SIEMENS
Ingenuity for life

Automotive and transportation

Honda R&D Co., Ltd

Resolving NVH of hybrid vehicles

Product

Simcenter

Business challenges

Reduce vibrations at restart of hybrid engines while balancing fuel economy and performance

Take into account the entire powertrain restart process and allow for varying in-cylinder pressure

Establish an integrated, inter-departmental solution approach to vehicle design, using the same models throughout the design and development cycle

Reduce time to market

Keys to success

A solid, long-term partnership for collaboration and co-development

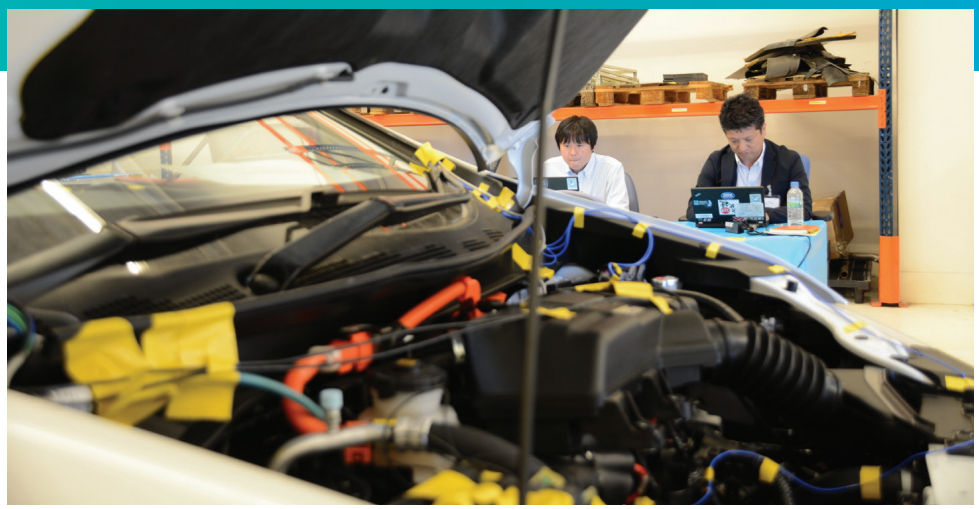
Best-in-class testing and processing hardware and software for data acquisition, model development, analysis and validation

Honda R&D Co., Ltd uses Simcenter solutions to solve hybrid engine restart vibrations

Slowly but surely, the Western world is becoming familiar with cars going into sleep mode when idling – for example, while stopped at a traffic light. Engine start-stop systems (also called idling stop) have been quite common for a solid decade now, and their presence probably will keep growing. The first systems date back to the early 1980s, with the release of the Volkswagen Polo Formel E. in 1983 (in Europe only). Interestingly, disturbing vibrations at engine restart are the reason that start-stop systems didn't quite catch on back then, and are still an impeding factor for widespread adoption today.

Please don't stop the music

The benefit of idling stop systems is obvious. The start-stop feature not only cuts fuel consumption by 10 to 15 percent, but also reduces emissions accordingly. With fuel efficiency ranking at the very top of parameters that consumers consider when buying a car, engine start-stop has become the norm for original equipment manufacturers (OEMs) today. According to IHS Automotive, almost 70 percent of cars driving in Europe (where gas prices are highest) have the start-stop capability on board. But adoption is far behind the curve in other, less urbanized areas of the world, including the United States, with only seven percent of cars equipped, and many owners turn the feature off when they have it.



Results

Development of a new methodology that allows accurate prediction of powertrain behavior during idling restart

Integration of MBD throughout Honda departments

Consolidation of NVH with Honda brand image

Better prediction of time to market through better control of the development cycle

This resistance cannot merely be reduced to laggards, and therefore raises concern throughout the automotive industry. The antagonism stems from the vibrations that come with restart, which are considered annoying because they interrupt or spoil music or silence. In contrast to starting the engine by physically turning a key or pushing a button, restart vibrations occur when passengers do not expect or want them. The vibration noise is especially disturbing in hybrid vehicles, which restart their engines while driving without any driver causal action like shifting gears. Engine restart happens entirely on the car's terms, rather than on those of the driver. As with turbulence on an airplane, the element of surprise can render an experience even more unpleasant than it would be.

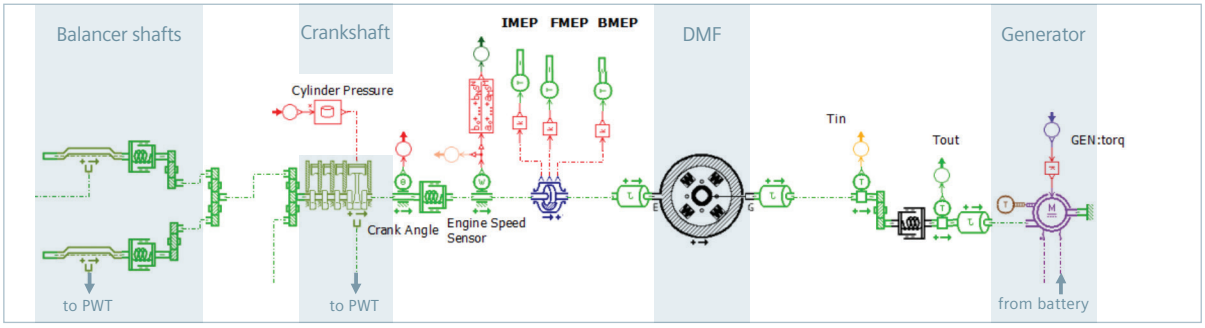
Honda R&D Co., Ltd – an early adopter

As customers' wishes are predictors of their buying behavior, Japanese OEMs specializing in hybrid and electrified powertrains are investigating ways to resolve the noise, vibration and harshness (NVH) issues that go hand-in-hand with the restart technology. Honda R&D Co., Ltd wanted to be an early adopter with regards to the technology, which is why the company sought assistance from Simcenter™ Engineering services.

Honda and Siemens have been partners for decades, specifically through the use of Simcenter™ products and services. In fact, Honda has been a devoted and satisfied user of Simcenter SCADAS™ data acquisition hardware and Simcenter Testlab™ software for more than 20 years.

"Thanks to our collaboration with Simcenter Engineering, our development cycle time is under better control."

Satoshi Watanabe
Model-Based Development for Powertrain NVH
Honda R&D Co., Ltd



Hybrid driveline torsional model including combustion engine and generator to study ICE restart vibrations.

From test, through engineering consulting to system simulation

Mr. Satoshi Watanabe, responsible for Model-Based Development (MBD) at the powertrain NVH department at Honda, explains how Simcenter testing tools far exceeded competitor alternatives long ago: "The Simcenter testing tools were multi-purpose; they allowed for transfer path analysis, impact testing, modal analysis and others, whereas the competition was still focused on performing just a single task."

With this versatility, Honda was able to optimize their testing processes significantly. "There was no more need to change the test setup and specialist between measurements, losing precious time," Watanabe explains. "Overall, thanks to the Simcenter tools, our testing process became much more integrated." Honda is still using Simcenter testing solutions for data acquisition and validation today.

"Thanks to the technology transfer, we understand how to reproduce the applied techniques and adapt them to resolve all kinds of issues. We can now do this by ourselves, using our own assets to the fullest."

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Model-Based Development for Powertrain NVH
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"By predicting systems behavior upfront, the workload afterwards is significantly reduced, which allows us to focus our efforts and resources on other priorities, such as brand image and value."

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"Before we started developing hybrid vehicles, we were doing fine with our established processes and knowledge base. However, we want to explore ways in which our development cycle could be faster."

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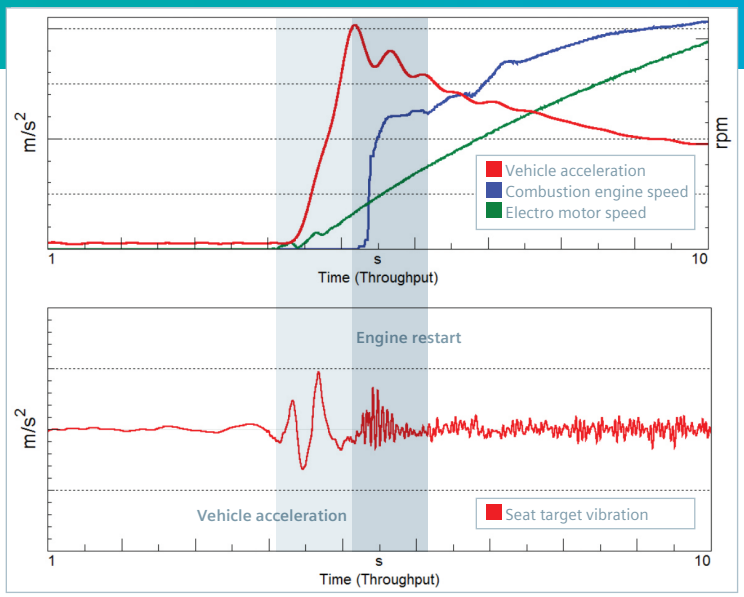

Vehicle acceleration maneuver in hybrid mode: combustion engine restarts to charge the battery after initial pure electric propulsion, generating body vibrations.

Working with the Simcenter testing equipment, Honda accumulated a lot of in-house know-how, especially with regards to NVH. The company currently has this knowledge organized into different operational departments, each pursuing their specific sets of targets. This was the most effective approach to tackle the attribute- and subsystem-specific challenges of vehicle development. But with the advent of hybrid vehicles and their more complex NVH concerns, the company decided to review the departmentalized approach.

"Before we started developing hybrid vehicles, we were doing fine with our established processes and knowledge-base," Watanabe says. "However, we want to explore new ways to shorten our development cycle." Upon encountering the engine restart NVH issue in their Odyssey platform, Honda decided to implement other Simcenter solutions, and to contact Simcenter Engineering services. Simcenter Engineering would help Honda to couple their valuable but compartmentalized knowledge into an integrated solution approach.

"In order to properly capture and resolve the coupling issue as soon as possible, and before prototype availability, Simcenter Engineering experts introduced us to the Simcenter Amesim systems simulation software," Watanabe explains. With this software, Honda managed to build fully integrated engine and vehicle models, which were scaled to take into account combustion, mechanics and controls.

A subtle but significant difference

Due to the psychological and largely subjective factors at play, the restart issue is more intricate than science would lead one to suspect. Typically, when an engine starts, body vibrations are caused by the rigid body eigenvalues of the power plant during initial combustion. The difference between normal start and restart however, is that we expect these vibrations to occur in the former case. While expectations are difficult to objectify and therefore generalize, the only effective strategy seems to be to reduce restart vibrations to their absolute minimum, without compromising engine performance.

Conventionally, prediction of noise and vibration phenomena from the powertrain uses a method that inputs the measured in-cylinder pressure values as a source of engine vibration. "However, departing from a fixed in-cylinder pressure value, these models do not consider the parameters for engine cranking and firing, which contribute greatly to engine restart vibration," says Tom Van Houcke, a Simcenter NVH expert closely involved throughout the project.

Using Simcenter Amesim™ software, Simcenter Engineering experts and Honda set out to develop a new prediction technique and a new evaluation method for engine restart vibrations. Honda can now accurately predict the entire powertrain restart process, beginning with the vehicle controls signals causing a certain in-cylinder pressure, which then results into driveline torque, particular suspension and powertrain bushing interface forces and eventually body vibration shock.

Allowing for the in-cylinder pressure to deviate, Honda can now determine the parts characteristics for the engine restart vibration in the vehicle design stage, as well as other noise and vibration phenomena, such as idling noise and vibration.

Technology partners for life

Honda appreciates more than the successful completion of the project today. "Thanks to our collaboration with the Simcenter Engineering team, our development cycle time is under better control," Watanabe asserts. Moreover, after the project completion, Honda received a full technology transfer, enabling them to reproduce all the techniques and methodologies for other purposes than engine restart vibrations. "Because of the technology transfer, we understand how to reproduce the applied techniques and adapt them to resolve all kinds of issues. We can now do this by ourselves, using our own assets to the fullest," Watanabe concludes.

As a result, Honda is now integrating and using MBD throughout their departments, which is allowing them to anticipate a variety of issues and frontload their solution. "Discussions are started earlier and thereby we avoid problems," Watanabe says. "By predicting systems behavior upfront, the workload afterwards is significantly reduced, which allows us to focus our efforts and resources on other priorities, such as brand image and value."

With Simcenter Amesim, Honda R&D created fully integrated engine and vehicle models that take into account combustion, mechanics and controls.

Solutions/Services

Simcenter Engineering
Simcenter Amesim
Simcenter Testlab
Simcenter SCADAS

siemens.com/simcenter

Customer's primary business

Honda R&D Co., Ltd develops automobiles, aircraft, motorcycles and power equipment.
www.honda.com

Customer location

Tokyo
Japan

Engineering services as gatekeeper to the Simcenter portfolio

Honda considers the collaboration with Simcenter Engineering services of great value in staying ahead in the race towards new technologies and methodologies, such as those developed in the context of this project. "Integrating 1D, 3D CAE and test is the strength of Simcenter Engineering, which has the Simcenter product portfolio at its disposal," Watanabe concludes. "As long as this combination of solutions is available, we will continue to work together in the future."

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