



International VDI Conference

# CVT in automotive applications – Set screws for better efficiency



## With current lectures from:

Bosch • Dana • Dynax • Eindhoven University of Technology • EXEDY • FEV • Fuji Heavy Industries/Subaru • GCI • GIF – Entwicklungsgesellschaft • Jatco • Karlsruhe Institute of Technology • Leibniz University of Hannover • LuK • NISSAN • Politecnico di Bari • Punch Powertrain • Torotrak

## Talk to us about:

- CVT in competition with MT and DCT
- Field experiences: CVT in series applications
- Opportunities for hybrid powertrain systems by integrating a CVT
- Challenges in designing control systems for CVT based powertrains
- Improving efficiency through evolution of hydraulic control system and electro-hydraulic CVT actuator
- Alternative continuous variable concepts



Visit the parallel International VDI Congress "Drivetrain in Vehicles" for free! 1.300 participants and 70 additional lectures!

» 21 and 22 June 2016,  
Friedrichshafen (Germany)

## Goldponsors

An event organized by VDI Wissensforum GmbH

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## Your benefit to visit the International VDI conference "CVT in automotive applications – Set screws for better efficiency"?

- Hear 19 international presentations focused on the special technical challenges on CVT in automotive applications.
- Become member of a globally operating network with representatives from the Japanese, US and European market.
- Benefit from the free entrance to the technical program of the parallel International VDI Congress "Drivetrain in Vehicles" with more than 1.300 participants and 70 additional speeches.
- Compare the portfolios of more than 80 suppliers in the accompanying exhibition.

## Overview of the VDI Congress "Drivetrain in Vehicles" and the VDI conferences "CVT" and "Transmissions in mobile machines"

### Monday, June 20, 2016

#### Spezialtage (only in German):

9.00 – 17.00 Uhr, Ringhotel „Zur Krone“ Friedrichshafen-Schnetzhausen

Spezialtag 1

#### Kupplungen in Antriebssystemen

Grundlagen – Entwicklungsstrategien - Innovationspotenziale

Spezialtag 2

#### Tribologie & Schmierungstechnik

Grundlagen und Anwendungen in Maschinenelementen (Gleitlager, Wälzlager und Zahnradpaarungen)

#### Pre Check In

18:00 – 20:00 Uhr, Graf-Zeppelin-Haus, Friedrichshafen

### Tuesday, June 21, 2016

07:30 Registration

08:30 Welcome address and plenary lectures

10:30 Coffee break and visit to the exhibition

11:00 Start of the conferences



11:15 Drivetrain in Vehicles – Plenary lectures

CVT in automotive applications

Transmission in mobile machines

12:15 Lunch and visit to the exhibition

13:45 DCT

Concepts

Components

CVT in automotive applications

Transmission in mobile machines

15:45 Coffee break and visit to the exhibition

16:30 By wire systems

Shift elements

Methods

CVT in automotive applications

Transmission in mobile machines

18:00 Evening reception and Jubilee Highlight Science Slam

### Wednesday, June 22 2016

08:30 Start of the conferences

08:30 CVT in automotive applications

Transmission in mobile machines

08:45 Drivetrain in Vehicles – Plenarvorträge/plenary lectures

09:50 Coffee break and visit to the exhibition

10:30 Drivetrain

Simulation

Lightweight

CVT in automotive applications

Transmission in mobile machines

12:00 Lunch and visit to the exhibition

13:30 Automatic Transmission

NVH

Software simulation

CVT in automotive applications

Transmission in mobile machines

15:00 Awarding of the best paper for junior engineers

15:10 Closing remarks and end of the congress

## A special thanks to our CVT expert committee



**Prof. Dr.-Ing. Dr. h. c. Albert Albers**, Head of IPEK, IPEK – Institute of Product Engineering, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany



**Hong Jiang**, Department Manager, Transmission/Driveline and Powertrain As-Installed Systems R&A, Ford Motor Company, Dearborn, USA



**Takashi Shibayama**, Fellow, R&D Technology Officer, Jatco Ltd, Atsugi City, Japan



**Andreas Englisch**, Vice President Product Units CVT (LC), Wet Double Clutch, TC (Europe), LuK GmbH & Co. KG, Buehl, Germany



**Shigeo Murata**, Engineering Director, Powertrain Engineering Division, Nissan Motor Co., Ltd., Atsugi, Japan



**Han-Hein Spitt**, Director, Gasoline Systems, Continuously Variable Transmission, Project Management Department, Sales and Marketing, Bosch Transmission Technology BV, Tilburg, The Netherlands



**Hans Fleischmann**, Head of Development Automatic Transmissions, Audi AG, Ingolstadt, Germany

# Tuesday, 21 June 2016

## First Conference Day:

07:30 Registration

### Plenary Lectures Congress and Conferences

08:30 **Welcome and opening by congress chair**

**Dr.-Ing. Harald Naunheimer**, Senior Vice President Corporate R&D, ZF Friedrichshafen AG, Friedrichshafen, Germany

08:40 **Anniversary greetings**

**Prof. Dr.-Ing. Udo Ungeheuer**, president, VDI The Association of German Engineers, Duesseldorf, Germany

08:55 **30 years Drivetrains for Vehicles - history and future**

**Prof. Dr.-Ing. Bernd-Robert Höhn**, Emeritus, Institute for Machine Elements/FZG, Technische Universität München, Garching, Germany

09:10 **Driveline Intelligence – efficiency, comfort and safety**

- Market needs, technology trends
- Predictive driving (DAS sensors and V2X)
- Interaction driveline and automated driving

**Dr.-Ing. Stefan Sommer**, CEO, ZF Friedrichshafen AG, Friedrichshafen, Germany

09:30 **Challenges and opportunities regarding real world efficiency**

- What “efficiency” means for car drivers, industry and authorities
- How today’s drive cycles reflect emissions reality
- Opportunities and limitations of electrified powertrains
- Powertrain and transmission designs for real-world requirements

**Dipl.-Ing. (FH) Bernd Eckl**, Executive Vice President Sales, Marketing, Business Development & Corporate Communications, GETRAG, Untergruppenbach, Germany

09:50 **SUBARU CVT toward 2020**

- Pioneer of mass production CVT
- Further CVT expansion in the market
- Next generation CVT

**Osamu Eriguchi**, General Manager of Transmission Design Department, Fuji Heavy Industries Ltd., SUBARU Engineering Division, Tokyo, Japan

10:10 **Future drivetrain requirements for global off-highway markets**

**Christopher A. Myers**, Global Director Tractor Platform Engineering, Product Engineering Center, Deere & Company, Waterloo, USA

10:30 **Coffee break and visit to the exhibition**

### Conference “CVT in automotive applications”

11:00 **Welcome address and opening of the conference by conference chair**

**Prof. Dr.-Ing. Dr. h.c. Albert Albers**, Head of IPEK, IPEK – Institute of Product Engineering, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

11:15 **Keynote**

### Technologies need to have more flexibility

- Limitation of technologies aiming to improve only efficiency
- Flexibility – the key to evolve for technologies
- CVT – distinctive flexibility and the potential to evolve

**Dr. Ryozo Hiraku**, Alliance General Manager for Powertrain Advanced Engineering, Technology Planning Department, Nissan Motor Co., Ltd., Atsugi Kanagawa, Japan

### NISSAN MOTOR CORPORATION



Session Chair: **Andreas Englisch**, LuK GmbH & Co. KG, Buehl, Germany

### Drive system

11:35 **CVT in comparison to other transmission concepts**

- Comparison of CVT, DCT and MT - State-of-the-art powertrain for B-class vehicles
- Simulation and vehicle measurements
- Efficiency, comfort, performance

**Dr.-Ing. Gereon Hellenbroich**, Department Manager Transmission Design and CAE, **Co-authors:** Peter Janssen, Dr. Ingo Steinberg, all of FEV GmbH, Aachen, Germany

### Transmission Concepts – Methods

11:55 **Enhanced performance of next generation LINEARTRONIC**



- Unique concept of high efficiency variator and longitudinal transaxle configuration
- Improving fuel economy by the expand ratio spread and reduce friction losses
- Optimizing driving comfort and dynamics by the new shift strategy

**Masami Oguri, M.Sc.**, Manager of Transmission Project Group, Transmission Design Department,

**Co-authors:** Hironaga Itou, Naoyuki Akiyama, all of Fuji Heavy Industries Ltd., SUBARU Engineering Division, Tokyo, Japan

12:15 **Lunch break and visit to the exhibition**

13:45 **How to build better CVTs?**



- Benefit of well optimized CVT components for customer
- Latest status of development of CVT chains, testing results concerning durability and NVH
- Outlook for further development of CVT chain – create a new modular concept
- Further ideas for components inside the CVT transmission

**Dipl.-Ing. André Teubert**, Senior Manager Development CVT, LuK GmbH & Co. KG, Buehl, Germany

14:15 **VT5, the next high efficient CVT Generation of Punch**

### Powertrain



- CVT potential
- Family approach
- Transmission Lay-out
- Efficiency Measures

**Ir. Koen Laurijssen**, Chief Engineer, System Engineer VT5, CVT – Controls Engineering – Powertrain Simulation

**Co-Authors:** Dr. Ir. Alex Serrarens, Ir. Elias van Wijk, Ing. Gert-Jan Vogelaar, all of Punch Powertrain, Sint-Truiden, Belgium and Eindhoven, The Netherlands

14:45 **Start/Stop-Coasting and CVT: an effective, customer perceivable and attractive fuel-saving combination**



- Operating concept, requirements for the vehicle system, driver experience
- Successful feasibility study for CVT applications based on simulations
- High fuel-saving potential, evaluation of driver comfort and hardware requirements for the CVT at restart

**Alexandre Pigeard**, Engineer (Master degrees), Section Manager Software and Simulations, Research & Development, Engineering Transmissions, **Co-authors:** Tom van Dongen, both of Bosch Transmission Technology B.V., Tilburg, The Netherlands, Steffen Strauß, Robert Bosch GmbH, Schwieberdingen, Germany

15:15 **Testing the CMM model of chain-CVT transmissions in steady-state and shifting conditions**



- Experiment on shifting response of chain and belt continuously variable transmissions
- Modelling of shifting response and comparison with experiments

**Prof. PhD Giuseppe Carbone**, Professor, Department of Mechanics, Mathematics and Management, Politecnico di Bari, Italy

15:45 **Coffee break and visit to the exhibition**

16:30 **Model-based system design methods for vehicular powertrains**

- Automated-discrete-topology modeling for hybrid powertrain design
- Integrated design procedures: examples of optimal powertrain sizing
- Influence of physical design specifications on the control design specifications for CVT-based powertrain design

**Dr. Ir. Theo Hofman**, Assistant Professor, Mechanical Engineering, **Co-authors:** Rob Roijackers, Wouter van Buul, all of Eindhoven University of Technology (TU/e), Eindhoven, The Netherlands



17:00 **CVT-Hybrid – low emission, high performance**



- The Multimode CVT – example for an advanced CVT hybrid concept
- Key aspects: efficiency enhancement by temporary variator disconnection combined with direct gear driving
- Simulation results regarding CO2 benefits, vehicle performance and driving comfort by using a CVT hybrid

**Dr. Christian Lauinger**, Manager Advanced Development CVT / wet DC, **Co-authors:** Dipl.-Ing. Andreas Götz, Dipl.-Ing. (FH) Bernhard Walter, all of LuK GmbH & Co. KG, Buehl, Germany

17:30 **End of the conference day**

18:00 **Reception and evening lunch**

19:30 **Jubilee Highlight**

**Science Slam 2016**  
**The award of the "Golden Gear"!**

They are young and brainy and have a sense of humour. We are talking about four junior scientists who have just graduated from university. They will tell you in a joking and humorous manner how to bring across scientific contents to someone in a fun way. And you, the audience are the jury who will vote for the winner of this contest with different levels of your applause. Look forward to

- Doris Aschenbrenner from the University of Würzburg talking about "Networking 4.0",
- Johannes Kretzschmar from Jena University talking about "Frankenstein's electric vehicle",
- Mogan Ramesh from the Technische Universität München talking about "My engine is a vegan" and
- Stefan Kurtenbach from RWTH Aachen University talking about "Programming transmission software".

Who is going to win the Golden Gear?

## Wednesday, 22 June 2016

# Second Conference Day:

**Session Chair: Takashi Shibayama, Jatco, Japan**

**Components**  
**Actuators – Clutches and torque converters –**  
**Materials - Tribology**

08:30 **Development of hydraulic control system for a new wide-range CVT**



- New wide-range CVT feature
- Control system for the new wide-range CVT
- Key technologies for the new hydraulic control system

**Katsuo Kato**, Development Engineer, Hardware System Development Department, Jatco Ltd, Atsugi City, Kanagawa, Japan

08:50 **Development of an improved electro-hydraulic CVT actuator**



- Explanation and design principles of the Servo-Actuation-System
- Control performance and robustness with regard to shifting and pulley clamping
- Actuator loading and power consumption

**Loek Marquenie, M.Sc.**, Project Leader, Research & Development, **Co-authors:** Ir. Jacques van Rooij, Ir. Tim Clephas, all of Gear Chain Industrial BV, Eindhoven, The Netherlands

09:10 **The trend and future of Torque Converter for CVT**



- Change with the time of requirements on TC for CVT compared with that of Step AT's
- Future TC for CVTs
- Slip or Lock up?

**Shinji Fujimoto**, Executive Officer, Executive General Manager, Development Headquarters and **Nobuyoshi Shiomura**, **Co-authors:** Keiji Sato, Yuuki Kawahara, all of EXEDY Corporation, Neyagawa-City, Osaka, Japan

09:30 **Improvement of transmission efficiency by reducing the drag torque in disengaged wet clutch**



- Reducing CO<sub>2</sub> emission by improvement of efficiency of transmission
- Facing of friction disk made with paper based material
- Improvement of the fuel efficiency of vehicles by reduction of drag torque in open disengaged wet clutch, achievement by grooving on friction disk surface
- An analytical model for estimating the drag torque characteristics

**PhD Shahjada A. Pahlovy**, Research and Development Engineer, Advanced Technology Development,

**Co-authors:** Dr. PhD Syeda Faria Mahmud, Norio Takakura all of Dynax Corporation, Tomakomai, Hokkaido, Japan

09:50 **Coffee break**

10:30 **Recent material developments for further optimization of pushbelt CVT power density**



- Transmittable power & torque, transmission size, ratio coverage, and durability
- Improvement of the fatigue properties of the pushbelt loops
- Use of high-alloyed maraging steels with high mechanical strength and high fatigue strength
- Improved fatigue properties of pushbelt loops by optimization of the maraging steel compositions and hardening heat treatments

**Bert Pennings**, Ir. PDEng., Research Engineer, Research & Development, Bosch Transmission Technology B.V., Tilburg, The Netherlands

11:00 **Tribosystemic view of CVT in drive systems**



- Understand complex friction mechanisms in context of overall system behaviour
- Generate robust friction systems for efficient CVT applications, ensure system properties, which enables reducing system safety and thus increasing energy efficiency
- Analyse the influence of complex kinematic relationships on the tribological behaviour, gain simulation models of processes and the impact on the system behaviour
- Evaluate benefit of CVT for electrified drive systems

**Dipl.-Ing. Sascha Ott**, Managing Director

**Co-authors:** Prof. Dr.-Ing. Dr. h.c. Albert Albers, Dipl.-Ing. Katharina Bause, all of IPEK Institute of Product Engineering, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

11:30 **Influences of surface structures on the efficiency of continuously variable transmissions**

- Experimental tests with differently structured pulley surfaces
- Simulations for the lubricant displacement in the tribological contact and for the system behavior of the variator
- Influences of the structures on the efficiency and the performance depending on the operating point

**Dipl.-Ing. Jan-Niklas Mach**, Research Associate

**Co-author:** Prof. Dr.-Ing. Gerhard Poll, both of Institut für Maschinenkonstruktion und Tribologie, Leibniz University of Hannover, Germany



12:00 **Lunch**

**Session Chair: Han-Hein Spit**, Bosch Transmission Technology BV, The Netherlands

**Alternative Continuous Variable Concepts for automotive and automotive-related applications**

13:30 **CVT powerpath solutions using Continuously Variable Planetary (CVP) for maximum fuel economy**



- Development of multimode CVT power path concepts by using a continuously variable planetary that optimize ratio spread and efficiency
- A loss model of the CVT transmission for a vehicle simulation to estimate fuel economy
- An example of a fuel economy simulation for a typical automotive application

**Gordon McIndoe**, MSc. Mechanical Engineering, Technical Expert Transmission Systems, Light Vehicle Driveline Technologies, Dana Holding Corporation, Leander, Texas, USA

**Co-author:** Evrim Taskiran, Dana Spicer Brugge office, Belgium

14:00 **The Cone-Ring-Transmission will go into production!**



- Concept and efficiency of the Cone-Ring-Transmission (KRG)
- Comparison to other CVTs
- Way to Series Production

**Dr.-Ing. Heinz-Dieter Schneider**, Manager Construction and Development, **Co-author:** Dipl.-Ing. Roy Rompelberg, both of GIF – Entwicklungsgesellschaft mbH, Alsdorf, Germany

14:30 **High efficiency “full-toroidal” traction drive CVT – Technology improvements and application to front wheel drive cars**

- Increased traction drive efficiency
  - Reduced parasitic losses
  - Minimized actuator power required to change speed ratio and optimized clamp load
  - Combining these advances into a high efficiency front wheel drive CVT
- John Fuller**, B.Eng. (Hons), Director Intellectual Property, New Concepts and Intellectual Property, **Co-author:** Chris Gaskell, both of Torotrak Group, Leyland, UK



15:00 **Conclusions by the conference chair and end of the conference**

**Exhibition and Sponsoring**

Would you like to get face to face with the high-powered participants attending the VDI Conference „CVT in automotive applications“ and present your products and services? For an optimum presentation of your company, make use of the exhibition held in parallel with the conference or book a sponsorship opportunity.

Mrs. Martina Slominski  
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Fax: +49 211 6214-167  
Email: slominski@vdi.de



**CVT in automotive applications – Set screws for better efficiency**

21 and 22 June 2016, Friedrichshafen, Germany

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**Please register for:**

- International VDI Conference „CVT in automotive applications – Set screws for better efficiency“, 21 and 22 June 2016 (01K0831016)
- VDI-Spezialtag „Kupplungen in Antriebssystemen“ am 20. Juni 2016 (02ST062001)
- VDI-Spezialtag „Tribologie & Schmierungstechnik“ am 20. Juni 2016 (01ST133001)

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**Conference venue:** Kultur- und Congress-Centrum Graf-Zeppelin-Haus, Olgastraße 20, 88045 Friedrichshafen, Germany, Phone: +49 7541/288-0, Fax: +49 7541/288 150, Email: [info@gzh.de](mailto:info@gzh.de)

**Accommodation:** A limited number of rooms have been reserved for the benefit of the conference participants.

**Contact:** Verkehrsamt e.V., phone +49 7541 30 01-0. A reservation form can be found at [www.transmission-congress.eu](http://www.transmission-congress.eu)

**Information:** The price includes the compendium, coffee breaks, beverages during breaks, lunches and the evening reception. The participants get the VDI report at the venue.

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