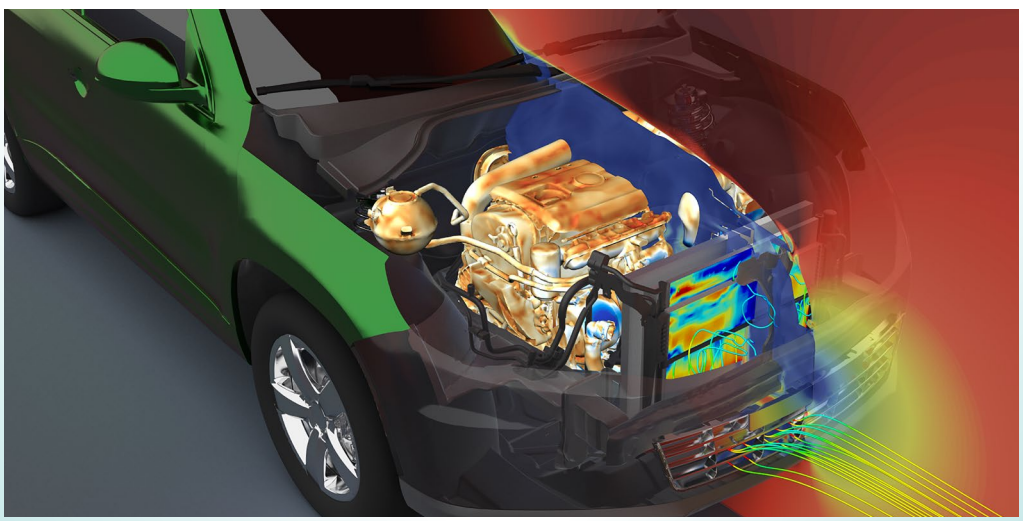
DE
Digital Engineering

MAKING THE CASE FOR

MORE SIMULATION, MORE OFTEN



Whether designing a product as cutting-edge as a lightweight electric vehicle or as cut-and-dry as a conventional HVAC system, engineering teams are faced with an array of challenges that require a new approach.

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MAKING THE CASE FOR MORE SIMULATION, MORE OFTEN

The traditional design process, which taps into limited use of simulation only at key intervals, is no longer a reliable on-ramp to creating high-quality, cost-effective products. The stakes are higher for a variety of reasons: The pace of innovation has greatly accelerated and consumers have a growing appetite for smart products, personalized to meet their needs. According to the McKinsey Global Innovation Survey, an overwhelming 84% of executives said innovation was critical for growing their businesses. The Accenture Tech Trends Report confirmed that mass customization is central to the next wave of competitive advantage, cited by 85% of respondents to that survey.

Engineering organizations are grappling with other challenges, including shorter time-to-delivery cycles and a more rigorous regulatory climate. Complexity is on the rise as software and electronics continue to dominate a larger percentage of product real estate, and there is increasing interest in smart and sustainable products, which calls for wholesale changes to the engineering process. Companies are also confronting a litany of other pressures such as soaring costs, a propensity for product recalls and delays, safety risks, and the incessant drum beat for continuous innovation. You only have to glance at recent headlines to grasp the dangers of sticking with the engineering status quo.

To stay abreast of the competition and mitigate serious product development risks, engineering organizations must embrace new ways of working to support a more iterative design workflow. Specifically, engineers need to consider a range of conflicting objectives and challenges as they shepherd product designs through an infinite number of incremental changes. At the same time, engineering teams need to be able to accurately predict and measure the impact of possible design changes and proposed improvements on real-world performance before they lock in to a specific design and prior to creating expensive, physical prototypes.

"Why do people use software? Either to save costs, get to the design quicker, or because they have to innovate," contends Alan Rose, CEO of Corrdesa, which offers solutions enabling the prediction of corrosion using computational techniques.

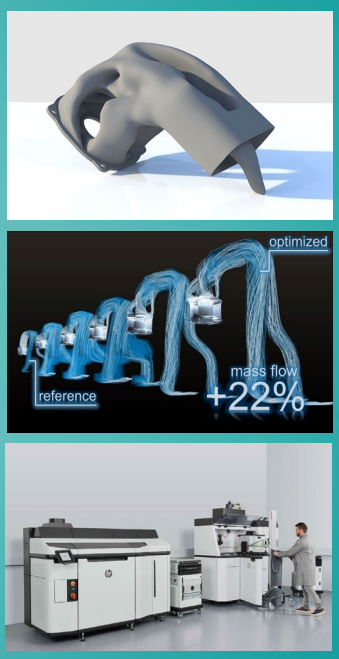
3D PRINTING AND SIMULATION

From four months to four weeks? HP reduced development times drastically for the new ventilation system in the HP Multi Jet Fusion 5200 3D printer using CFD-based topology optimization with Simcenter STAR-CCM+. Simulation delivered an improved mass flow in the 'mighty duct' by 22%.

For the HP printer to work effectively, the print head has to be cooled in order to maintain the reliability of the printhead. The air duct that HP redesigned in Simcenter STAR-CCM+ was an integral part of that process. The company wanted to achieve more performance from the general flow and more balance between the two printheads.

Using the generative design capabilities of Simcenter STAR-CCM+, HP created a new duct design with four distinct flow guiding veins to remove the "swirl" from the air flowing through the duct. Improving the duct efficiency meant the printheads run faster by 14.8% and the development time improved by 75%.

Click here for a video on the HP duct design.



Optimized design for the HP 3D printer air duct via simulation.

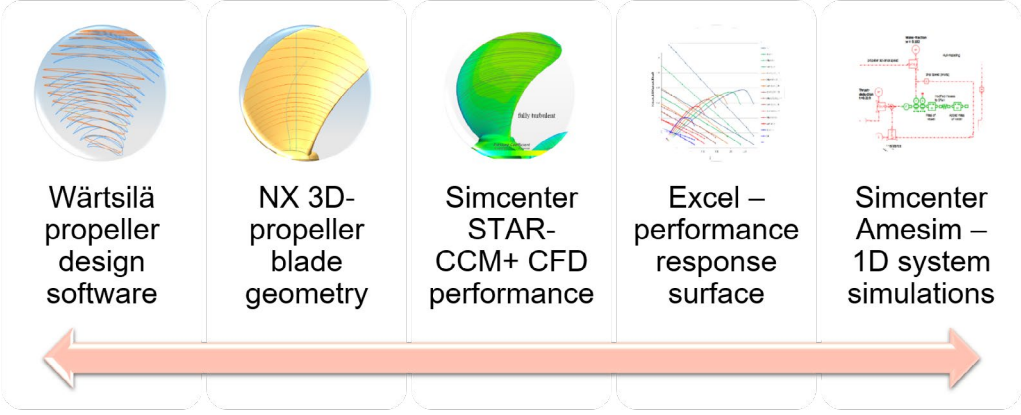
SIMULATION TO THE RESCUE

One of the most effective ways to reinvent the process and deliver consistent design improvements is to inject fast and cost-effective simulation throughout every stage of the workflow. The combination of more frequent and more widespread use of simulation is the key to allowing engineers to consider hundreds of designs options—not merely a handful. Through multiphysics simulations and streamlined workflows, engineers are better able to efficiently navigate an infinite number of potential design changes, making them better situated to zero in on the best options for improving product performance. A simulation-driven design process also encourages teams to focus on the overall performance of a product as opposed to only a handful of worst-case scenarios. In the end, more widespread use of simulation helps engineering organizations uncover efficiencies early on in the process, ultimately resulting in the delivery of higher quality, more innovative products at less cost.

An Aberdeen Group study on simulation-focused product development confirmed growing interest in simulation as a fast and low-cost approach for considering hundreds, potentially thousands, of design trade-offs as part of a streamlined process. Nearly three-quarters (75%) of survey respondents are tapping into simulation earlier in the development process to improve product designs, while 53% are promoting collaboration between analysis experts and design engineers. Forty-nine percent of responding engineering organizations are combining physics into their analysis efforts to increase simulation realism, and 42% are capturing the expertise of simulation experts and making that knowledge more accessible to a broader audience.

Wärtsilä Propulsion, which makes propulsion systems for large ships, is increasing its reliance on engineering simulation to minimize the surprises in its testing practices. As part of its OPTI design approach, the company routinely simulates the whole ship, the propeller, the free surface, sinkage, and trim, creating a digital twin that helps facilitate more efficient propeller designs. Computational Fluid Dynamics (CFD) has always played a role in the company's design process, but what's changed is more widespread trust in the process and a commitment by a larger segment of the user population to tap into the benefits of simulation-led design. "I think if you do not use simulations and if you stick to the old way of designing, you'll run the risk of not being competitive anymore," says Norbert Bulten, Wärtsilä's product performance manager.

Click here for a video on Wärtsilä Propulsion's use of digital twins in marine propeller design.



The simulation process at Wärtsilä to design marine propellers.

SAVING $500K BY REDUCING EMISSIONS

Becker Marine Systems designed an innovative energy savings device—the Becker Mewis Duct—for marine vessels in six weeks using simulation, delivering $500,000 in savings per ship, per year, while reducing CO2 emissions by 1000 tonnes in some cases. This wouldn't be possible without the ability to explore hundreds of designs often to find a unique duct for every project.

IBMV Maritime Innovationsgesellschaft mbH, a subsidiary of Becker Marine, develops and launches innovative technology for the maritime market. The team at IBMV used STAR-CCM+ software for CFD to create the unique Becker Mewis Duct.

So far, the company has delivered more than 1,000 of these ducts, demonstrating the value of CFD simulation in marine design. Without the intensive design exploration enabled by Simcenter STAR-CCM+, the engineers could not deliver such finely tuned devices on a tight schedule.

"For each scenario, we use Simcenter STAR CCM+ to carefully adjust over 40 design parameters to create a unique duct. Although there are similarities, the duct that we design for each vessel is absolutely unique. No two ducts are ever alike," says Steve Leonard, Head of CFD and Research Development, IBMV.

Click here to read an article on the use of simulation to design the Becker Mewis duct.

The unique Becker Mewis duct, born in simulation with Simcenter STAR-CCM+.

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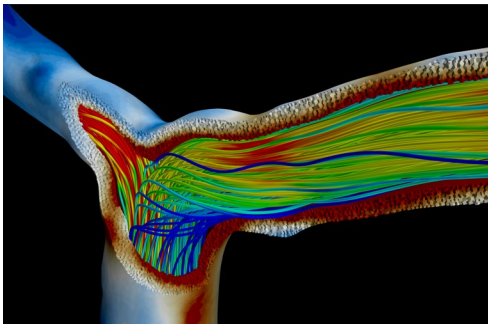
MULTIPHYSICS SIMULATION RAISES THE BAR ON INNOVATION

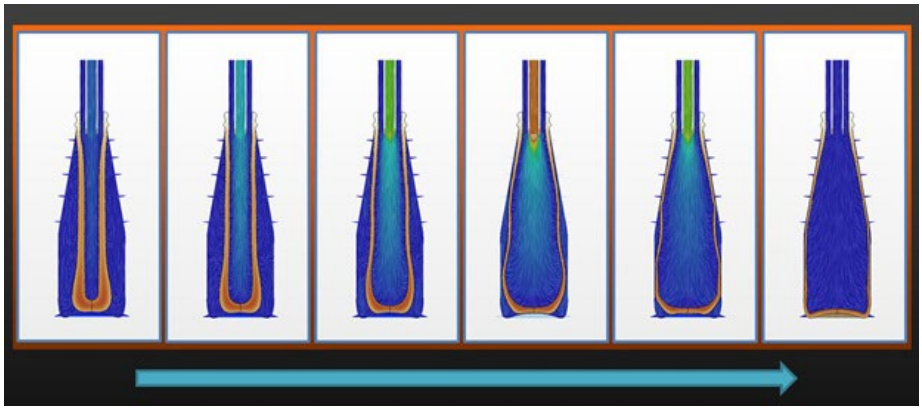
Solving complex industrial problems not only requires more widespread use of simulation, it also demands access to a simulation tool suite that covers a variety of physical phenomena and engineering disciplines. Real-world design problems can't be neatly separated into convenient categories like aerodynamics or heat transfer. Moreover, when investing in simulation and simulation practices, it's necessary to consider a product across its operating lifetime, not just analyze its performance in the worst-case scenario. Failure to account for all possible physical interactions can lead to uncertainty, which leads to inefficiencies and mistakes, including a propensity to over-engineer products to ensure additional layers of safety.

Bottero Group employs multiphysics simulation as part of its bottle design processes given the complexity of the related physics. "The structural and fluid dynamics aspect of the cooling of molten glass cannot be separated because they are very, very coupled," explains Marcello Ostorero, Bottero's innovation platform manager. "Understanding the actual temperature of the glass is by far the most important factor in ensuring the strength and quality of the final containers. Multiphysics simulation … is the only way that we can achieve that."

Multiphysics simulation delivers a maximum level of realism using fewer assumptions while ensuring engineering teams don't have to compromise on fidelity. Because the software accurately captures all of the relevant physics that influence product performance, engineers can predict the consequences of design changes on real-world product function. At the same time, by minimizing the number of assumptions, engineering teams can be more confident that the predicted behavior of their designs will match how it actually operates under real-world conditions.



Fluid-structure interaction of an intercranial bifurcation enabled by multiphysics simulation in Simcenter STAR-CCM+.



Bottero use simulation not only help the bottle design, but engineers were also able to decrease the bottle mass. Image courtesy of Bottero/Siemens Digital Industries Software.

LUXURY AND COMFORT FROM MULTIPHYSICS SIMULATION

Jaguar Land Rover vehicles are known as much for their sleek aerodynamic shapes as they are for their numerous luxe appointments, including HVAC systems designed to provide the ultimate comfort experience for drivers and their passengers.

Jaguar F-type cabin environment simulation in Simcenter STAR-CCM+ helps to maintain desired comfort levels.

The powerhouse behind that push for comfort: Simcenter STAR-CCM+ multiphysics CFD simulation tool from Siemens Digital Industries Software. The ability to simulate all the physics involved in creating a vehicle HVAC system, including acoustic noise, de-icing, defogging, and thermal comfort all in the same tool help JLR engineers arrive at a final design quickly, using physical tests only for verification. In addition, the ability to evaluate design changes through simulation, not physical tests, enables the JLR team to push innovative ideas to market quickly, helping to maintain the luxury brand's reputation for a high-quality comfort and a top-of-the-line driving experience.

"If we can save a prototype, the software is paying for itself," says Karamjit Sandhu, technical specialist at JLR. "For systems such as the defrost system, we no longer build any prototypes apart from the final model. We rely totally on Simcenter STAR-CCM+ to design the system."

COMMON CHALLENGES & HOW TO OVERCOME THEM

LACK OF AUTOMATION

One of the biggest challenges to increased use of simulation is the lack of automation in the traditional simulation processes. Because simulation's utility is at its peak when it generates a constant stream of data that informs and guides the design process, it's critical for organizations to automate the process. This helps ensure that changes are propagated and accessible to all stakeholders and that there are steps in place to make the processes repeatable so they can have an effect at scale.

For example, engineering teams should be able to easily redeploy models with little to no manual effort, and the software should automatically update the simulation pipeline with new information that reflects changes in the design so everyone stays in the loop. Simcenter STAR-CCM+ facilitates building consistent, repeatable simulations that track to on-going design changes via a number of capabilities, including bidirectional links between the platform and CAD/PLM software so geometry updates are automatically represented and automatically meshed. The software also repairs and defeatures imported CAD geometry to create a detailed closed surface, resulting in high fidelity of results. Capabilities that aid in managing design studies and evaluating different possibilities help ensure efforts can be repeated. Using the platform's workflow automation capabilities, Simcenter STAR-CCM+ users reported a reduction in engineering time up to 90%.

Simulation automation and design exploration paved the way for Martin UAV to deliver the innovative V-BAT.

Using the automation and design exploration capabilities of Simcenter STAR-CCM+, Martin UAV created V-BAT, the first ducted true-VTOL (vertical take-off and landing) UAV in the world. The company was able to explore thousands of designs to find the optimal tradeoff, getting answers quickly and delving into more detailed simulation.

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Click here to see a video on Martin UAV's use of simulation.

COMPLEXITY IN CONNECTING TOOLS AND SETTING UP PROCESSES

When multiphysics is involved, there is associated complexity connecting tools and setting up a streamlined process. Users are often forced to manually connect multiple domain-specific simulation tools—for example, those for fluid dynamics, particle flow, or electromagnetics—and do so using hard-to-maintain scripts. With a single dedicated multiphysics CAE tool like Simcenter STAR-CCM+, a broad range of validated physics models are contained within a single platform, eliminating the need for mapping between different computational meshes and allowing for the simulation of reality regardless of complexity.

Once a simulation model has been created, it should be easily deployable to other stakeholders in the design chain with little to no manual effort. This allows highly-skilled engineers to investigate the full range of design configurations and operating scenarios as part of the decision-making process instead of struggling to recreate models on their own. The optimal multiphysics platform should also allow users to create and modify CAD models using a parametric 3D modeler while providing a bi-directional link between the multiphysics platform and the CAD and PLM software so geometry updates are automatically represented in the corresponding simulation modules. Multiphysics platforms like Simcenter STAR-CCM+ also provide a way to codify and share simulation best practices to guarantee consistency across the design chain.

The ability to combine CFD and 1D tools using Simcenter STAR-CCM+ and Simcenter Amesim has allowed car giant General Motors to streamline its engine design process, reducing the number of tests and allowing for a greater number of iterations without adding engineering talent.

The ability to combine CFD and 1D tools using Simcenter STAR-CCM+ and Simcenter Amesim has allowed car giant General Motors to streamline its engine design process, reducing the number of tests and allowing for a greater number of iterations without adding engineering talent. “We’re able to go from CAD to solution to answer quickly,” says Jeff Schlautman, an analysis technical specialist for GM. “The faster we can turn analysis around, the more optimized the design becomes and the better the engine is when we hit the final gate.” GM uses the streamlined analysis workflow to solve lubrication flows, thermal problems, and heat transfer in the engine.

Click here to see a video on General Motors’ use of Simcenter STAR-CCM+.

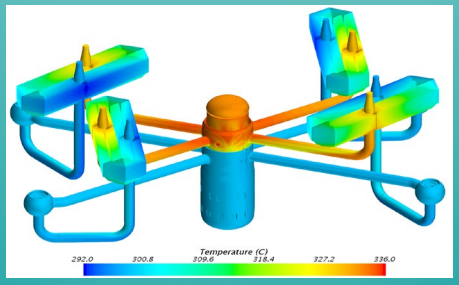
OVERSIMPLIFICATION TO MAKE THINGS WORK

Conventional simulation approaches rely on a large degree of simplification of real-world conditions in order to easily formulate, recreate, and test those scenarios. This approach creates inherent flaws within the results because they are based on a range of assumptions. With tools like Simcenter STAR-CCM+, engineering groups can get a more technically detailed and accurate forecast with minimal assumptions, all at a lower cost than having to test physical prototypes.

HIGHLY DETAILED MODEL HOLDS KEY TO REACTOR SAFETY

With a mesh size of 1 billion cells, the simulation model for OKB Gidropress' water-water energetic reactor (VVER) ranks among the largest simulation models, retaining incredibly detailed physics, down to the actual pump rotation and wheel profiles. Given the goal for rigorous safety, simplification was not an option, yet design cycles demanded expediency—a balance accomplished using Simcenter STAR-CCM+. "Before it took six months to simulate the complete VVER reactor, but with Simcenter STAR-CCM+, we can do this in two weeks," says Volkov Vasilii, an engineer for OKB Gidropress.

Video on OKB Gidropress

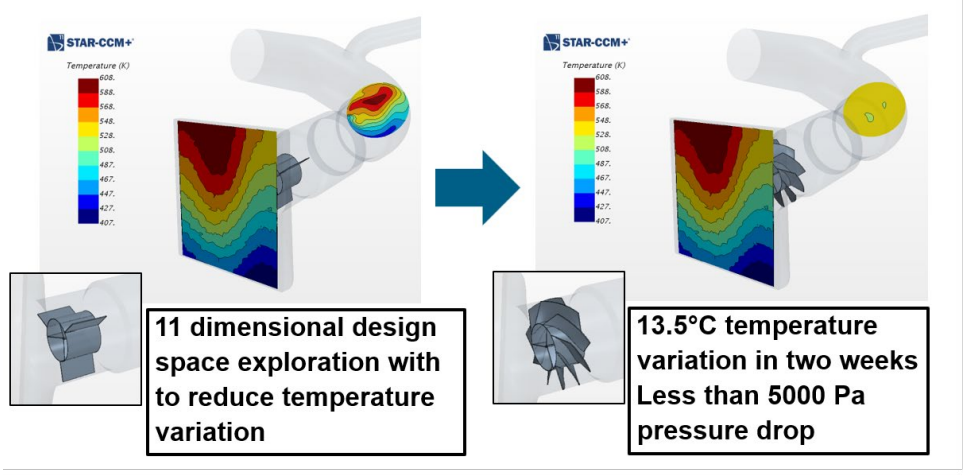


One of the largest nuclear CFD simulations from OKB Gidropress using Simcenter STAR-CCM+.

LACK OF OPTIMIZATION AND SCRIPTING EXPERTISE TO SUPPORT DESIGN EXPLORATION.

While use of simulation for validation or to predict performance has benefits, the real advantage comes with harnessing the power of simulation to guide the design process by predicting the effect of changes on a product's behavior and by employing intelligent optimization to zero in on optimal designs. Simcenter STAR-CCM+ makes automated design exploration and optimization accessible to all engineers via the Design Manager, which leverages automated meshing, pipelined workflow, and accurate physics to overcome the complexities of deploying simulation in this manner.

The built-in HEEDS design exploration engine, which facilitates both single and multi-objective optimization studies, requires no expert knowledge. By leveraging the HEEDS functionality, Airbus was able to ramp up design exploration and simulate close to 300 variants of an aircraft bleed-air-system in less than two weeks as opposed to the six months that it historically took. Better yet, the team was able to reduce temperature variation on the component by 91%. "With Simcenter STAR-CCM+ and its new optimization capability, we learned what makes a good design and how to improve the performance of the system," says Andreas Ruch, ECS analyst at Airbus.



Baseline and optimized design of aircraft bleed-air system on an Airbus A320.

LACK OF COMPUTE RESOURCES

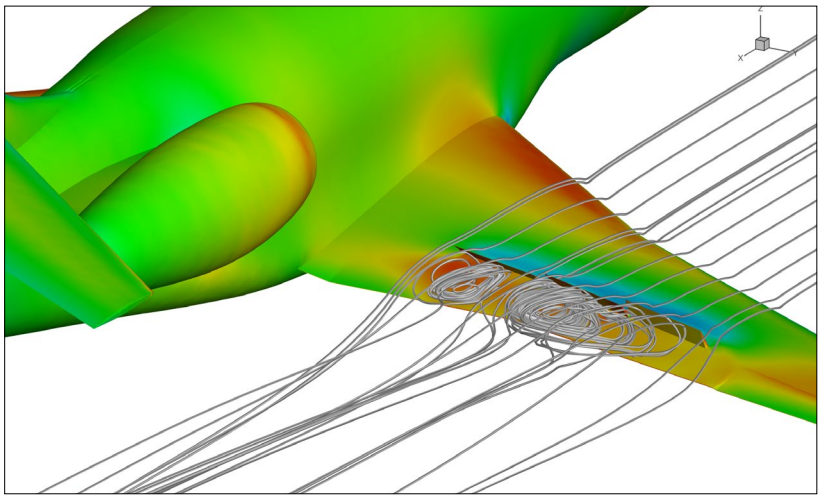
More detailed and robust simulation demands significant compute horsepower, raising concerns about how to cost-effectively take advantage of high performance computing (HPC) resources. Cloud computing can deliver a cost-effective route to computing resources to execute larger and more complex simulations. Cloud-based options are also well suited to support burst scenarios, when engineering teams need access to more robust computing infrastructure at key intervals in the design process when simulation plays a larger role.

Increasingly, usage of CFD resources can also fluctuate depending on project workload and other factors, including the time of year. This is a challenge with traditional licensing schemes that typically charge on a per-core basis, often leading to underutilized resources along with associated high costs or restrictions due to insufficient licenses. Platforms like Simcenter STAR-CCM+ offer flexible licensing plans to address these challenges and make it easier and more cost-effective to expand simulation use. Specifically, the platform is accompanied by flexible licensing options that make it easy to allocate budgets when and where it makes sense. These include:

- Power Tokens for affordable design exploration and optimization;
- Power Sessions, for regular and interactive use of simulation with no dependencies on core counts; and
- Power-on-demand, to accommodate infrequent usage bursts.

By deploying simulation on the cloud using elastic computing with AWS and Siemens' Power-on-demand licensing option, TLG Aerospace is able to deliver an aerodynamic database with hundreds of simulation results to support aircraft certification, saving close to $300,000 on every project. "We can now bid on projects that have greater scope, be more competitive, pass on the savings to our customers, and do much more with our dollar," said Andrew McComas, engineering manager and aerodynamicist for the firm.

The complexities of modern product design call for more, and more widespread use of multiphysics simulation regardless of industry. Investment in a robust multiphysics platform like Simcenter STAR-CCM+ can help engineering organizations reinvent design practices, promote more widespread use of simulation, and embrace the paradigm shift necessary for competitive advantage and meeting the challenges that lie ahead.



TLG Aerospace uses Simcenter STAR-CCM+ on the cloud to run hundreds of aerodynamic simulations.

THE BENEFITS OF SIMCENTER INTEGRATION

Simcenter STAR-CCM+ is built on the backbone of industry-leading CFD and integrates a broad range of best-in-class multiphysics models. But another key benefit is the tight integration the software has with the Simcenter portfolio, which opens up access to a range of simulation, testing, and intelligent reporting and data analytics tools, expanding the available horsepower to tackle the challenges of engineering today's complex products.

Through seamless integration with Simcenter, design teams can easily manage simulation data and processes, including Simcenter STAR-CCM+ models, in the context of the Teamcenter PLM system. This functionality becomes critical as use of simulation becomes pervasive throughout the various stages of the design lifecycle and by more participants in the process. Siemens' open platform also ensures simulation models created in competing tools can be melded into a holistic simulation and data management environment.

Siemens makes it easy and cost effective to take advantage of the full Simcenter portfolio via its new Simcenter Flex Licensing model. The licensing plan maximizes deployment flexibility and delivers easy access to the entire simulation portfolio through a pool of credits that can be combined and can coexist with existing Simcenter licensing plans.

Simcenter STAR-CCM+, combined with the tools from the Simcenter portfolio, puts the full range of analysis capabilities at engineers' disposal, making it easier to spread the benefits of simulation throughout the entire lifecycle.

THE KEY INGREDIENTS FOR MORE PERVASIVE SIMULATION

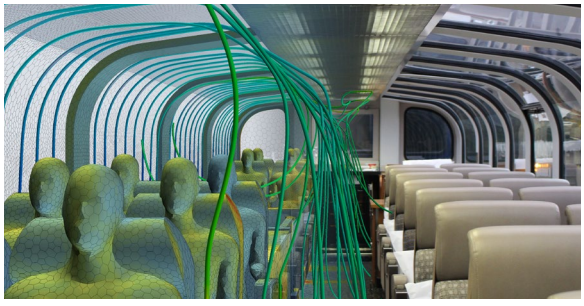
Fast, cost-effective and ubiquitous simulation can help organization's rise to the challenge of the modern design landscape. How do you get there? Here's what's required to make simulation an integral part of the design workflow:

DESIGN GOAL: Going from one design to hundreds, allowing for more extensive iteration and tradeoff exploration.

WHAT'S REQUIRED: Built-in workflow automation and an integrated CAE solution ensures engineers can iterate faster within a single platform and user interface, reducing the design lifecycle by as much as 90%. Because there is no need for separate tools, teams can do more intelligent design exploration and optimization, analyzing thousands of design trade-offs to arrive at the one most likely to meet the target objectives.

DESIGN GOAL: Establish a high-fidelity digital twin of a product, including its physics, to optimize performance.

WHAT'S REQUIRED: A tool that can create and model realistic geometry (regardless of complexity) in an expedient manner, enabling key design decisions in a matter of hours, not weeks. Multiphysics capabilities for fluid dynamics, heat transfer, combustion, particles, motion, and multiphase, among others, should be part of a single tool set, allowing for the simulation of the physical reality, no matter how complex that reality may be. Simcenter STAR-CCM+ performs at five times the speed of competing tools when modeling geometries boasting thousands of parts. It also incorporates automated cleanup and meshing technologies, plus a CAD-to-mesh pipeline to further accelerate the model-building process.



High-fidelity digital twins can optimize performance.

DESIGN GOAL: Making decisions in hours, not weeks. The ability to simulate realistic physics isn't worth much if the process takes too long. Engineers require fast, accurate results to drive product design and innovation, and Simcenter STAR-CCM+ delivers, producing complex analysis in a matter of hours, not weeks.

WHAT'S REQUIRED: Solvers that can take advantage of the efficiencies of parallel processing, leveraging all available compute resources to deliver results faster. Simcenter STAR-CCM+ offers solvers that can scale to 100,000 cores and take advantage of parallel processing across the complete simulation pipeline. Flexible licensing models will also ensure that simulation software costs don't limit hardware utilization so budgets can be allocated when and where it matters most.

DESIGN GOAL: Partners collaborating to create and refine simulation best practices and maximize software investments.

WHAT'S REQUIRED: Siemens' Dedicated Support Engineer (DSE) model supports more frequent and more pervasive simulation by assigning engineering groups a single engineer who serves as the primary support contact. In this way, the DSE is intimately familiar with the design goals and challenges, leading the way for more widespread use of simulation. A global engineering services group backstops the DSE, aiding in the transference of in-house simulation expertise and know-how.

TAKE THE NEXT STEPS:

Weaving robust multiphysics simulation throughout the design process can help you achieve better designs on a faster timetable. To learn more about ubiquitous Multiphysics simulation and the capabilities of Simcenter STAR-CCM+, watch this video on why customers use Simcenter STAR-CCM+.

Click here to see a video on why customers use Simcenter STAR-CCM+.

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RESOURCES

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