Tuesday, October 27

Welcome and Keynote
Session Code: TRANS100
Room Judea Ballroom
Session Time: 8:00 a.m.

Organizers -

Chairpersons -
Charles Gray, Ford Motor Company

Time | Paper No. | Title
--- | --- | ---
8:00 a.m. | ORAL ONLY | Welcome and Introductions
Charles Gray, Ford Motor Company

8:05 a.m. | ORAL ONLY | Keynote Presentation: Impact of Solenoid Impedance on Energy Consumption in Solenoid-Driven Hydraulic Transmission Applications
Daniel Nicholson, General Motors Co.

Tuesday, October 27

Panel Discussion - Transmission and Driveline Innovation and Integration Trends
Session Code: TRANS200
Room Judea Ballroom
Session Time: 8:30 a.m.

Organizers -

Moderators -
Michael Harpster, General Motors

Panelists -
Kiran Govindswamy, Director, Transmission & Driveline, FEV North America Inc.; Charles Gray, Director, Transmission & Driveline Engineering, Ford Motor Company; Juergen J. Greiner, ZF Friedrichshafen AG; Jeremy W. Holt, President, TREMEC; Dimitri N. Kazarinoff, President, AVL North America Inc.; Michael B. Solt, Director of Automatic Transmission Engineering, FCA US LLC; Christopher P. Thomas, BorgWarner Inc.;

Time | Paper No. | Title
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ORAL ONLY | Learn more about the panelists
Bios

Tuesday, October 27

Transmission and Driveline Sub-systems/Launch Devices, Part 1
Session Code: TRANS200
Transmission shifting clutch drag and performance are metrics that are constantly being optimized. Reducing drag is required for efficiency improvements, while clutch performance is directly felt by the end customer. Traditionally, improving one has a negative effect on the other. Reducing drag typically means opening the shifting clutch pack by lifting off the piston. A lifted-off piston can be difficult to control. Schaeffler has developed a piston module that allows liftoff without sacrificing controllability. This presentation will show the concept and its status.

Matthew L. Frary, Schaeffler Group USA Inc.

The increasingly strict legislation for reducing vehicle consumption rates is currently triggering detailed studies on powertrain losses that look at technically feasible and financially appropriate reduction possibilities. High losses are caused among others by the hydraulic pumps used for actuation, cooling and lubrication in automatic transmissions. Systems with a fixed connection between combustion engine and hydraulic pump generate surplus hydraulic power as engine speed increases. Only adjustable systems or those decoupled from the combustion engine can supply energy as it is actually needed with considerable reductions in losses. The following paper looks at dual-clutch transmissions as an example of the currently used actuation, cooling and lubrication systems, discussing their distribution and properties together with the advantages and drawbacks. The results are then used as the basis to present various technically appropriate hydraulic modules for a new eight-speed dual-clutch transmission together with the supply solutions, evaluating their performance in various driving cycles with regard to energy consumption. This is carried out using simulation tools that are verified by validation at hydraulic test benches.

Wayne Petzke, IAV Automotive Engineering Inc.

The electric Controllable Mechanical Diode (eCMD) is a one or two way ratcheting clutch that can be turned on or off with an electro-mechanical device. The future of powertrains is more electrification of content in order to improve parasitic losses, increase power density, and lower cost by eliminating hydraulic controls. eCMDs are a technology that can be used in select positions in current multi-ratio transmissions including DCTs and AMTs, in advanced hybrids, and in EV powertrains. There is also application for AWD systems, accessory drives, and various disconnect functions in powertrain.

John Kimes, Kom LLC
Transmission and Driveline Sub-systems/Launch Devices, Part 2

Session Code: TRANS900
Room Judea Ballroom
Session Time: 1:00 p.m.

Chairpersons - Steven Wesolowski, Dana

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<th>Time</th>
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<tr>
<td>1:00 p.m.</td>
<td>ORAL ONLY</td>
<td><strong>Clutch and Software capabilities in DCT Applications</strong></td>
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<td>One of the great opportunities with a dual clutch transmission is to create arbitrary launch and shift profiles, ranging from imperceptible ( \xi ) limousine( \xi ) shifts to ferocious ( \xi ) F1( \xi ) style shifts. This paper presents relevant launch and shift profile capabilities of dual wet clutches, enabled by a unique clutch design and software designed to realize these capabilities in a creative, robust and repeatable way.</td>
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<td>The feeling of any maneuver depends on the way torque is transferred to the wheels. In order to create the desired feeling during launch and shifting, torque profiles are carefully generated depending on the driver( \xi )s demand. The presentation provides an insight in the related `torque target( \xi ) generation and how it communicates with the engine and its electronic stability program</td>
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<td>Paul Rorick, TREMEC</td>
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<td>1:30 p.m.</td>
<td>ORAL ONLY</td>
<td><strong>Torque Converter Dampers - Addressing the Needs of the Modern Powertrain</strong></td>
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<td>Recent Corporate Average Fuel Economy (CAFE) requirements have increased dramatically. These regulations have forced major powertrain changes by vehicle manufacturers as a means to meet current and future standards. Changes include engine downsizing and downspeeding along with cylinder deactivation. These technologies improve fuel economy, but at the price of increased torsional vibration of the engine. In order to fully reap the rewards that these new powerplants can provide, a new paradigm in torsional vibration isolation is required to maintain and further improve vehicle vibration and comfort levels. How can this paradigm be achieved?</td>
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<td>Mike Swank, Schaeffler Group USA Inc.</td>
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2:00 p.m.  ORAL ONLY  Torque Converter Clutch Capacity Optimization
Torque converters are an integral part of automatic transmissions and have a significant effect on vehicle performance and fuel economy and, therefore, on emissions. Modern transmission design with increasing number of gears requires the converter to fit in smaller space with comparable or improved functionality. One of the important components in the torque converter is the lockup clutch. It allows a direct connection between engine and transmission for fuel economy optimization. The clutch is designed to have enough capacity to transmit engine torque to the transmission without energy loss.
At higher engine speeds clutch capacity starts to diminish. This phenomenon has been studied and analyzed using Computation Fluid Dynamics (CFD). New computational methods have been applied and determined the root cause. Extensive component geometry optimization has been conducted in order to find a solution without impacting the transmission/converter space claim. Several turbine-cover washer configurations will be presented to address the issue. Clutch capacity improvement was confirmed through a dynamometer test.
Michael E. Fingerman, Prashant Modi, FCA US LLC

2:30 p.m.  ORAL ONLY  New Steel Belt Technology for CVT Efficiency Improvement
To select transmission with flexible feature which makes itself applicable to world wide market is increasingly required instead of changing transmission types region by region concerning the market situation.
Jatco has been encouraging the evolution and prevalence of CVT which essentially has high flexibility for realizing good fuel economy, and expanded its worldwide penetration.
In this presentation, our new technologies of steel belt for Jatco CVT8 will be introduced.
Jatco has developed completely new 28-mm belt. This belt has been developed for the Jatco CVT8 to obtain higher efficiency, a smaller size and a lighter weight.
In the presentation, the key technology of the new 28-mm steel belt will be explained. The key technologies include specific shape, geometry and material.
Kazuhiro Hayakawa, JATCO, Ltd.

Tuesday, October 27

Fluids and Lubricants
Session Code: TRANS500  Session Time: 3:00 p.m.
Room Judea Ballroom


Chairpersons - Scott Halley, Lubrizol Corp.
Shell’s High Quality Gas to Liquid (GTL) Base Oil and its Application in Automotive Lubricants

Shell GTL base oils are high quality Group III base oils with superior low-temperature viscometrics and volatility properties compared with other typical Group III base oils. Improved low temperature properties of Shell GTL base oils provides formulation capability in the areas of cold start, fuel economy and deposit control. Combined with reduced volatility, Shell GTL base oils provide a cost-effective route to deliver superior fuel economy oil formulation. A significant amount of development work has taken place over many years, proving the performance capability of Shell GTL base oils in a wide variety of applications.

Zhou Xu, Shell Global Solutions (US) Inc.

Ultra Low Viscosity ATF without Compromising Hardware Durability

OEMs and automatic transmission (AT) manufacturers are exploring ultra-low viscosity AT fluids (KV100 < 4.8cSt) for their future designs in an effort to increase efficiency. Manufacturing logistics can be simplified if those same ULV fluids could be used in current and legacy transmissions as well. While future designs can be adjusted to enable the use of ULV fluids there are concerns whether the durability of existing transmissions would be compromised with the use of such fluids.

This presentation discusses several of the technical hurdles which need to be overcome when using ultra-low viscosity AT fluids and highlights new AT technology that enables an ultra-low viscosity AT fluid to be used effectively in future as well as current transmissions.

Mariam Shamszad, Lubrizol Corp.

Advanced ATFs Exceeding Industry CO2 Targets & Enabling Smart FE Solutions

The automotive industry is continuously striving to reduce its CO2 emissions footprint. Castrol’s leading lubricant solutions are renowned in the industry and co-engineering developments have led to many examples of improved transmission efficiency for customers in the past.

In addition to formulating unique driveline products with the OEM/Tier-1 for first fill applications, Castrol has recently been able to demonstrate additional benefits to its customers by smart and risk-free formulation management of existing technology platforms.

In the following case study Castrol will demonstrate how it was able to unlock hidden fuel economy potential by reformulating existing and future low and ultra-low viscosity ATFs, without changing the fluid performance profile and adhering to the technical requirements of the OEM. Test results have been verified through rigorous measures along the development and testing chain.

This smart formulation approach will enable the OEMs to grasp additional CO2 credits without significant investment in hardware modification.

Matthias Donner, BP PLC
Transmission Technologies

Wednesday, October 28

Session Code: TRANS300

Room Judea Ballroom

Session Time: 8:30 a.m.

Transmission Controls, Software and Modeling, Part 1

Session Code: TRANS400

Room Judea Ballroom

Session Time: 10:30 a.m.


Chairpersons - Berthold Martin, FCA US LLC

Time   Paper No.   Title

8:30 a.m.  ORAL ONLY  A comparison between low voltage, low-cost hybridization solutions
Fuel economy and CO2 regulations world-wide demand for a strict but clear average fleet fuel reduction target in the coming decade. A massive uptake of light to mild hybridization is therefor required. In this presentation we compare existing and new 12V and 48V solutions on functionality, cost, performance and off course the fuel economy improvements. Special focus is given on new powerful solutions using combinations of 48V battery- and kinetic energy (flywheel) storage. It is shown that such low voltage dual storage solutions compete with high voltage full hybrid performances at a fraction of the cost.
Alexander Serrarens, Punch Powertrain

9:00 a.m.  ORAL ONLY  Application of a Variglide Traction Planetary into an Automotive Drivetrain
The Variglide continuously variable planetary device is introduced. The methodology of incorporating into an automotive transmission application is described and various simple, high efficient powerpath arrangements are presented.
Gordon McIndoe, William Waltz, Dana Holding Corp.

9:30 a.m.  ORAL ONLY  Lestran's Orbital IVT
An infinitely variable transmission (IVT) utilizing oscillating torque generated from the centrifugal forces of rotating masses to transmit mechanical power is presented. The objectives of the presentation are to show recent design improvements, explain the mechanics, and show that this IVT is viable for a large array of automotive, commercial, and military vehicle applications. Recent design improvements enable the IVT to scale in size to any vehicle application including earth movers and main battle tanks while maintaining high efficiency. This IVT controls torque amplitude rather than speed ratio as in traditional designs. This unique approach combines the high mechanical efficiency of fixed gear ratio transmission with the high engine efficiency obtained using a Continuously Variable Transmission (CVT) in a lightweight, rugged, and high-torque package.
Terry Lester, Chief Technical Officer, Lestran Engineering
**Adaptation of DCT control algorithms to iClutch™ Intelligent Clutch System for Manual Transmissions**

BorgWarner has a long history of developing wet clutch and hydraulic control modules for Dual Clutch Transmissions (DCT). In addition, BorgWarner has developed the complete control algorithms for DCT’s. Recently, BorgWarner has developed the iClutch™ intelligent clutch system, an electro-hydraulic system that actively controls the clutch in a manual transmission. It includes an add-on, fully integrated hydraulic control module and an optional wet friction clutch. The control algorithms have also been developed by adapting the DCT algorithms to the single clutch and master/slave architecture of MT’s. This presentation will discuss the development of the BorgWarner iClutch™ intelligent clutch system control algorithms and present results from prototype vehicle tests.

Mark R. Buchanan, BorgWarner Inc.

**Tool Assisted Calibration, Methodology to Automate Calibration and Maintain Knowledge**

A transmission shift map can be roughly defined from several inputs (pedal map, fuel consumption, transmission, etc.) then evaluated in the vehicle. The industry has pushed to more “autonomous” tools which provide a result based on defined input criteria. Autonomous tools do not often require engineering knowledge, so engineers learn the process of running the tool and not the technical calibration development process.

INCA-FLOW provides the capability to implement flow chart based modules created around a specific calibration task following the classic calibration methods. Complexity can be adjusted to individual tasks and modules can be extended or linked. The tool is built around the process therefore concept knowledge can be transferred to new engineers so understanding of the results is still present. When calibrations are validated it is still possible to find faults and the implausibility of results rather than blind output of an autonomous tool. Automated tools such as these can be run online, offline or supplied with data from simulation environments. With proper implementation, automated tools provide an input for the vehicle’s relevant data for investigation. Measurement data is evaluated considering specific concerns (fuel consumption, acceleration, torque, etc.). After evaluation is done, all results are written in common file formats and the output can be easily input to calibration tools.

Automated tool assisted calibration saves resources (time, workload, test vehicles), because engineers can focus on more relevant tasks while the tool is performing repetitious tasks or processing information.

Alexander Nass, IAV Automotive Engineering Inc.
11:30 a.m.  ORAL ONLY  Real Time Execution of Data based Models on Embedded Systems

The design of experiment (DoE) method and the related data-based modeling have been successfully used for many years in the area of powertrain calibration and function development. Typically the models are used in a PC environment as plant models or are used in real-time applications in hardware-in-the-loop systems. It is also possible to have these data based models executed real-time in embedded control systems. Usage of this methodology in powertrain controllers has not been widely adopted. Recently new algorithms have been established which ease the application of data based modeling in embedded control. For powertrain function development at Bosch, the DoE tool ASCMO from ETAS is used. A Gaussian process regression (GPR) model is the backbone of the algorithm. The possibility of executing such a GPR model in real-time on a current 32-bit powertrain multicore controller with sufficient accuracy has been investigated. The GPR models have advantages compared to other modeling methods particularly with respect to model setup and model accuracy, but they call for strong computational power as they require the evaluation of many exponential functions. Even for controllers with a 32bit floating point arithmetic processing unit the precise calculation of an exponential function according IEEE 754-2008 is a challenge. This is true also in state of the art multicore systems as they have to take care of many other functions with real time requirements. This presentation explains how some of the challenges have been overcome, which limitations are still present, and illustrates some implementation results.

Siegbert Baqué, Robert Bosch LLC; Rene Diener, Robert Bosch GmbH

Wednesday, October 28

Transmission Controls, Software and Modeling, Part 2

Session Code: TRANS600
Room Judea Ballroom
Session Time: 1:00 p.m.


Time  Paper No.  Title

1:00 p.m.  ORAL ONLY  Efficiency Improvement of Transmission Using Housing -Rolling Bearing -Shaft System Analysis

The low friction rolling bearing is one of the components for efficiency improvement in transmission. Rolling bearing has nonlinear stiffness and friction depends on micro geometry and the external load. Therefore the system analysis of transmission including the components such as shaft and housing is very important for design of rolling bearing. In this report, we introduce the transmission system analysis software and some case studies.

Hideo Nishizawa, Rajeesh Ravindran, Kenichi Shibasaki PhD, NSK, Ltd.
1:30 p.m.  ORAL ONLY  Control and Integration Challenges for Transmissions with More Gear Steps
The automotive industry has undergone a race toward transmissions with an increasing number of gear steps in recent years. It has certainly made transmission design more difficult with increased system complexity, the number of the transmission operating modes, and possible switching among those modes. On the other hand, transmission internal inertias and ratio spread have also increased with the number of gear steps. However, there is a question that has been largely overlooked. That is, what are the implications to transmission control and vehicle integration in this race? In this presentation, fundamental dynamic analysis has been performed on selected transmissions with an increasing number of gear steps. The vibration modes, natural frequencies and contributing components have been identified for each of the transmissions. By comparing the dynamic characteristics of these transmissions, a clear trend can be seen that the driveline system with a higher number of gear steps is generally more prone to vibration in response to clutch torque during gear shifting. Such an observation can be explained through: 1) a common structure consisting of transmission and driveline components identified that is shared with virtually all gear shifting, and 2) the component parameters that are possibly involved with the increased gear steps. Generally speaking, it creates new challenges for transmission control and vehicle integration to achieve consistent shift performance, and clutch control execution of a higher precision is needed. More stringent requirements on the clutch design and transmission control systems are expected for transmissions with a higher number of gears, and software development and calibrations are likely to face new challenges. The presentation will include fundamental analysis and typical gear shift control results.
Dongxu Li, General Motors Co.

2:00 p.m.  ORAL ONLY  Observers for Clutch Pressure Sensing
The Kiss Point is defined as the point where a clutch piston has been stroked through the clutch pack clearance and begins to build up torque capacity. Due to clutch wear and environmental factors, the kiss point changes over time and miles. The control system must determine this critical parameter over the life of an automatic transmission to ensure exceptional shift quality. Most Kiss Point detection is done by detecting some shaft speed event during a shift and modifying it through heuristic means using simple logic, so it can better detect the Kiss Point for subsequent shifts. Through modern control techniques such as observers, it is possible to derive a dynamic model that can estimate the Kiss Point on the fly. This improves accuracy and decreases calibration over the more conventional approaches leading to better shift quality performance.
Hussein Dourra, FCA US LLC
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| 3:30 p.m. | ORAL ONLY | **Automated Verification and Validation Methods for Transmission Control Software**
With the increasing popularity of seamless gear changing and smooth driving experience along with the need for high fuel efficiency, transmission system development has rapidly increased in complexity. So too has transmission control software while quality requirements are high and time-to-market is short. As a result, extensive testing and documentation along with quick and efficient development methods are required.

Thomas Tasky, FEV North America, Inc.

| 4:00 p.m. | ORAL ONLY | **Pressure-based Pilot-operated Clutch Control Optimization via Model-in-the-Loop**
As the number of peripheral components grows to accommodate ever increasing demands for functionality and performance in transmission applications, the integration of different technologies to obtain the best solution in terms of performance to a given application is considered to be the essence of system design.

The behaviour of a mechatronic system is determined by the interdependencies of its components. Therefore, the design and development of mechatronic systems in transmission applications require an integral approach to deal with sub-systems and subprocesses of multiple domains, i.e. hydraulic, mechanical, magnetic, and electrical.

The integration of mechatronic systems can be performed by components (hardware-integration) and by information processing (software-integration). The information processing consists of low-level and high-level feedback control, supervision and diagnosis, and general process management.

This paper illustrates a simulation-based multi-domain approach for the component integration of a hydraulic control unit (HCU) on an information processing fashion. The integration of the HCU components, i.e. valve driver, solenoid valve, spool valve, actuator and transmission, is demonstrated on an automatic transmission clutch control application.

Taking advantage of the co-simulation capabilities, a pilot-based clutch control algorithm was optimized in Model-in-the-Loop. The matching of electromagnetic, magneto-mechanical and mechanic-hydraulic control loops was conducted on a bottom-up fashion, evaluating the functionality at each abstraction level. Simulation and measurement results are presented to verify and validate the proposed approach to fulfil the system requirements.

Oscar Sarmiento, Continental AG
HIL Based Transmission Shift Quality Testing

The shift quality of a transmission is one of the major factors influencing ride comfort and drivability of a vehicle. This shift quality is a function of both the transmission hardware and the software in the electronic control unit which includes both algorithms and calibrations. Because of this, the transmissions are tested in unison with the electronic control units on powertrain dynos. This is also an opportunity for the engineers to figure out preliminary calibrations for optimal performance/ride quality.

The next step is to install the transmission in a prototype vehicle and have the test drivers get a ‘feel’ for the upshifts and downshifts under various driving conditions. This process is somewhat subjective and requires extensive testing on prototype vehicles which may not be ready when the transmission is.

The approach we are presenting couples a powertrain dyno with a high-fidelity vehicle dynamics model running in real time. This enables the users to:

1. Analyze the ride comfort during various shifting situations during the dyno testing phase.
2. Evaluate the ride comfort based on more objective parameters.
3. Make better calibrations to the transmission control software.

Kunal Patil, dSPACE Inc.