SIEMENS DIGITAL INDUSTRIES SOFTWARE

Topology optimization with Simcenter STAR-CCM+

Generate optimal additive manufacturing designs to meet engineering requirements early on

Benefits

- Generate optimal additive manufacturing designs
- Meet engineering requirements early in the design process
- Generate designs that satisfy the available space restrictions
- Improve product performance by optimizing heat efficiency and flow paths

Summary

Generative engineering is gaining more attention with the industrialization of additive manufacturing. Using topology optimization (TO) for structural problems was adopted early on to accommodate for out-of-the-box generative engineering needs. In the past, flow-centered problems usually focused on trial-and-error design methods, which led to conservative designs that were unable to unlock additive manufacturing benefits.

TO for fluid flow takes advantage of additive manufacturing's full potential. It enables you to:

- Automatically generate optimized designs using powerful gradient-based optimization methods
- Create early design concepts, which are driven by engineering targets without needing a starting design
- Design better performing products that naturally fulfill packaging constraints

SIEMENS

siemens.com/simcenter

Simcenter STAR-CCM+ offers the solution

Using TO in Simcenter™ STAR-CCM+™ software, which is a part of the Xcelerator™ portfolio, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software, offers an integrated solution for fluid/thermal problems. To run an adjoint TO, you need to only define your design envelope and flow/thermal objectives by cost functions. This method will chisel away the parts of your geometry that hinder the cost function, which turns them into a solid and defines the optimal flow path shape. It allows you to solve engineering problems with competing objectives in a streamlined manor.

These competitive attributes are key to the additive manufacturing landscape. Simcenter STAR-CCM+ provides:

- Productivity with reduced engineering time and an easy-to-use pipelined workflow, which is delivered from a single and integrated user interface (UI)
- A competitive method based on the level set approach, which enables clean designs by employing a moving interface around the predicted flow path
- A flexible and powerful optimization method with versatile cost function and constraint definitions to tackle a variety of engineering problems

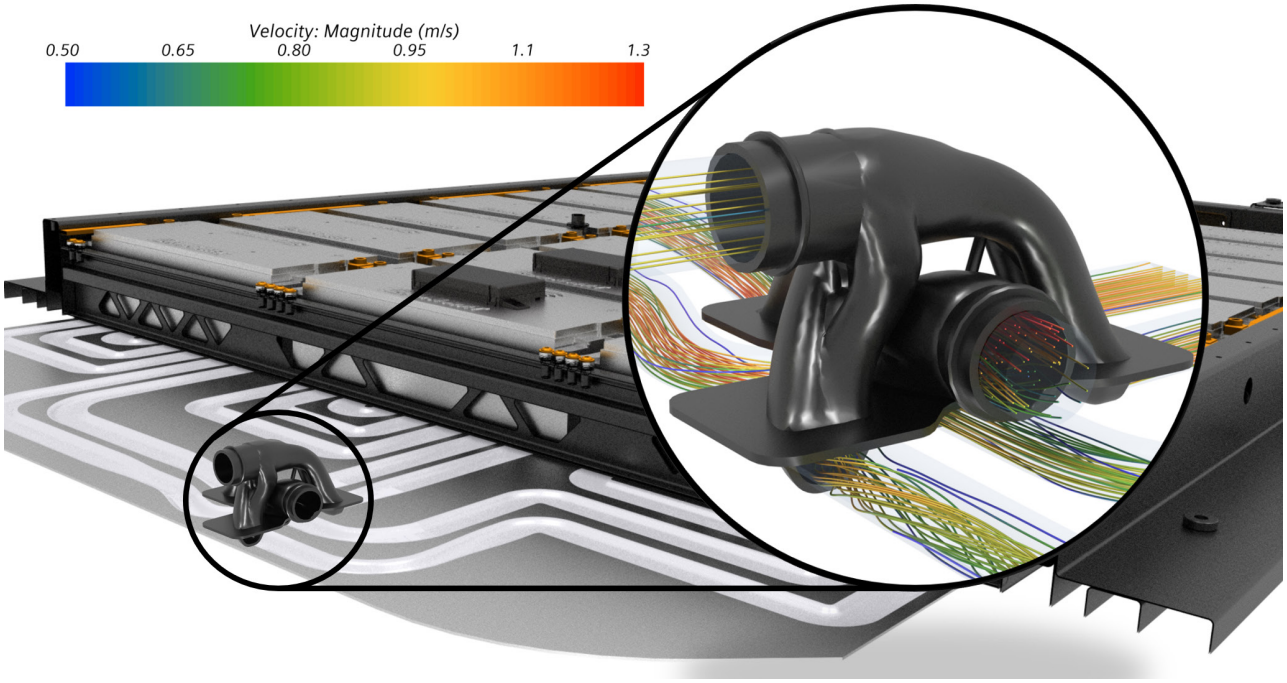

Figure 1. Design evolution of battery-cooling manifold.

Productivity

Using Simcenter STAR-CCM+ enables an efficient and customizable workflow with:

- Automated and repeatable TO execution for efficient problem solving
- Geometry transfer to and from NX™ software, which enables you to seamlessly integrate the new design in the additive manufacturing production chain
- A clean flow path with the level set approach, which significantly reduces turnaround time by minimizing manual geometry cleanup and computer-aided design (CAD) reproduction
- Automatic mesh adoption of the evolving fluid/solid interface, which balances computational effort and accuracy
- Automatic generation of a closed surface, which provides a new watertight design to directly export the resulting geometry or use it inside Simcenter STAR-CCM+

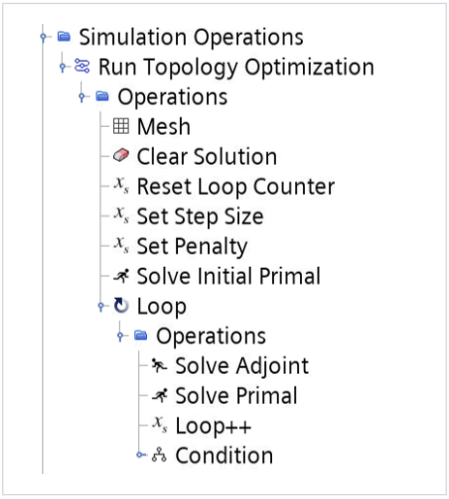

Figure 2. Simulation operations used to drive the TO process from start to finish.

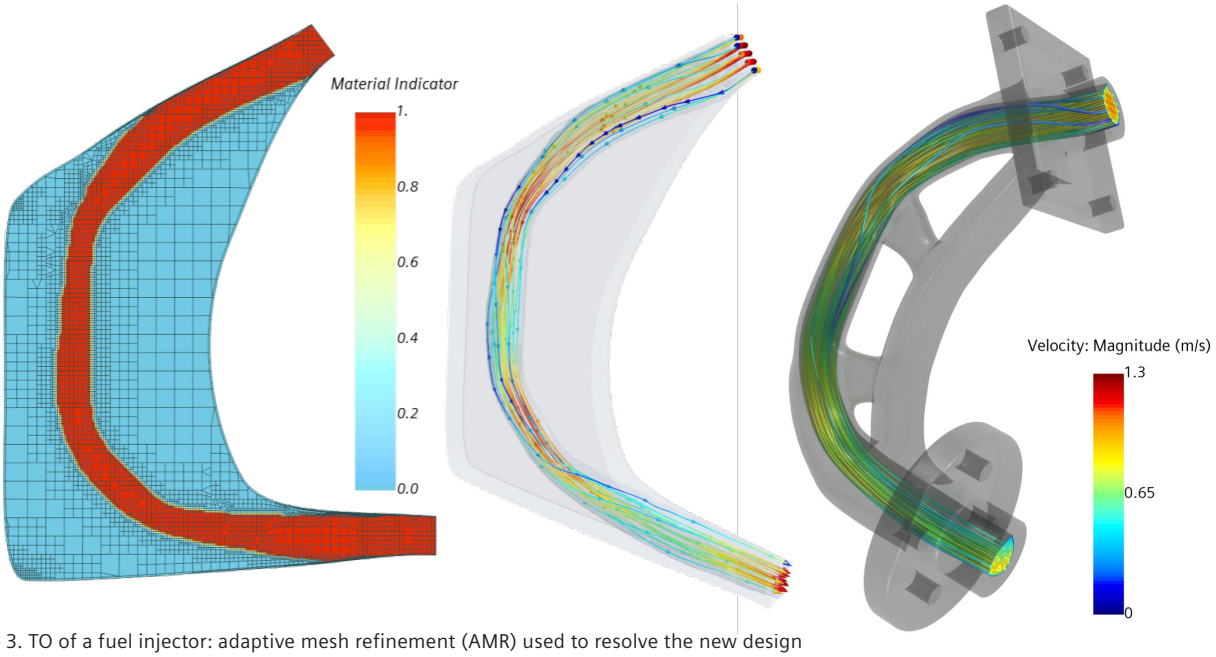

Figure 3. TO of a fuel injector: adaptive mesh refinement (AMR) used to resolve the new design interface (left) and the combination with structural TO (right).

Competitiveness

Achieve high-performing designs using Simcenter STAR-CCM+ with a unique level set approach:

- Reduce the clean-up and CAD reproduction time, which minimizes production cost with a cleaner interface between solid and fluid. This reduces kinks and folds in your designs and eliminates the spare pockets of flow created by traditional, porosity-based methods of topology generation. It creates a robust optimization process, which allows users to run with semi-converged adjoint and flow solutions for the intermediate optimization steps
- Clearly define the interface between the fluid and the fictitious solid surrounding the design to apply treatments and mimic a boundary. This can be turbulent wall treatment or AMR of the fluid/solid interface

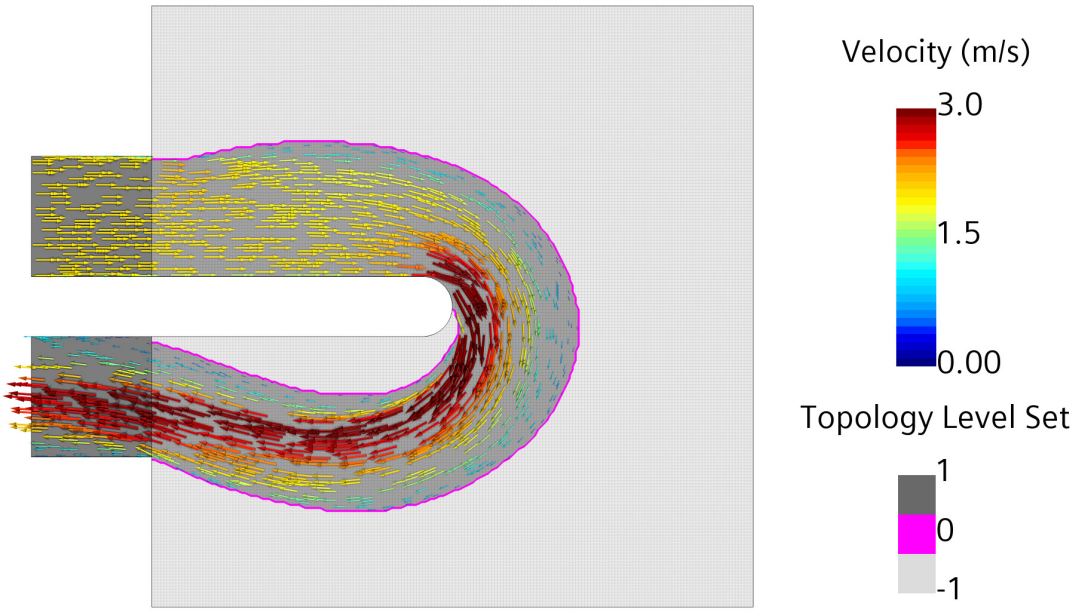

Figure 4. Level set field for robust TO, which leads to clearly defined fluid-solid interfaces.

Flexibility

Supplying solutions for a vast array of engineering problems makes TO meaningful in day-to-day operations such as:

- Solving engineering problems with competing attributes using a constrained optimization method. Users can define one objective with multiple flow/thermal and volume constraints
- Balancing tradeoffs between engineering performance and the design's volume via the integrated volume constraint. It allows the user to specify the domain percentage to occupy with flow or solid
- Solving a larger class of engineering problems by expanding beyond structural TO. User-defined cost functions enable quick definition and analysis of various fluid flow and thermal scenarios

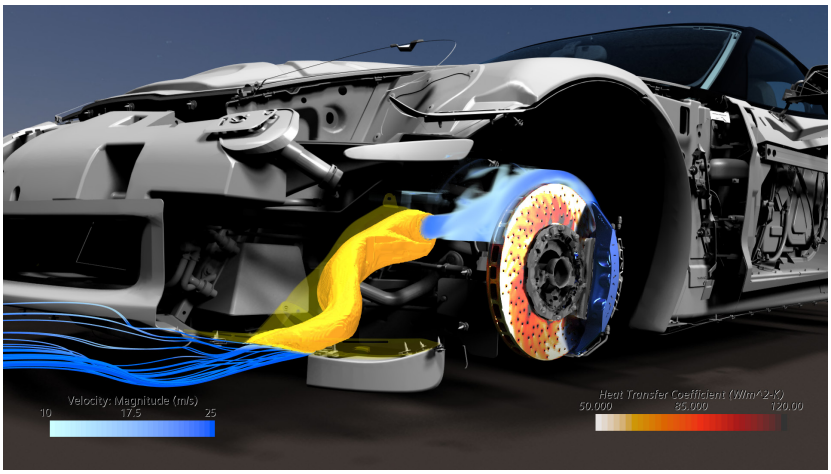

Figure 5. New brake cooling duct for automotive brakes.

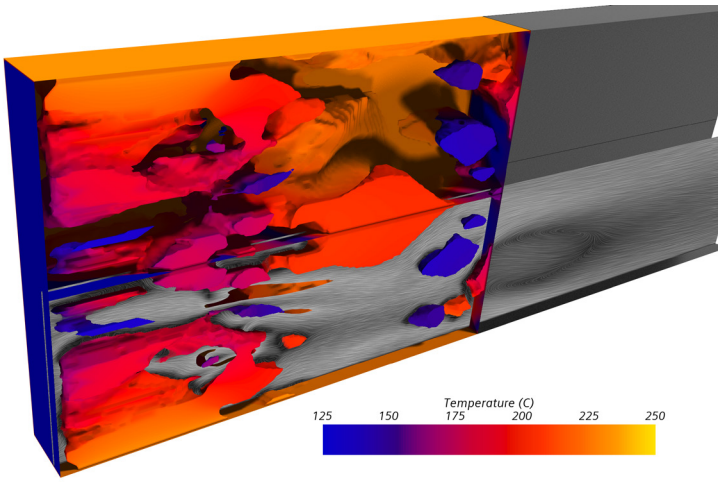

Figure 6. Conformal cooling for injection molding part.

Siemens Digital Industries Software

siemens.com/software

Americas
1 800 498 5351

Europe
00 800 70002222

Asia-Pacific
001 800 03061910

For additional numbers, click here.

© 2021 Siemens. A list of relevant Siemens trademarks can be found here. Other trademarks belong to their respective owners.

83776-D3 7/21 A