV*

- Final Assembly: 21%
- Chassis: 21%
- Powertrain: 32%
- Body: 26%
- Engine: 25%
- Transmission: 7%

• Manufacturers: transmission represents a significant portion of manufacturing cost
• Consumers: transmission equipment will be an important factor affecting purchasing decision
• Engine and transmission match is very important for fuel consumption, ride quality and vehicle handling
• Transmission: the next wave of R&D in China?

Past, Present and Near Future of Transmission Market

- Despite cost competitiveness, high fuel efficiency and good sense of control, MT is losing ground to AT
- Automated transmissions have negligible penetration in LCV segment (<1%) and remain marginal in the long run
- Assuming business as usual, 33% of light vehicles (44% of passenger cars) will be equipped with automated transmissions by 2012
Brief Review of Manual Transmission

Start of MT6*

End of MT4

* Major players include VW, Getrag, Aichi Machine, Aisin AI and Chery
Why Automated Transmissions?

- Ever-congested metro areas
- Fast urbanization
- City residents’ purchasing power
- Increasing number of female drivers

*: According to Sinotrust, female car-owners rose from 20.3% in 2002 to 30.9% in 2006

^: From cnauto, automated transmission claimed second place amongst the most attractive options to female drivers
Segment Distribution of Automated Transmissions

Penetration to all segmentations
CAGR = 30%

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A Schematic Introduction of ATs

AMT

AUTOE

CVTE

DCT

Source: auto.howstuffworks.com
Options of Automated Transmissions: AMT

- Resulting from plunge of Chery QQ in 2007
- Introduction of QQ6 and S-18 in 2008

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<td>81%</td>
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• Resulting from plunge of Chery QQ in 2007
• Introduction of QQ6 and S-18 in 2008

Volume vs. Penetration

Millions
0.0% 0.5% 1.0% 1.5% 2.0%

Penetration
Options of Automated Transmissions: AUTOE

Majority of automated transmissions

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<td>13%</td>
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</table>
Options of Automated Transmissions: CVTE

- Niche market player
- Mainly applied to engines <2000cc
Options of Automated Transmissions: DCT

- Applicable to all segments
- Number of gears $\geq 6$
# Comparison of Structure and Mechanism

<table>
<thead>
<tr>
<th>Key Components</th>
<th>AMT</th>
<th>AUTOE</th>
<th>CVTE</th>
<th>DCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shifting control module + Manual transmission</td>
<td>Hydraulic torque converter + Planetary gear sets</td>
<td>Wet clutch (or torque converter) + Pulley + Metal belt (or chain)</td>
<td>Two wet or dry clutches + Layshaft gear sets</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gear Ratio Change Mechanism</th>
<th>AMT</th>
<th>AUTOE</th>
<th>CVTE</th>
<th>DCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls the clutch operation and shifts the gears through the control module</td>
<td>Actuation of clutches and brakes associated with planetary gears</td>
<td>Change of the “effective” radius of pulleys</td>
<td>Actuation of double clutches and the pre-selected gear sets</td>
<td></td>
</tr>
</tbody>
</table>
Technical Features: A Subjective Rating in General

- Riding Quality
- Cost
- Torque Capacity
- Efficiency
- Powertrain Integration
- Ease of Operation

Consumer

Manufacturer

MT
AMT
AUTOE4
AUTOE6
CVTE
DCT
Major AT Programs in China

Existing or Planned Manufacturing Facilities of Foreign Manufacturers

- **AMT**: Magneti Marelli
- **AUTOE**: Aisin AW, ZF, Shanghai GM, Honda, Antonov
- **CVTE**: Jatco, Punch
- **DCT**: Borg Warner

R&D Activities of Domestic Manufacturers

- **AMT**: FAW
- **AUTOE**: Geely, Chery, Great Wall
- **CVTE**: Geely, Chery, Sanming, Rongda
- **DCT**: SAIC-Brilliance
Analogous Comparison: Powerplant and ATs

\[\text{CVTE} \leftrightarrow \text{Hybrid}\]
\[\text{AMT} \leftrightarrow \text{CNG/LPG}\]
\[\text{AUTOE} \leftrightarrow \text{Gasoline ICE}\]
\[\text{DCT} \leftrightarrow \text{Diesel ICE}\]

In China

✓ Technology Application
✓ Market Presence
✓ Supporting Facilities
# Analogous Comparison of Powerplant and ATs in China

<table>
<thead>
<tr>
<th></th>
<th>Technology Application in China</th>
<th>Market Presence in China</th>
<th>Supporting Facilities in China</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pair 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMT</td>
<td>Slight modification to MT</td>
<td>Very low penetration</td>
<td>Good with long time MT production</td>
</tr>
<tr>
<td>CNG/LPG</td>
<td>Slight modification to ICE</td>
<td>Very low penetration</td>
<td>Good with long history of ICE production</td>
</tr>
<tr>
<td><strong>Pair 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUTOE</td>
<td>Relatively mature</td>
<td>Majority of ATs</td>
<td>Good with gear industry</td>
</tr>
<tr>
<td>Gas Engine</td>
<td>Relatively mature</td>
<td>Majority of ICEs</td>
<td>Good with engine components production</td>
</tr>
</tbody>
</table>
### Analogous Comparison of Powerplant and ATs in China

<table>
<thead>
<tr>
<th>Technology Application in China</th>
<th>Pair 3</th>
<th>Pair 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CVTE</strong></td>
<td>Relatively new</td>
<td>New</td>
</tr>
<tr>
<td><strong>Hybrid</strong></td>
<td>Relatively new</td>
<td>Small but has potential</td>
</tr>
</tbody>
</table>

| Market Presence in China       | Low penetration | Low penetration | Small but has potential |

<table>
<thead>
<tr>
<th>Supporting Facilities in China</th>
<th>Lack of facilities for belt, pulley etc.</th>
<th>Lack of facilities for battery, motor etc.</th>
<th>Good with engine components production</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DCT</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Diesel Engine</strong></td>
<td></td>
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</tr>
</tbody>
</table>
A Geographical Perspective

Diesel + DCT

Gasoline + AUTOE

China?

Hybrid + CVTE

Does this happen just by chance?
China: Several Key Propositions

• No single winner for automated transmissions in the medium or long term
  - **Market**: co-existence of foreign and domestic OEMs
  - **Technology**: pros and cons for each type of automated transmission
  - **Consumer**: diversified preferences and driving patterns due to large population of consumers living in widely different environments

• Then, the winning strategy:

<table>
<thead>
<tr>
<th>Foreign Manufacturers</th>
<th>Chinese Domestic Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Closely follow the market and consumer preferences</td>
<td>• Closely follow the market and consumer preferences</td>
</tr>
<tr>
<td>• Manufacturing localization and expansion</td>
<td>• Development of technology know-how is a must</td>
</tr>
<tr>
<td>• Local R&amp;D, if possible, is a big plus</td>
<td>• In line with vehicle and engine strategy</td>
</tr>
<tr>
<td></td>
<td>• Establishment of feasible business model</td>
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</tbody>
</table>
In addition to their vehicle and engine programs, Chinese domestic manufacturers have to consider the following factors:

<table>
<thead>
<tr>
<th>Factor</th>
<th>AMT</th>
<th>AUTOE</th>
<th>CVTE</th>
<th>DCT</th>
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<tbody>
<tr>
<td>Supporting Facilities in China</td>
<td>💚</td>
<td>💚</td>
<td>🟥</td>
<td>💚</td>
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<tr>
<td>Application Limitations</td>
<td>🟥</td>
<td>💚</td>
<td>🟥</td>
<td>💚</td>
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<tr>
<td>Fuel Efficiency</td>
<td>💚</td>
<td>🆕️*</td>
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<tr>
<td>Technical Hurdles</td>
<td>💚</td>
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<td>🟥</td>
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<td>Market Acceptance</td>
<td>🟥</td>
<td>💚</td>
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</table>

* Efficiency varies with the number of gears
### Rising Star: DCT
- ★ The best suitability
- ★ Cost could be reduced with economies of scale

### Question: CVTE
- ? Setup of supporting facilities
- ? Increase of torque capacity

### Cow: AUTOE
- 🐄 High market share
- 🐄 Relatively steady growth

### Dog: AMT
- ✕ Limited penetration
- ✕ Limited growth potential
Conclusions

• While manual transmissions will remain in majority in the short-term, automated transmissions continuously gain market acceptance at an increasing pace.

• Given the market complexity, there will be no single winner for automated transmissions in China even in the long term.

• In China, there is indeed similarity between AMT and CNG/LPG, AUTOE and gasoline ICE, CVTE and Hybrid, DCT and Diesel. Meanwhile, the latter 3 pairs also mate together in 3 major markets.

• For Chinese domestic manufacturers, DCT appears to be a very promising product in the long run.
Thank You!

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