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Ingenuity for life

Delphi Diesel Systems

Going green with innovative diesel fuel injection systems

Product

Simcenter

Business challenges

Offer "greener" injection systems solutions

Reduce vehicles' environmental impact

Develop reliable products

Keys to success

Optimize the design of injector nozzles

Reduce the number of costly, time-consuming physical tests

Exchange models among internal teams and customers

Results

Maximized simulation predictability

Improved collaboration internally and externally

Significantly reduced testing, costs and time-to-market

Delivered high-fidelity fuel injection system models per customer requirements

Advanced brand attributes: sustainable development and reduced impact on the environment

## New rules of the game: tighter emission standards and shorter time-to-market

Vehicle emission regulations are becoming more and more stringent. For example, the Euro 6 emission standards will go into effect in 2014 and original equipment manufacturers (OEMs) will continue to face tough environmental regulations throughout the world. This also affects automotive suppliers, who must adopt a "greener" approach, reducing pollutant emissions while increasing fuel economy.

Delphi Diesel Systems (Delphi) designs, manufactures and assembles diesel fuel injection systems and components (including injectors, fuel pumps, rails, fuel filters and engine control units), and develops control strategies. Diesel injector design is one of the core competencies of the Delphi technical research and development (R&D) center, located in Blois, France and employing about 700 R&D specialists.

This R&D center must operate under the new rules of the game on the worldwide auto market. To meet emission requirements, it is vital to optimize combustion, which requires accurate control of the quantity of fuel injected into the combustion chamber. In addition, the design of the injector nozzle affects the mechanical
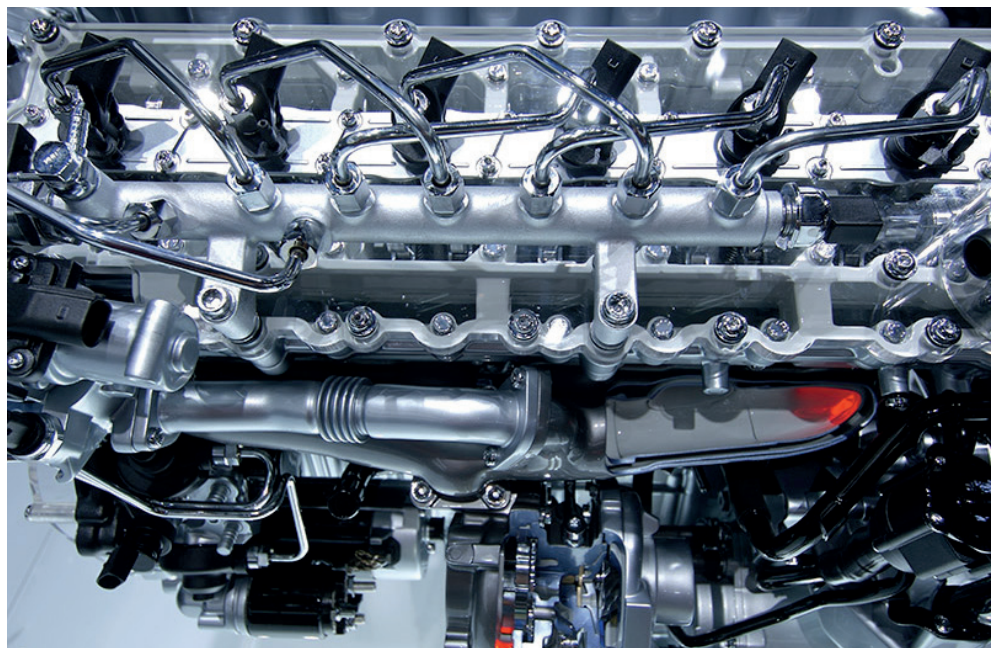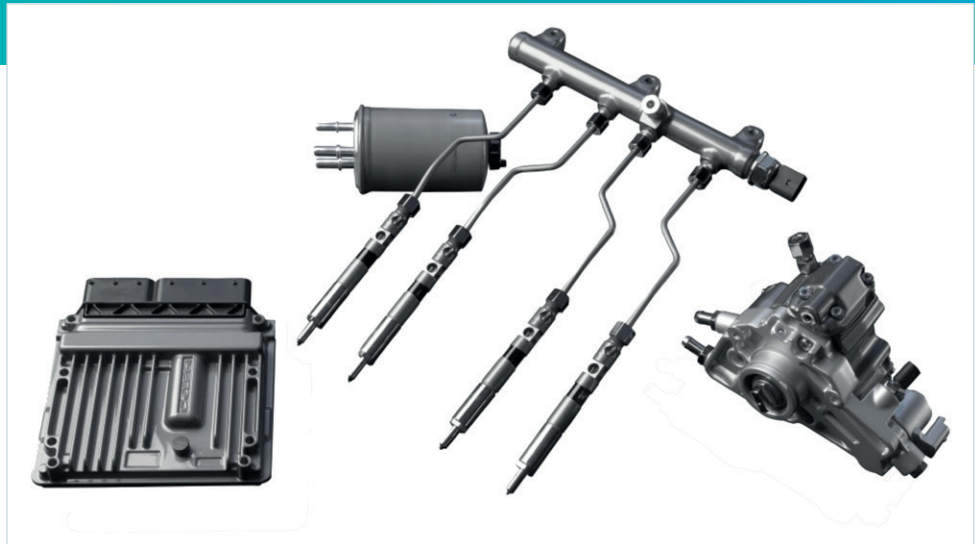
Diesel injection system components.

durability of the injector and the performance of the whole engine. Injection systems optimization wouldn't be possible without simulation, because of the high cost of physical parts needed for tests. Moreover, the time required for physical testing would result in a huge amount of data to manage and analyze, making it impossible to meet the company's time-tomarket goals.

Modeling of the injector nozzle using Simcenter Amesim

Delphi started using Simcenter Amesim™ software from Siemens Digital Industries Software for the injector simulation several years ago. The company chose this software, which is part of the Simcenter™ portfolio, because of its extensive libraries of components representing elementary physical phenomena, which can be assembled in complex system models. Moreover, using the control validation functionality

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Solenoid Injector Simulation Manager
Delphi Technical R&D Center

of Simcenter Amesim enabled the Delphi solenoid injector simulation service to supply models to the injection systems team that is in charge of system control strategies development. Today, Delphi is actively using the Simcenter Amesim Automotive package and in particular the Simcenter Amesim Hydraulic Component Design library, the Simcenter Amesim Hydraulic Resistance library, the Simcenter Amesim Thermal library, and the Simcenter Amesim Signal, Control library.

To precisely control the amount of injected fuel, Delphi engineers created a supercomponent, enabling them to represent injector functioning within a temperature range from -40 to +120 degrees celsius (C) and a pressure range from 80 to 2000 bars, as accurately and realistically as possible. Delphi studied different geometries of the nozzle seat. To guide the flow during the full lift, an untruncated needle is often used for low-flow injectors, whereas a truncated one is used for high-flow injectors to reduce pressure losses. Delphi started looking for a solution that would allow its engineers to model these complex hydraulics phenomena and maximize simulation predictability.

The solution came from the use of Simcenter Amesim. Delphi decided to adapt the Simcenter Amesim poppet with the conical seat component to narrow the specific application. This Simcenter Amesim component enables engineers to model pressure losses at the truncation, seat and sac entry levels. To optimize the use of the Simcenter Amesim component, Delphi engineers carried out computational fluid dynamics (CFD) nozzle analyses.

From the flow versus lift and force versus lift curves obtained, the engineers found that the force applied on the nozzle was less linear in the case of the truncated needle. They then compared results obtained using the Simcenter Amesim component and CFD.
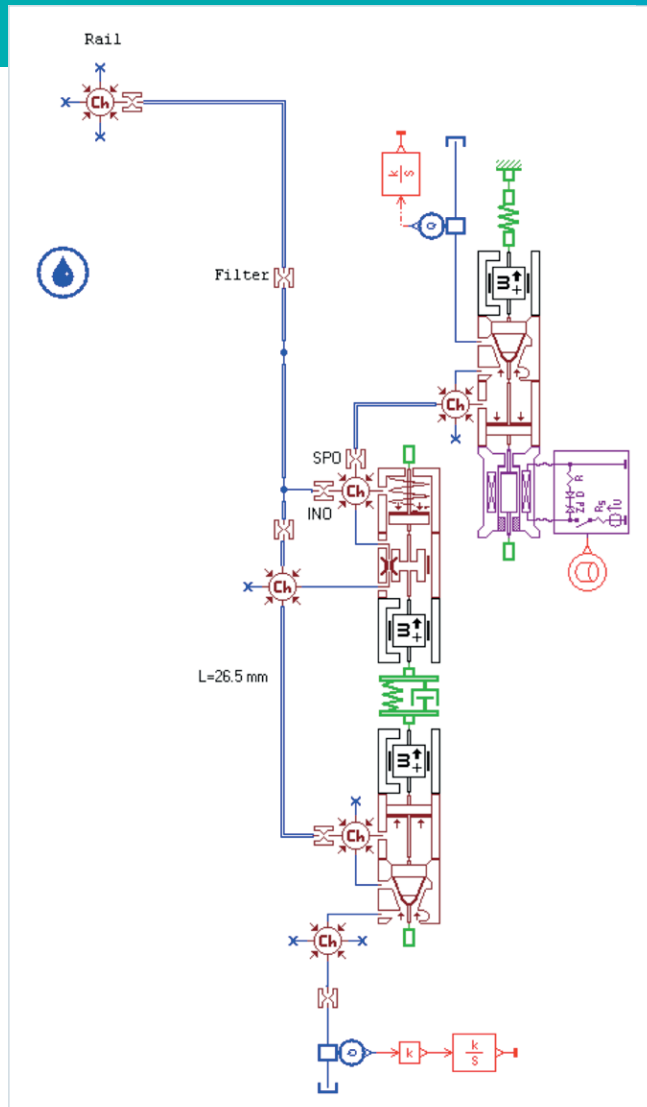
Delphi optimizes its products to enable the accurate control of the amount of fuel injected using diesel injection system modeling via Simcenter Amesim.

The correlation between force-lift curves, especially for the truncated needle, was not adequate. So Delphi used CFD to understand flow phenomena and used the results to adjust parameters of the supercomponent, which took into account the restriction between the needle and the nozzle. This allowed Delphi to optimize force modeling in accordance with the lift, without affecting the flow-lift curve.

Streamlined, collaborative and green
The above method enables Delphi to keep central processing unit (CPU) time short. The use of CFD results, in conjunction with

Solutions/Services

Simcenter Amesim
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simcenter-amesim

Customer's primary business

Delphi Automotive PLC is a leading global supplier of technologies for the automotive and commercial vehicle markets. Headquartered in Gillingham, England, Delphi operates major technical centers, manufacturing sites and customer support services in 32 countries, with regional headquarters in Luxembourg, Brazil, China and the United States. Delphi delivers innovation for the real world with technologies that make cars and trucks safer as well as more powerful, efficient and connected.
www.delphi.com

Customer location

Blois
France

Simcenter Amesim modeling, enables Delphi to analyze one injection point in less than 30 seconds. The entire injector mapping process (40 working conditions) now takes about 15 minutes.

In addition, the use of Simcenter Amesim enables the injection systems team to supply OEMs with "black box" models with restricted access to sensitive model parameters and reduced CPU time, but with enough data to understand the exact amount of fuel injected.

Today, the main brand attributes of Delphi diesel products are sustainable development and reduced impact on the environment. Injection systems optimization projects underpin this approach. More accurate injectors enable Delphi to limit fuel consumption as well as reduce energy supplied to the system and, as a result, reduce each vehicle's carbon dioxide (CO_2) emissions impact. Moreover, Simcenter

Amesim is a key factor in improving sustainability.

The success of the Simcenter Amesim roll-out has Delphi interested in Simcenter Sysdm software, a collaborative solution for model and data management. This would enable the solenoid injector simulation and injection systems teams to easily share their models, capitalize on different versions and optimize the organization's system simulation process.

"Model-based systems engineering is truly our future," says Vincent Pichon, solenoid injector simulation manager at the Delphi technical R&D center. "Simulation is the way forward. It enables us to study as many injector architecture choices as possible, with different parameters and test conditions. Simcenter Amesim is an ideal tool for this. Allowing for model exchange internally as well as with Delphi's customers, Simcenter Amesim meets our needs well."

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