Punch Powertrain

Siemens PLM Software helps automotive manufacturer develop new generation of switched reluctance motors with superior NVH performance

Developing a powerful partnership
The development of electrical motors for hybrid and electrical automotive propulsion presents many engineering challenges. Mechanical engineers can choose from a large variety of motor types and configurations, and have to effectively evaluate all possibilities. Besides the right conceptual configuration and control strategy for maximized energy efficiency, the demanding passenger car industry also requires optimal noise, vibration and harshness (NVH) behavior of the motor.

Simcenter™ Engineering services helped Punch Powertrain implement an efficient, simulation-based process for vibro-acoustic

Product
Simcenter

Business challenges
Implement simulation-based approach, combining electromagnetics and vibro-acoustics
Reduce motor noise to target level
Avoid tonal noise on critical frequencies

Keys to success
Combine test and simulation for the creation of validated simulation models
Couple the vibro-acoustic model with the electromagnetic model
Analyze modifications to the validated simulation model

Results
Reduced total development time by at least 50 percent
Developed new generation of motors with better NVH performance
Implemented a new simulation-based process with knowledge transfer

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optimization of electrical motors. The partnership resulted in a surprising and dramatic change of the conceptual design of the motor.

Switched reluctance motors challenge NVH performance

Based in Sint-Truiden, Belgium, Punch Powertrain invents and develops next-generation, continuously variable transmissions (CVTs) and hybrid powertrains. In addition to its core activity of supplying full transmission systems, the company focuses on research into new drive concepts for hybrid and electrical vehicles. Only the best concepts that deliver the highest functional performance and customer satisfaction, while minimizing fuel consumption and emissions, will be commercialized and produced. In this context, Punch Powertrain is currently investigating the potential of switched reluctance (SR) motors for drivelines.

“When we consider the fact that it took only half a year to put this process in place, we can definitely say that the total development time has been reduced by at least a factor of two.”

Diederik Brems
Mechanical Engineer
Punch Powertrain
“Thanks to Simcenter Engineering and the optimization process they used with the simulation solution from the simcenter portfolio, we are now working on a new generation of commercially competitive switched reluctance motors for automotive propulsion.”

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Mechanical Engineer
Punch Powertrain

“The main advantages of using switched reluctance motors for propulsion in hybrid and electrical vehicles is the simple construction and absence of expensive permanent magnets,” says Diederik Brems, who is a mechanical engineer at Punch Powertrain. “But since control for maximum efficiency leads to high torque ripple, these motors usually produce a relatively high noise level in a tone that is often perceived as annoying. Controlling that NVH behavior is a prerequisite to achieve a competitive solution, especially in the passenger car market in which the expectations for NVH performance are very high.”

Simulating the entire process
Engineers at Punch Powertrain are constantly looking at different configurations and control strategies, and recognize the value of Siemens PLM Software products in this process.

“We had been using Simcenter Testxpress software quite often for basic measurements and we did smaller projects with Simcenter Engineering,” says Brems. “But this time we really wanted to go the extra mile. We usually implement our ideas on physical prototypes – quite an expensive process. Development, production and testing of a prototype can easily take up to 15 weeks. We had enough work to keep us busy for two to three years. That led us to ask Simcenter Engineering for a proven digital approach.”

The inquiry resulted in Punch Powertrain and Simcenter Engineering working together on the project to generate a simulation model containing both the electromagnetic and the NVH behavior of a switched reluctance motor. The advantage of coupling those two physical aspects is obvious: engineers can immediately see the effect of changing the control strategy on the motor’s NVH behavior. By using test and simulation software from the Simcenter portfolio, Simcenter Engineering could cover the entire vibroacoustic part of the process with Siemens PLM Software products. This included creating the finite element (FE) model, correlation between the physical model and FE model and acoustic radiation studies. By coupling the simulation solution from the Simcenter portfolio to JMAG® electromagnetic software, the entire simulation process was completed.

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Diederik Brems
Mechanical Engineer
Punch Powertrain
Solutions/Services
Simcenter Engineering
www.siemens.com/plm/simcenter-engineering
Acoustics simulation

Customer’s primary business
Punch Powertrain invents and develops next-generation, continuously variable transmissions and hybrid powertrains. Besides its core activity of supplying full transmission systems, the company focuses on research into new drive concepts for hybrid and electrical vehicles.
www.punchpowertrain.com

Customer location
Sint-Truiden
Belgium

Reducing development time by at least a factor of two
“This validated model allowed us to virtually simulate all the variations we had in mind,” notes Brems. “When we consider the fact that it took only half a year to put this process in place, we can definitely say that the total development time has been reduced by at least a factor of two. But even more important is what we have learned. After the project, we implemented some drastic changes on different levels to the structure, to the control strategy and even to the topological configuration.”

Combining these changes mitigates the electromagnetic forces in the motor and avoids heavy excitation of certain critical structural stator modes. The result is a completely different switched reluctance motor with much better NVH behavior.

“Thanks to Simcenter Engineering and the optimization process they used with the simulation solution from the Simcenter portfolio, we are now working on a new generation of commercially competitive switched reluctance motors for automotive propulsion, with an optimized current scheme and satisfactory NVH performance,” concludes Brems.

Using Simcenter Engineering services and tools, Punch Powertrain developed a new generation of motors featuring notably better NVH performance.