**Product**
Simcenter

**Business challenges**
Optimize fuel economy by supporting the automotive downsizing trend
Predict and minimize judder and low-frequency booming
Gain insights in order to make the correct decisions at the beginning of the design process

**Keys to success**
Combine test and simulation techniques as an integrated approach
Deploy a full vehicle model-based approach for the prediction and elimination of clutch judder
Technology transfer to address gear whine and judder upfront in the design phase
Employ full vehicle modeling approach combining test, 3D and system simulation methodologies
Engage on-site assistance for technology, follow-up and communication

Aisin AW reduces booming, judder and gear noise, and implements best-practice NVH techniques across its standard development process

**Tackling new vibrations**
In the automotive industry, the pursuit for greater efficiency, lower emissions and a “greener” brand image has put pressure on subsystem and component design. While dealing with a downsized engine, transmissions should operate as effectively as possible with a minimum of losses. To optimize performance and minimize losses, the torque converter should be used as little as possible, resulting in early engagement of the lock-up clutch. Trends for producing higher torque at lower engine revolutions per minute (RPMs), together with an earlier clutch lock-up required for efficiency savings, have increased the propensity for vibrations and thus can create comfort and durability issues.

**A 10-year partnership**
As the world’s largest automatic transmission manufacturer (market share), Aisin AW is continuously seeking operational improvement. One especially productive venture occurred in 2003, when the company put together a team of subject matter experts to find solutions for future quality issues. The experts examined, for example, how to deal with gear whine and how to cope with the torque converter.
Looking for a technology partner, Aisin AW engaged the Simcenter™ Engineering services of Siemens PLM Software to solve a gear whine issue.

Before Aisin AW collaborated with Simcenter Engineering experts, the company worked in a troubleshooting mode for solving noise, vibration and harshness (NVH) issues. “At that time, 20 percent of the gearboxes had noise issues,” explains Hiroki Tsuji, group manager of the starting device analysis group, core Component Engineering Aisin AW. “Simcenter Engineering recommended a transfer path analysis (TPA) and helped with a combined simulation and test approach to understand the relation between noise sources, vibration and the effect on perceived user comfort.”

One year later, Aisin AW and Simcenter Engineering signed a framework agreement, which was expanded in 2006 to fulltime, on-site assistance by a Simcenter expert. The on-site assistance engendered close collaboration and helped Aisin AW solve durability and NVH issues, including gear whine, gear rattle, booming, torsional vibrations and transient phenomena such as judder and shift shock. Simcenter experts used advanced methodologies, including testing solutions and 3D to 1D modelbased system engineering (MBSE) solutions.

“Thanks to technology transfer between the companies, Aisin AW now addresses issues such as gear whine and judder upfront in the design phase,” says Tsuji. “Many NVH techniques we learned from Simcenter Engineering are now part of our standard development process, such as transfer path analysis.”

Eliminating clutch judder
“In one of our recent projects with Simcenter Engineering, we wanted a full vehicle, model based approach for the prediction and elimination of clutch judder,” says Tsuji. The cause of self-excited clutch judder is known to be the

Results
No more judder in transmission prototypes
Gained 50 percent time reduction when troubleshooting a new NVH issue
Significantly reduced overall development time
Increased overall operational efficiency through best-practice NVH techniques in the standard development process
Recognized as technology partner of automotive OEMs, resulting in competitive advantage

“Thanks to technology transfer, we now address issues such as gear whine and judder upfront in the design phase.”

Hiroki Tsuji
Group Manager
Starting Device Analysis Group
Core Component Engineering Department
Aisin AW
Simcenter Engineering applied a customized powertrain NVH solution, using Simcenter Amesim™ software, and correlated the simulation models with the test bench data. "Based on Simcenter Amesim, we identified the root causes,” says Tsuji. “Our engineering team can now make correct design choices during the concept phase and support troubleshooting if judder arises at the prototype stage. When making the prototype afterwards, we are certain it is judder-free."

Reducing low-frequency booming
In another project, Aisin AW contacted Simcenter Engineering to help them solve a low-frequency booming noise issue. Low-frequency booming is a relatively new phenomenon and a consequence of engine downsizing and restrictions on torque converter usage. Fewer cylinders mean that more torque is transferred per cylinder, which results in higher forces that are less balanced and damped within the transmission.

As the appearance and severity of the booming vibration issues depend on the combination of the vehicle body, suspension, transmission and damper, Aisin AW wanted to gain insights into the root causes at each level, and learn how to create a model that could accurately reproduce the phenomena. Simcenter Engineering experts developed a full vehicle modeling approach combining test-based description of the vehicle body, 3D suspension modeling in Simcenter 3D Motion software and 1D powertrain modeling in Simcenter Amesim software.

"The results of the full vehicle simulation gave us very good insight into the root causes of the booming noise at each level,” says Tsuji. “By changing the design, we could drastically reduce the booming peak.” The overall result was very effective, and Aisin AW has included the 1D

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Solutions/Services
Simcenter Engineering
www.siemens.com/plm/simcenter-engineering
Simcenter Amesim
www.siemens.com/plm/simcenter-amesim
Simcenter 3D
Simcenter Testlab

Customer’s primary business
Aisin AW is a major automotive technology manufacturer. The company develops automatic, hybrid and continuously variable transmissions, as well as car navigation systems for all types of vehicles. Its customers are automotive OEMs all over the globe, including Toyota, Mazda, Suzuki, Mitsubishi, BMW, Volkswagen, Volvo, Porsche, GM and others. www.aisin-aw.co.jp

Customer location
Anjo, Aichi
Japan

Simulation software and the test technology in the development program.

Preferred partner for automotive OEMs
The long-term relationship between the technical experts of Aisin AW and Simcenter Engineering is based on two common aspects of each company’s identity: high quality standards and innovative technology. The unique combination of test and simulation techniques and troubleshooting capabilities of Simcenter Engineering services helped Aisin AW to maintain its image as an innovative technology leader. “Applying Simcenter Engineering troubleshooting techniques, we realized about a 50 percent time reduction to come to a solution,” explains Tsuji.

Today, Aisin AW works in close collaboration with automotive OEMs to optimize fuel consumption via an integrated approach. The company continuously seeks a more global solution to answer current and future challenges. Tsuji notes, “The 10-year partnership with Simcenter Engineering significantly strengthened our position with automotive OEMs. Automakers now recognize Aisin AW as a valuable technology partner. Together, we work towards improved fuel consumption while ensuring comfortable driving.”

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Hiroki Tsuji
Group Manager
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Core Component Engineering Department
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