



## Transmissions Report – 2012 Edition

The latest edition of this report examines the key development drivers and challenges in the transmissions sector. The report focuses on key technologies and looks in particular at the following transmission types; Manual (MTs), Dual Clutch Automated Manual (DCT), Automatic (AT), Continuously Variable (CVT), Hybrid and Electric Vehicle.

Furthermore the report includes a section on clutch development and looks at the market development in key global regions. The report also includes 12 detailed profiles of the major suppliers active in this sector.

### Background to this research

The transmissions sector has undergone a number of important changes during the past few years, a trend that is likely to continue for the foreseeable future as OEMs strive to meet their regulatory obligations and reduce carbon dioxide (CO<sub>2</sub>) output by improving fuel economy.

For some decades the transmissions sector was dominated by in-house manufactured manual (MT) and planetary automatic transmissions (AT) in a competitive environment, where the business imperative was driven by cost control and the utilisation of existing installed capacity. Although some technology innovation inevitably moved the transmission forward, the pace of development was relatively slow.

Regulations to reduce both noxious gas emissions and greenhouse gas emissions have served to change the focus of transmissions development over recent years such that the sector can be seen to be at the frontline in reducing fuel consumption. This has led to a significant change.

### Table of Contents

#### Introduction

- Changing sector drivers

#### Transmission development drivers

- Emissions regulations

  - Europe

  - Japan

  - The United States

China

Other countries

Transmission efficiency gains

Performance characteristics

Product differentiation

Investment and installed capacity

Consumer and regional preferences

Transmission development challenges

Packaging

Weight

Torque density

Ratio spread

Noise, vibration and harshness (NVH)

Cost

Safety regulations

Transmissions technology

Manual Transmissions (MTs)

Automated manual transmissions (AMTs)

Dual clutch automated manual transmissions (DCT)

Commonality of componentry

Dry clutch or wet clutch?

Electro-hydraulic or electro-mechanical actuation?

DCT Suppliers

Automatic transmissions

Automatic transmissions gear set configurations

Six-speed automatic transmissions

Seven-speed automatic transmissions

Eight-speed transmissions

Nine-speed transmissions

Global AT production mix forecast by number of ratios

Manual override systems on automatic transmissions

Continuously variable transmissions (CVT)

Market considerations

## Other transmission technologies

Infinitely variable transmissions (IVT) or toroidal transmissions

VMTs Positively Engaged, Infinitely Variable Transmission

Antonov TX6

Zeroshift

## Hybrid transmissions

One-Mode and Two-Mode Hybrids

Getrag

Jatco

FEV

Antonov

IAV

## Electric vehicle transmissions

BorgWarner

Getrag

Oerlikon Graziano and Vocis

Xtrac

Fallbrook Technologies

## Clutch development

Electric Actuation

Hybrid integration

Clutch-by-wire

## Market development

Distinct developed markets

Western European transmissions production

North American transmissions production

Japanese and South Korean transmission production

Chinese transmission production

Indian transmission production

South American transmission production

## **SUPPLIER PROFILES**

Aichi Machine Industry

BorgWarner  
Getrag  
GKN Driveline  
JATCO  
Kongsberg Automotive  
LuK  
Oerlikon  
Torotrak  
Univance  
Valeo  
ZF

## FIGURES

Figure 1: Driveline improvements are capable of reducing CO<sub>2</sub> emissions by 15%

Figure 2: Advanced transmission potential contribution to overall CO<sub>2</sub> reduction

Figure 3: Global transmission sales

Figure 4: Eight reasons not to become complacent

Figure 5: Current European progress in CO<sub>2</sub> emissions

Figure 6: Cost vs fuel consumption improvements for powertrain technologies

Figure 7: EU emission standards - gasoline vehicles (top) and diesel vehicles (bottom)

Figure 8: Average fuel efficiency 2010 and 2015 targets for gasoline vehicles

Figure 9: CO<sub>2</sub> Improvement Rate (Base Year 2004)

Figure 10: US vehicle trends 1975 – 2009, fuel economy, power, weight

Figure 11: US Transportation Sector emissions scenarios

Figure 12: US targets for future GHG reductions (% reduction from 2005 levels)

Figure 13: Ricardo

Figure 14: World emissions standards timetable, 2001 – 2010

Figure 15: Automatic transmission efficiency gains compared to three-speed units

Figure 16: Launch response comparison between AT and DCT with turbo-boosting

Figure 17: Global transmission installed capacity by region, 2009 – 2017

Figure 18: Highest ranking reasons to change transmission technologies

Figure 19 The global market for two-pedal transmissions by type, 2005 – 2016

Figure 20 Two-pedal transmissions shares in Japan, Europe, the US and China, 2007 – 2016

Figure 21 Typical price ranges for transmission technologies (Europe)Source: CSM Worldwide and Jatco, Q3 2010:

Figure 22 Transmission value contribution by technology

Figure 23 Willingness to pay extra for AMTs, CVTs and DCTs

Figure 24: Transmission trends timeline

Figure 25 Global MT production (millions), 2011 – 2017

Figure 26 Global MT mix by number of ratios, 2011 – 2017

Figure 27: Zeroshift drive rings

Figure 28 Global AMT production, 2011 – 2017

Figure 29 Global DCT production, 2011 – 2017

Figure 30: The FTP C635 transmissions family in MT and DCT form

Figure 31: Getrag application range at June 2010

Figure 32: Getrag first generation range of wet clutch PowerShift DCTs

Figure 33: Getrag's new 6DCT250 DCT with dry clutch

Figure 34: Getrag dual mass flywheel damper dry clutch type

Figure 35 Getrag dual mass flywheel damper dry clutch type

Figure 36: LuK dry and wet double clutch assemblies for DCTs

Figure 37: 2010 Honda Accord Crosstour five-speed AT

Figure 38: Relative fuel savings for ATs

Figure 39: A simple epicyclic planetary gear set

Figure 40: Mazda's new SKY-Drive six-speed automatic transmission

Figure 41: A Ravigneaux gear set

Figure 42: Bosch Mechatronic Control Module

Figure 43: Cutaway of Ford's 6R140 Torqshift transmission

Figure 44: Mercedes-Benz 7G-Tronic automatic transmission

Figure 45: AT ratio trend, 2000 - 2011

Figure 46: ZF eight-speed automatic

Figure 47: ZF 9HP

Figure 48: Global AT mix by number of ratios, 2011 – 2017

Figure 49: Tiptronic shifter on a 2003 Porsche 911

Figure 50: Audi-LuK MultiTronic link-plate chain

Figure 51: Jatco's next-generation CVT, the first to apply an auxiliary gearbox

Figure 52: A Fixed Pitch Continuously Variable Transmission (FPCVT) assembly with two FPCVT units connected in series

Figure 53: CVT production by type (millions), 2011 – 2017

Figure 54: CVT production by region (millions), 2011 – 2017

Figure 55: A schematic of a toroidal transmission

Figure 56: Partial (left) and full (right) toroidal spaces within an IVT

Figure 57: Torotrak IVT variator

Figure 58: Infinitrak's epicyclic traction drive

Figure 59: VMT Technologies' concept for a positively engaged IVT

Figure 60: Comparison chart of existing transmissions with the Universal Transmission

Figure 61: Antonov TX6

Figure 62: Zeroshift drive rings

Figure 63: Toyota THS power-split transmission

Figure 64: two-Mode transmission exploded view

Figure 65: Cutaway of a two-mode transmission

Figure 66: Jatco's new transmission for parallel hybrid vehicles featuring motor independent drive

Figure 67: FEV's 7H-AMT

Figure 68: Antonov's three-speed transmission for electric vehicles

Figure 69: BorgWarner's 31-03 eGearDrive single speed transmission

Figure 70: Xtrac transmission for the Rolls-Royce 102EX

Figure 71: Hyundai clutch schematic

Figure 72: Torsional damping comparison: conventional and pendulum types with a six-cylinder diesel engine

Figure 73: ZF's hydrodynamically cooled clutch

Figure 74: LuK's dry double clutch unit

Figure 75: LuKs Multi Function Torque Converter (MFTC)

Figure 76: LuKs torque converter with its pendulum type absorber

Figure 77: Top ten transmission suppliers 2005 and 2011

Figure 78: Global transmissions production by region, 2011 – 2017

Figure 79: Global transmission forecast by type (millions)

Figure 80: Global transmission mix by type

Figure 81: European transmission production by type, 2011 - 2017

Figure 82: European transmission technology mix, 2011 – 2017

Figure 83: Increasing penetration of six-speed MTs in Europe

Figure 84: North American transmission production by type (millions), 2011 – 2017

Figure 85: North America transmission production share by type, 2011 – 2017

Figure 86: North American AT ratio number proportions, 2011 - 2017

Figure 87: Japanese and South Korean transmission production by type, 2011 – 2017

Figure 88: Japanese transmission production by type, 2011 - 2017

Figure 89: Japanese transmission production proportions, 2011 - 2017

Figure 90: Japanese and South Korean transmission production proportions, 2011 – 2017

Figure 91: Chinese transmission production by type, 2011 - 2017

Figure 92: Japanese and South Korean AT ratio number proportions, 2011 – 2017

Figure 93: Chinese MT production mix by number of ratios, 2011 – 2017

Figure 94: Chinese proportions of ATs by number of ratios, 2011 - 2017

Figure 95: Indian MT production by number of ratios, 2011 – 2017

Figure 96: South American transmission production by type, 2011 – 2017

Figure 97: South American MT production by number of ratios, 2011 – 2017

## **TABLES**

Table 1: Range of fuel consumption reduction potential, 2015-2020, for powertrain technologies

Table 2: Euro VI emission standards, g/km

Table 3: Current passenger vehicle emissions regulations in Japan

Table 4: Transmission types: strengths and weaknesses

Table 5: Attribute comparison MT versus AMT

Table 6: Production cost comparison for various transmissions

Table 7: Dry versus wet DCT performance