DIGITAL INDUSTRIES SOFTWARE

Maximizing simulation performance and reliability using co-simulation

Achieving more complex, realistic simulations with Simcenter Engineering services

Benefits

- Combine 1D and 3D simulation techniques to minimize development time and cost while maximizing performance and reliability
- Achieve more complex, realistic simulations
- Take advantage of 1D simulation speed and 3D simulation precision
- Frontload decisions to avoid issues later in the development lifecycle
- Design and virtually verify entire system, not just individual components

Summary

Simcenter™ Engineering services uses Simcenter STAR-CCM+™ and Simcenter Amesim™ software to make simulations faster, more complex and realistic. These solutions are part of the Xcelerator portfolio, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software.

For today's engineers, the ability to leverage multiple tools is essential to remain competitive. Tightening regulations and increasing prototype costs mean that predictive analysis is more important now than ever before.

In an environment of fast-paced change, engineers must find ways to minimize development time and cost while maximizing performance and reliability. A combination of 1D and 3D simulation techniques is one way to achieve this.

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How 1D and 3D co-simulation works

1D and 3D simulations complement each other by enabling access to information that may be missing when using one approach alone.

Typically, 1D simulations are fast. To achieve that speed, 1D simulations make many assumptions and do not consider the impact of detailed geometry.

Conversely, 3D simulation offers a high-level of detail and precision. However, it is computationally expensive to simulate a complete system using 3D.

By combining the two methods, engineers can take advantage of the highly detailed, comprehensive models offered by 3D, while enjoying the speed of 1D simulation.

Simcenter Engineering enables automotive companies to develop automation and customized workflows using 1D and 3D co-simulation. In this fact sheet, we will discuss some applications that are well-suited for this technique.

1D and 3D co-simulation for HVAC

Automakers seeking to improve cabin comfort for their customers often focus on optimizing heating, ventilation and air conditioning (HVAC) systems. Leveraging 1D and 3D co-simulation is especially efficient for HVAC, as it enables complete characterization of the system while minimizing physical tests and reducing the product's development lifecycle.

When modeling a vehicle cabin, the air and components must be modeled to achieve a high-fidelity simulation. This includes a wide variety of parts, including the electronics in the dashboard, glass and paneling. 3D simulation using Simcenter STAR-CCM+ can be used to capture flow and thermal behaviors.

To complement the detailed 3D simulations, Simcenter Engineering experts use 1D simulation in Simcenter Amesim to eliminate the need to model the refrigeration loop in detail. This normally entails a complex phase change and is computationally expensive, especially for an area that is typically not the focus of an HVAC investigation.

By coupling the 3D simulations in Simcenter STAR-CCM+ with the 1D simulations in Simcenter Amesim, the Simcenter Engineering team can help customers complete simulations in a few days from computer-aided design (CAD) to postprocessing. This is a significant improvement compared to traditional methods. This faster turnaround enables customers to perform more design exploration, which leads to more effective designs, identification and resolution of problems before production. It also enables customers to move prototypes to verification and validation (V&V) faster.

1D and 3D simulation for underhood thermal management

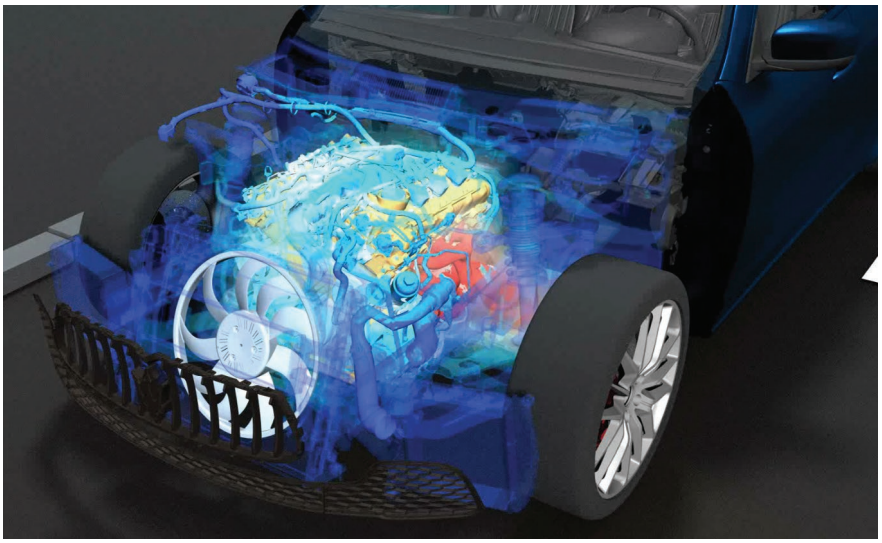
A key indicator of proper frontend airflow is keeping peak and average component temperatures in material limits in the underhood (engine bay) region under the harshest load conditions.

Simcenter Engineering helps customers model a variety of driving cycles to make sure the coolant circuit will perform as expected.

By using Simcenter Amesim, Simcenter Engineering experts can build a 1D system model consisting of the coolant loop from the radiator outlet back to the inlet, including all pumps and valves. This 1D simulation provides an effective way to enhance fidelity and maintain computational speed, particularly when the more detailed geometry is not available. Using this 1D system model, the team can still reasonably represent the cooling jacket and thermal input of the cylinders.

Next, Simcenter Engineering can be used to model the rest of the vehicle in 3D using Simcenter STAR-CCM+, which enables exploration of the radiator design space and the grilles and ducts in the front end of the vehicle. They apply transient boundary conditions of the respective drive cycles to both 1D and 3D models to include vehicle speed, inlet velocity, pump speed curve and wheel rotation.

While running the drive cycles, Simcenter Engineering experts monitor several key areas,



including the radiator top tank temperature. The radiator top tank temperature is an important parameter in cooling system design, as it provides information about how the system is performing under various load conditions. An accurate radiator pressure drop computation and local heat exchanges are required for computing the coolant temperature evolution. This makes sure there is enough flow to maintain proper temperature of the critical engine parts. By using 3D models, Siemens' engineers can monitor system performance and predict temperature distribution across the full vehicle under various load conditions, all with significantly less run time than traditional simulation methods.

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