SIEMENS
Ingenuity for life

Automotive and transportation

PSA Peugeot Citroën

Using Simcenter Amesim enables automaker to enhance fuel efficiency and reliability of powertrain components

Product

Simcenter

Business challenges

Reduce vehicle environmental impact

Guarantee reliability of increasingly complex systems

Maximize operational efficiency/profitability

Keys to success

Evaluate the impact of a design choice on powertrain thermal management performance

Perform vehicle energy balance analysis

Reduce the number of costly, time-consuming physical tests

Share and capitalize on knowledge between internal teams and suppliers

Results

Achieved increased reliability and fuel efficiency of powertrain components

Reduced powertrain component damage due to protection strategies

Significantly reduced testing and time-to-market

Enhanced internal and external collaboration

Enhancing powertrain thermal management

Car manufacturers face multiple challenges when designing powertrain architectures. They must reconcile numerous and sometimes contradictory requirements to reach the desired level of product quality, pollutant emissions, passenger comfort, fun-todrive performance, reliability and safety. And they must do all of this while striving to be profitable, shorten the product development cycle and reduce time-to-market.

Powertrain systems are becoming increasingly complex, and include a growing number of actuators, sensors, hybrid traction systems, and electric and electronic components, requiring controls and protection strategies to limit component damage. Developing powertrain thermal management strategies is a major issue for original equipment manufacturers (OEMs), and these strategies are taking more systems into account than ever before, including the internal combustion engine, gearbox, car interior, electric powertrain battery and electronic control units.

Powertrain thermal management optimization enables car manufacturers to reduce fuel consumption (for example, via warmup phase acceleration) and carbon dioxide (CO_2) emissions, and therefore allows the

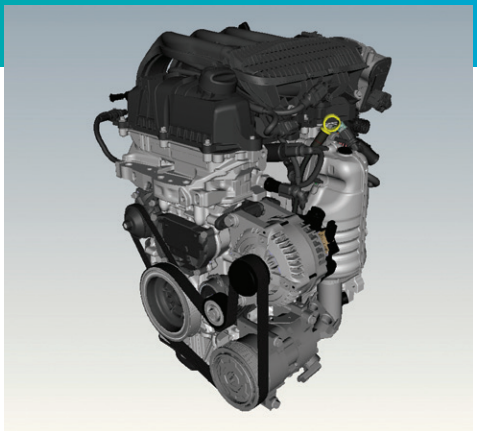
By combining 200 horsepower with 88 grams per kilometer of CO_2 emissions, the Citroën DS5 Hydrid4 produces a new driving experience.

OEMs to meet stringent international standards. It also facilitates appropriate powertrain cooling and passenger thermal comfort by controlling cooling fluid temperature and flow rate in the air heater. In addition, effective powertrain thermal management maintains an optimal operating temperature for the engine and gearbox, promoting component reliability and fuel efficiency. The thermal management system can adapt to vehicle usage under a variety of conditions, and set temperature thresholds to further help protect powertrain components.

Broad appeal

PSA Peugeot Citroën addresses powertrain thermal management by using simulation throughout the powertrain component and system design process. Moreover, the simulation approach is applied for validating supplier proposals as well as for powertrain control validation on hardware-in-the-loop (HIL) test benches, and for control precalibration.

In 1995, PSA Peugeot Citroën started using Simcenter Amesim™ software, the mechatronic system simulation platform, part of the Simcenter™ portfolio from Siemens Digital Industries Software. Prior to the Simcenter Amesim implementation, they had been using a variety of tools for power-train subsystem modeling. That often caused interoperability problems when conducting global system analysis.



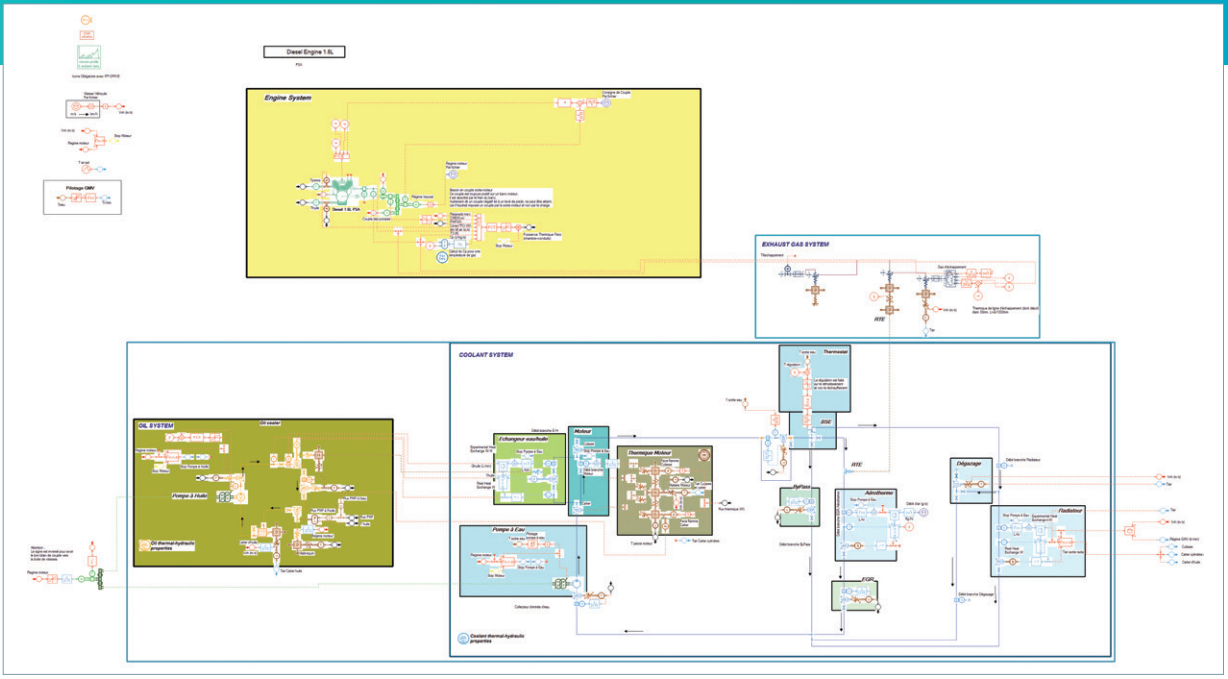
PSA Peugeot Citroën 1.2-liter 3-cylinder gasoline engine.

That's why a key factor in PSA Peugeot Citroën's decision to adopt Simcenter Amesim was the tool's broad set of predefined and validated component libraries, which are ideally suited for multi-domain system modeling.

"Without Simcenter Amesim, it would have been much more difficult to tackle current design challenges," says Eric Le Dantec, powertrain modeling and simulation expert at PSA Peugeot Citroën. "With a trial-and-error approach, the time required for physical testing would've been too long."

Simcenter Amesim covers the design phases from component sizing to full vehicle integration and validation without any model compatibility problems. For example, engineers in the PSA Peugeot Citroën powertrain architecture design department are actively using Simcenter Amesim for

Peugeot 508 RXH: a "through-the-road" hybrid vehicle with a distinctive allure and 107 grams per kilometer of CO_2 emissions.



Simcenter Amesim was used to build this thermal management powertrain system model.

coolant and oil circuit design. After that, in order to conduct complex powertrain thermal management analysis, completed models are plugged together. Then design engineers evaluate the impact of a design choice on the overall system and compare the efficiency of different architectures. By using Simcenter Amesim, in a matter of minutes they can choose between an electric and mechanical water pump or continuous and controlled flow in water-oil heat exchangers of the engine and gearbox.

PSA Peugeot Citroën, which is known for its best-in-class car handling, is also using Simcenter Amesim for vehicle dynamics synthesis. For controls integration work, PSA Peugeot Citroën often performs co-simulation using the Simulink® environment. A simplified workflow between Simcenter Amesim and Simulink was therefore also a key point in its decision.

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Powertrain Modeling and Simulation Expert
PSA Peugeot Citroën

"Real expertise can only emerge from teamwork. That's why it's impossible to carry out the design process effectively without cooperation among internal teams and suppliers. I think that the collaborative aspect will be at the heart of concern to improve the design process. Simcenter Sysdm software and Simcenter System Synthesis software are consistent with these trends."

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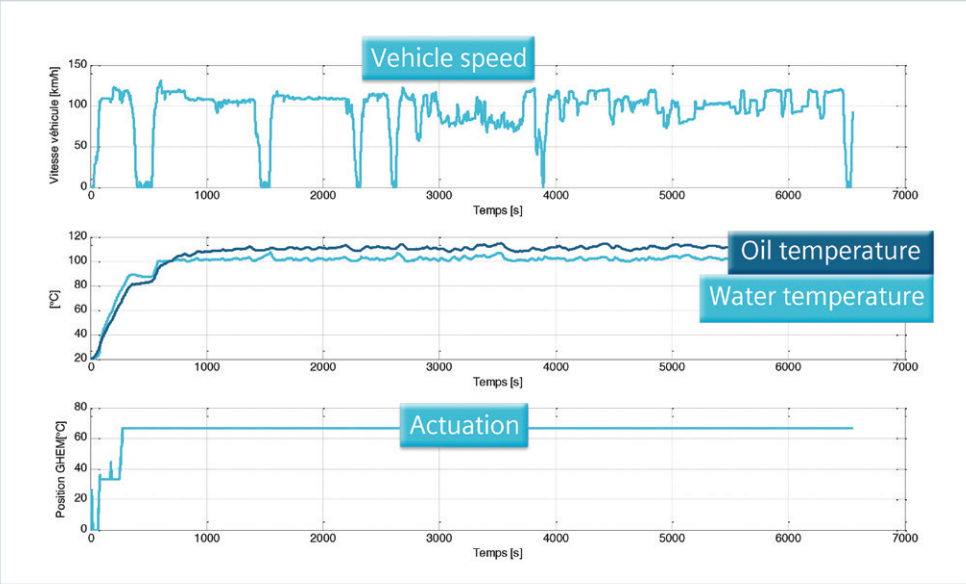

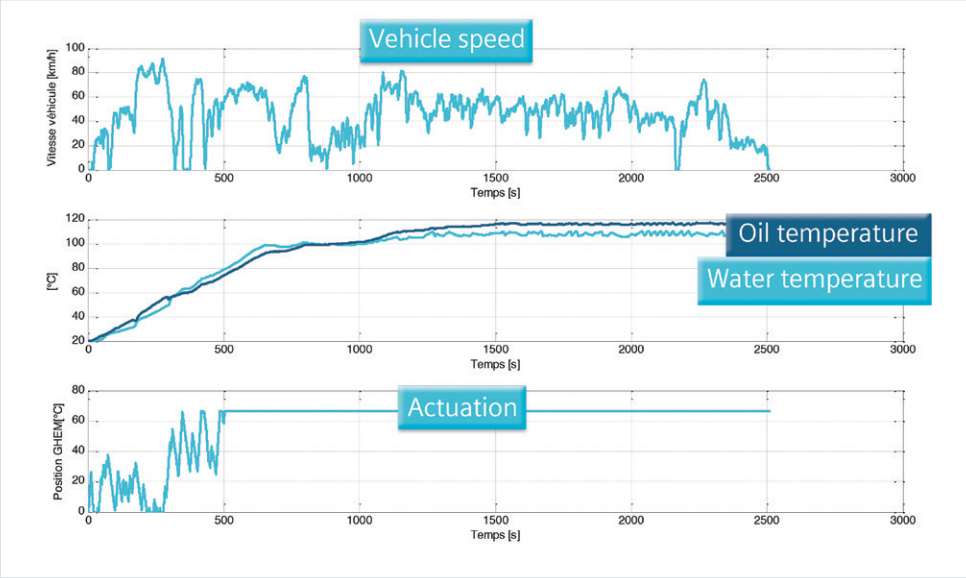

These graphs show the evolution of oil and water temperatures as well as transient requests of actuation components when driving on the motorway (graph above) and in the city (graph below).

Developing protective strategies

PSA Peugeot Citroën has recently extended its simulation approach to evaluating the effect of new technologies on powertrain component reliability. The powertrain architecture design department wanted to account for different usage situations in its powertrain system robustness analysis.

Design engineers built an engine thermal management model using Simcenter Amesim, and conducted co-simulation with Simulink. The use of Simcenter Amesim enabled engineers to measure the evolution of oil and water temperatures as well as transient requests of actuation components in different driving conditions.

Solutions/Services

Simcenter Amesim
Simcenter Sysdm
Simcenter System Synthesis
siemens.com/simcenter

Customer's primary business

With 32 manufacturing facilities, six research and development centers and 211,100 employees worldwide, PSA Peugeot Citroën is committed to using technological innovation to develop new, more environmentally and community-centered mobility solutions. Its three priority areas for the next five years are clean technologies, safety and onboard intelligence. www.psa-peugeot-citroen.com/en

Customer location

Paris
France

To assess damage, the reliability-based approach allowed powertrain design engineers to obtain component request histograms so they could understand the constraints that each component faces during its service life. This information enabled PSA Peugeot Citroën to size powertrain components and provide suppliers with specifications in order to meet durability requirements for the entire system.

Moreover, design engineers implemented protection strategies that account for component damage to safeguard the engine. These strategies allowed for either reducing the performance request above a certain threshold of component damage, or limiting the duration of the most damaging usage situations. The system simulation approach allowed the powertrain architecture design department to define these protection strategies and identify potential conflicts between them.

Facilitating collaborative simulation and modeling

"Real expertise can only emerge from teamwork," says Le Dantec. "That's why it's impossible to carry out the design process effectively without cooperation among internal teams and suppliers. I think that the collaborative aspect will be at the heart of concern to improve the design processes. Simcenter Sysdm software and Simcenter System Synthesis software are consistent with these trends."

In order to advance simulation robustness and foster continuity in projects, PSA Peugeot Citroën introduced strict modeling process rules, especially for rigorously defining component interfaces to allow for model compatibility.

"I don't see any alternative to model-based system engineering given the complexity of system design in the automotive industry," adds Le Dantec.

As proof of this, since 2012, Siemens Digital Industries Software and PSA Peugeot Citroën have participated in the French research project AGeSys (Atelier de Génie Système – Integrated System Engineering Platform), which aims to create an open platform supporting an architecture-driven, model-based system engineering approach for mechatronic systems and embedded software.

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