Siemens PLM Software

Simcenter STAR-CCM+

Engineer innovation with CFD-focused multiphysics simulation

www.siemens.com/mdx

The challenge of engineering

Your business is facing tough competition from all quarters. You need to consider conflicting challenges, such as improving the quality and increasing the range of your products while simultaneously reducing both their cost and time to market. Your customers are demanding smart products that are not only customized to meet their current needs, but will continue to evolve as they use them. The government and other regulatory bodies are passing increasingly stringent legislation that requires your products to be more energy efficient, more environmentally friendly and safer than ever before.

This highly competitive landscape is driving a golden age of innovation in which your products either evolve rapidly to meet the demands of the market, or are replaced by smarter, better, cheaper alternatives from your competitors. The choice is simple, either innovate or stagnate.

As you innovate new, improved products, your design evolves through a large number of incremental changes. You need to be able to predict how these intended improvements influence real world performance, for better or for worse. This is the challenge of engineers today: to efficiently navigate that infinite tree of potential design changes, making those choices that improve the product and rejecting the far more numerous "wrong choices" that would make it worse.

At Jaguar Land Rover, STAR-CCM+ is central in the design process of all current and future vehicle programs. Shown here is a cabin comfort analysis of an F-type luxury vehicle from JLR.

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

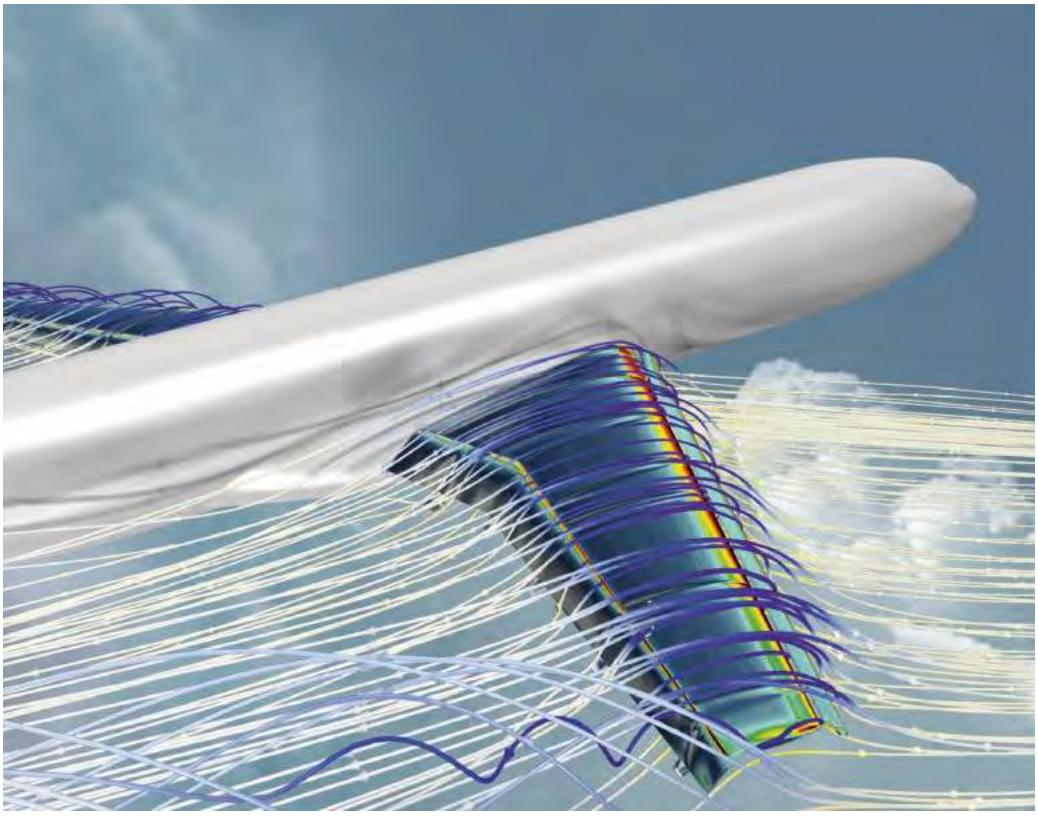
Karamjit Sandhu
Jaguar Land Rover

Simulation is the solution

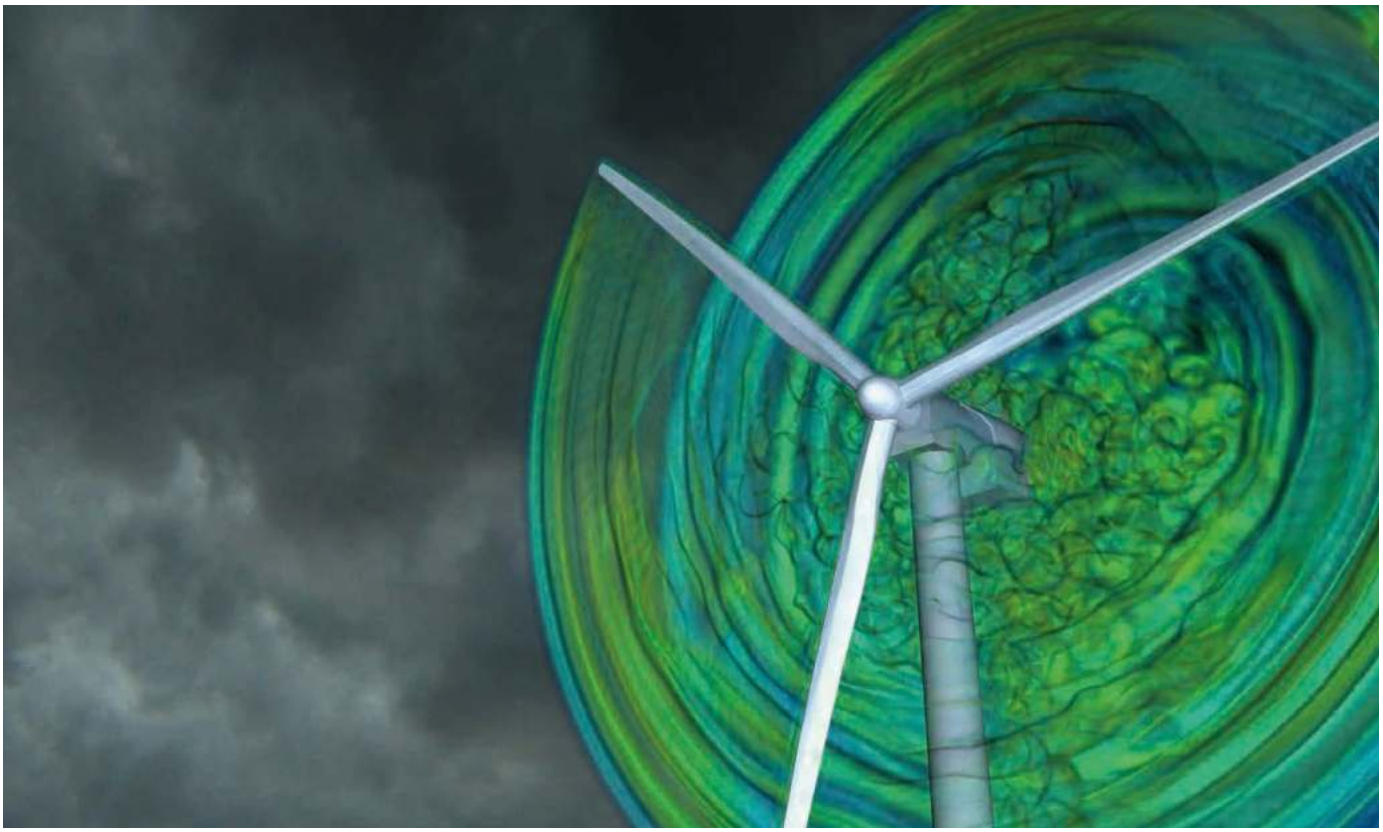
Engineering simulation allows engineers to see into the future, predicting the consequence of any design change on the real-world performance of their products. Deployed effectively, it can be used to improve your design through multiple iterations, providing data to guide the design process from its earliest stages, through to production and beyond. Engineering simulation offers comprehensive predictions that are more accurate and less expensive than experimental testing.

Beyond that, simulation gives engineers the opportunity to glimpse at "all possible futures," by exploring the performance of a product over the full range of operating conditions that it is likely to face in its working life, rather than just at a handful of carefully chosen design points. By considering the complete performance of a product, rather than only a handful of worst-case scenarios, engineers can almost always uncover and eliminate multiple inefficiencies. Ultimately, all this results in the delivery of higher quality and more innovative products that better fulfill your customer expectations.

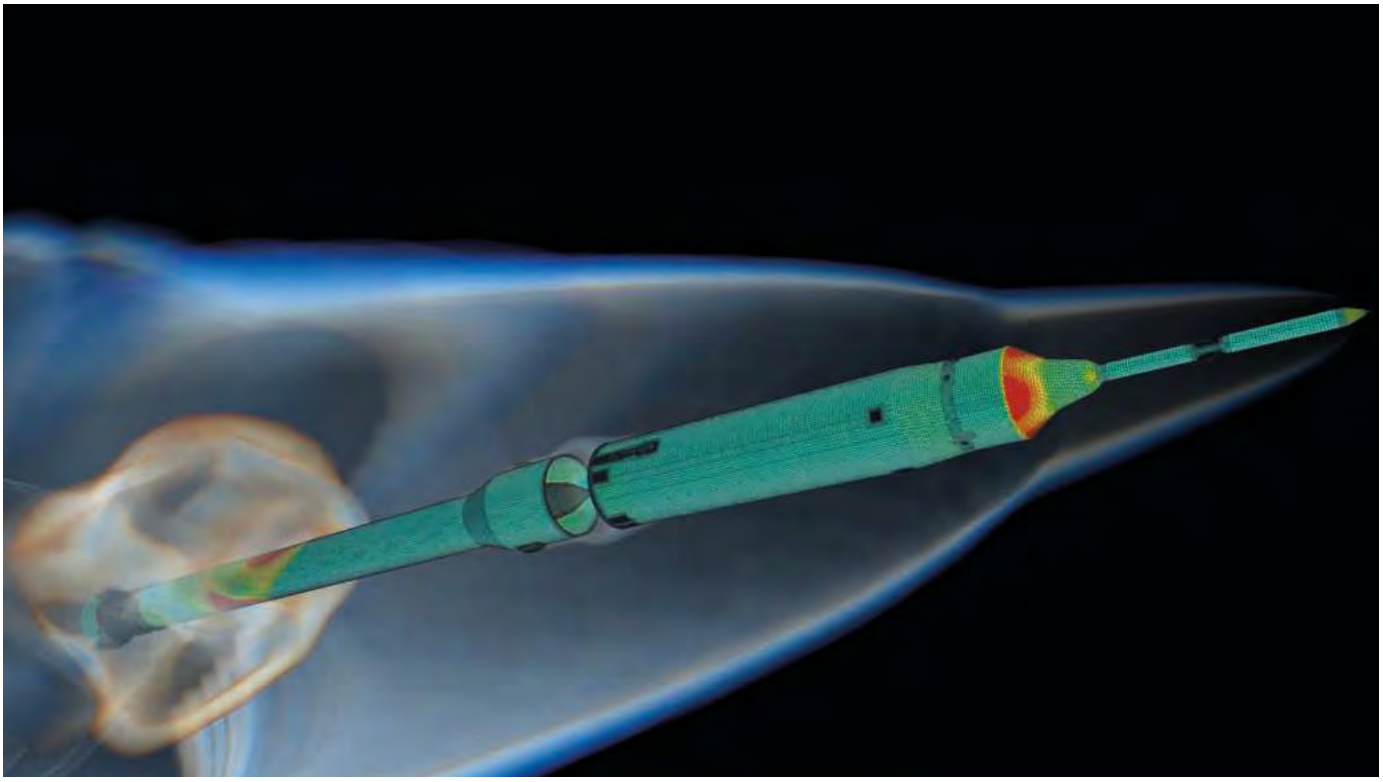
However, not all engineering simulation tools are created equally. In this document, we explore the essential requirements that such a tool must fulfill to add value to the industrial design process.



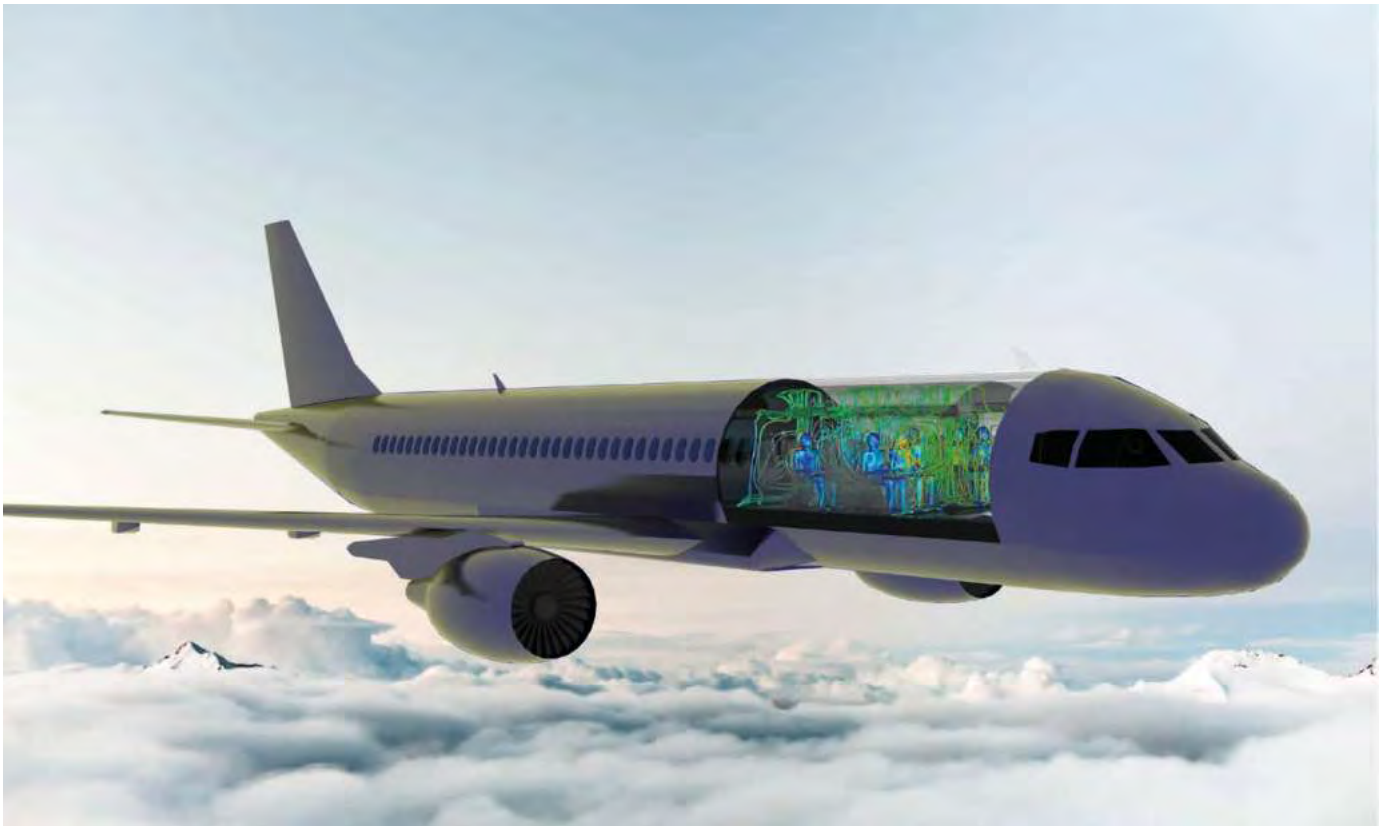
Virtually predicting the real-world performance of your products is key to thriving in an 'innovate or perish' environment. Shown here is the accurate simulation of the highly unsteady and complex flow over a high-lift wing.



Unsteady simulation of a wind turbine to assess aerodynamic efficiency.

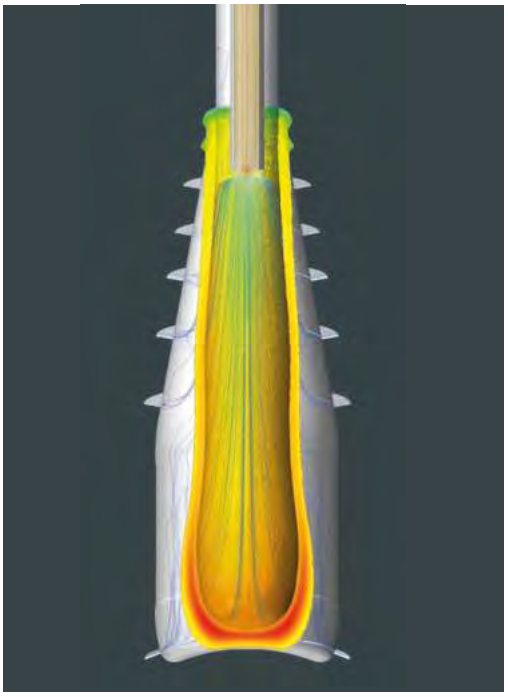


Unsteady simulation of an Ares launch vehicle to understand the aerodynamic characteristics of the stage separation.



Environmental control systems simulation to improve cabin comfort.

Gas dispersion safety study of an offshore floating platform.



"We have very complex physics. The structural and fluid dynamics aspect of the cooling of molten glass cannot be separated because they are very, very, coupled. Understanding the actual temperature of the glass is by far the most important factor in ensuring the strength and quality of the final container. Multiphysics simulation using a tool like STAR-CCM+ is the only way that we can achieve that."

Marcello Ostorero
Bottero Group

Bottero SpA drastically reduced manufacturing time, used 20 percent less raw material and produced lighter, stronger bottles with STAR-CCM+ multiphysics capabilities.

Realism through multiphysics

Solving complex industrial problems requires simulation tools that span a variety of physical phenomena and engineering disciplines. Real-world problems do not separate themselves into convenient categories such as “aerodynamics,” “hydrodynamics,” “heat transfer” or “solid mechanics.” Failing to account for important physical interactions leads to uncertainty, for which the usual remedy is over-engineering to ensure additional factors of safety.

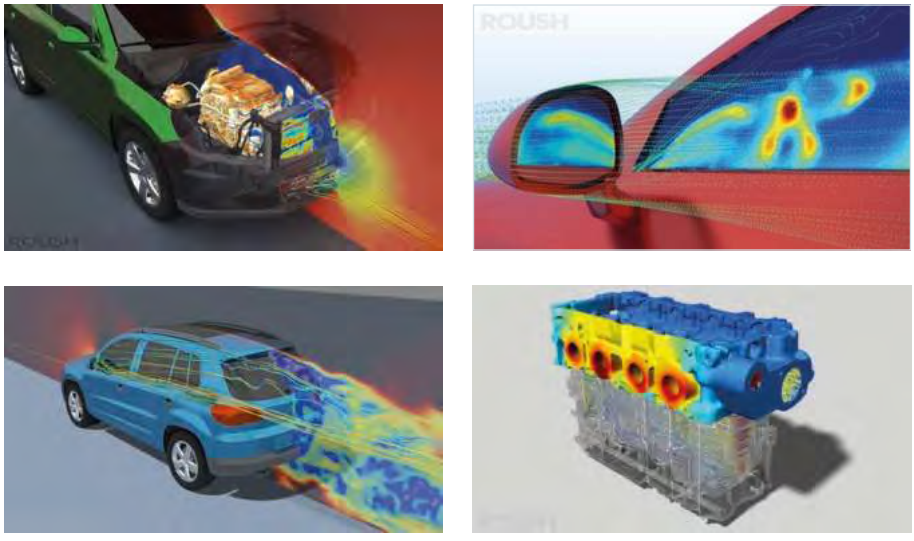
Only multiphysics engineering simulation can accurately capture all of the relevant physics that influence the performance of your product. By minimizing the level of approximation and the number of assumptions, you can be confident that the predicted behavior of your design will match its real-world performance.

Much more than a computational fluid dynamics (CFD) code, STAR-CCM+ is a best-in-class simulation tool that provides the most comprehensive set of physics models of any industrial Computer Aided Engineering (CAE) tool. By adopting a compromise free approach to physics modelling, you will have confidence that your predictions match the real-world behavior of your product across its full operating envelope.

The integrated multiphysics nature of STAR-CCM+ eliminates the need to learn and connect multiple tools and enables physical phenomena to be studied in a fully coupled manner, increasing the accuracy of your results. The single integrated user interface helps you cover your complete application scope with:

- A broad range of validated models to simulate disciplines and physics including CFD, computational solid mechanics (CSM), electromagnetics, heat transfer, multiphase flow, particle dynamics, reacting flow, electrochemistry, aero-acoustics and rheology
- Simulation of rigid and flexible body motions with techniques including mesh morphing, overset mesh and six degrees of freedom (6DOF) motion
- The ability to combine and account for the interaction between the various physics and motion models in a single simulation to cover your specific application

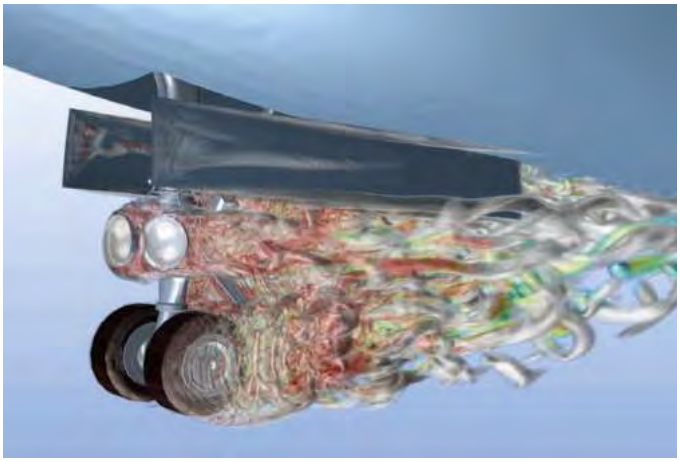
In STAR-CCM+, all of these capabilities are accessed from a single integrated environment that hosts the geometry, mesh, boundary conditions, physics models and simulation results. It also offers an easily accessible API to enable coupling to other simulation tools for the purpose of co-simulation when needed.



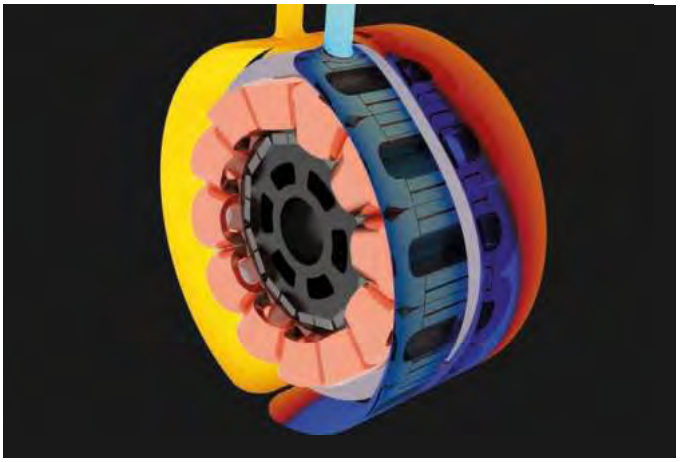
STAR-CCM+ facilitates multiphysics simulations from a single, integrated environment delivering realism in simulation. Shown here is the application of STAR-CCM+ at Roush Industries to tackle multiphysics challenges in automotive product development.

A true multiphysics platform

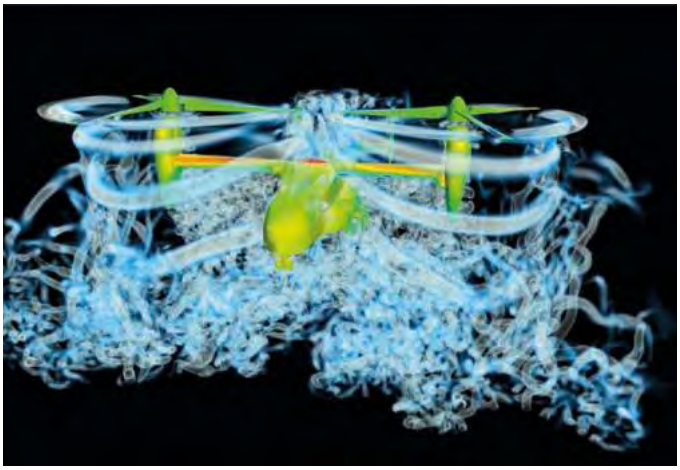
Simulate your products under real world conditions.



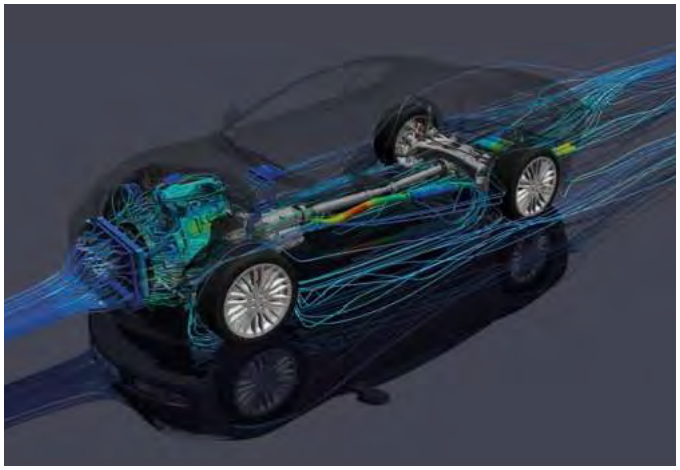
Aero-acoustics



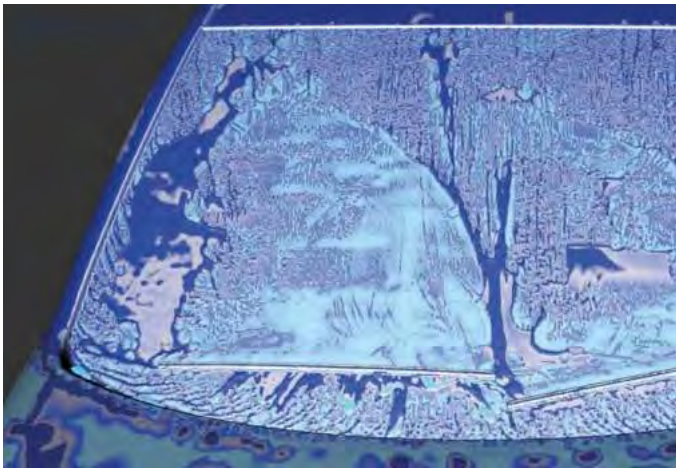
Electro-magnetics



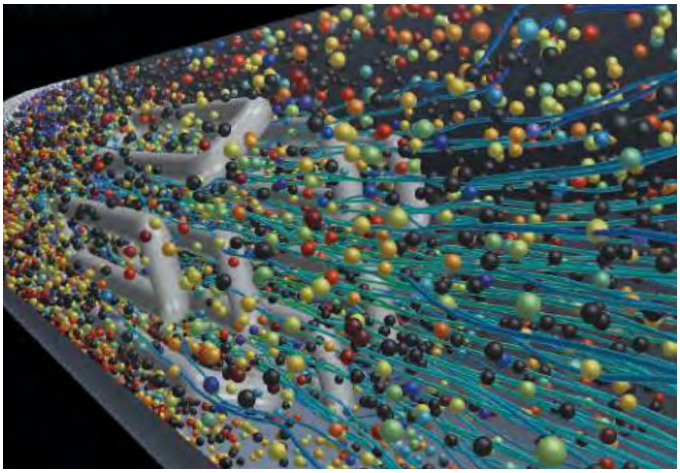
Fluid dynamics



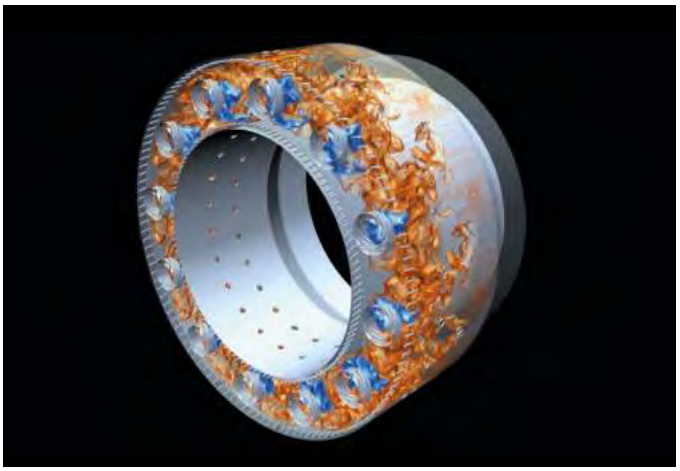
Heat transfer



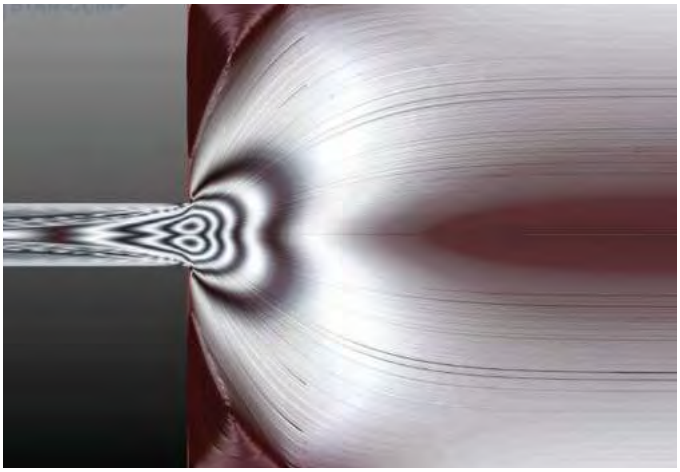
Multiphase flows



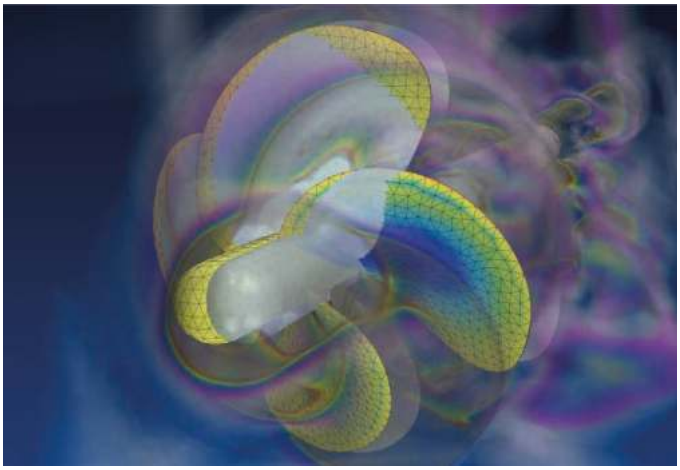
Particle flows



Reacting flows



Rheology



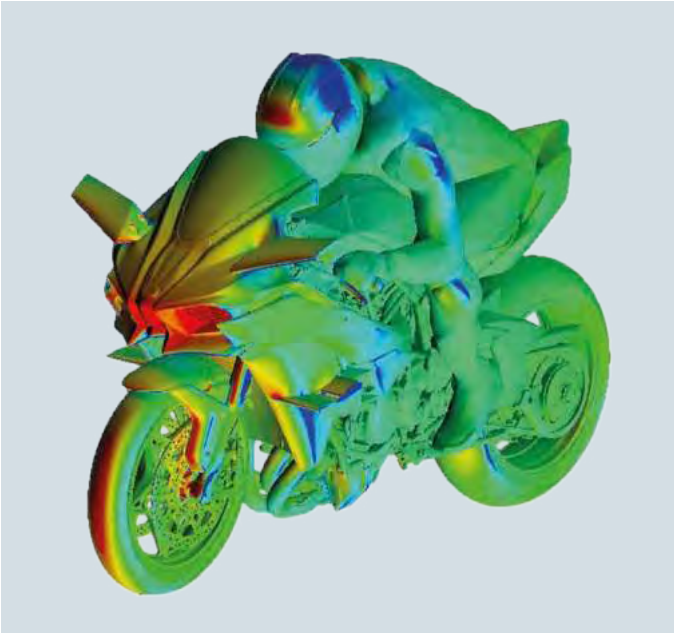
Solid mechanics

"The ability to effortlessly read CAD data, mesh a geometry, select boundary conditions, and set up physics models in STAR-CCM+ has tremendously sped up our design process. We've been able to deepen our analysis and drive engine designs faster and more effectively with the same resources as before."

Jeff Schlautman
General Motors

"Compared to before, now we can simulate several dozen cases in a reduced time. Thanks to this, the number of actual prototypes being turned out has also been reduced, making an extremely valuable contribution to lowering cost and man-hours alike. We feel that the application of STAR-CCM+ has proved highly effective on this front."

Eiji Ihara
Kawasaki Heavy Industries Ltd.



Automation enabled Kawasaki Heavy Industries Ltd. to reduce design time by 80 percent for the Kawasaki Ninja H2R/H2, the fastest production bike on earth.

Productivity through streamlined workflow and automation

No matter how realistic your simulation is, the data it provides is useless if it does not influence the final design of your product. Simulation adds the most value to engineering development when it generates a constant stream of data that informs and guides the design process through every decision point. This is only possible when the simulation process is a robust and automated one.

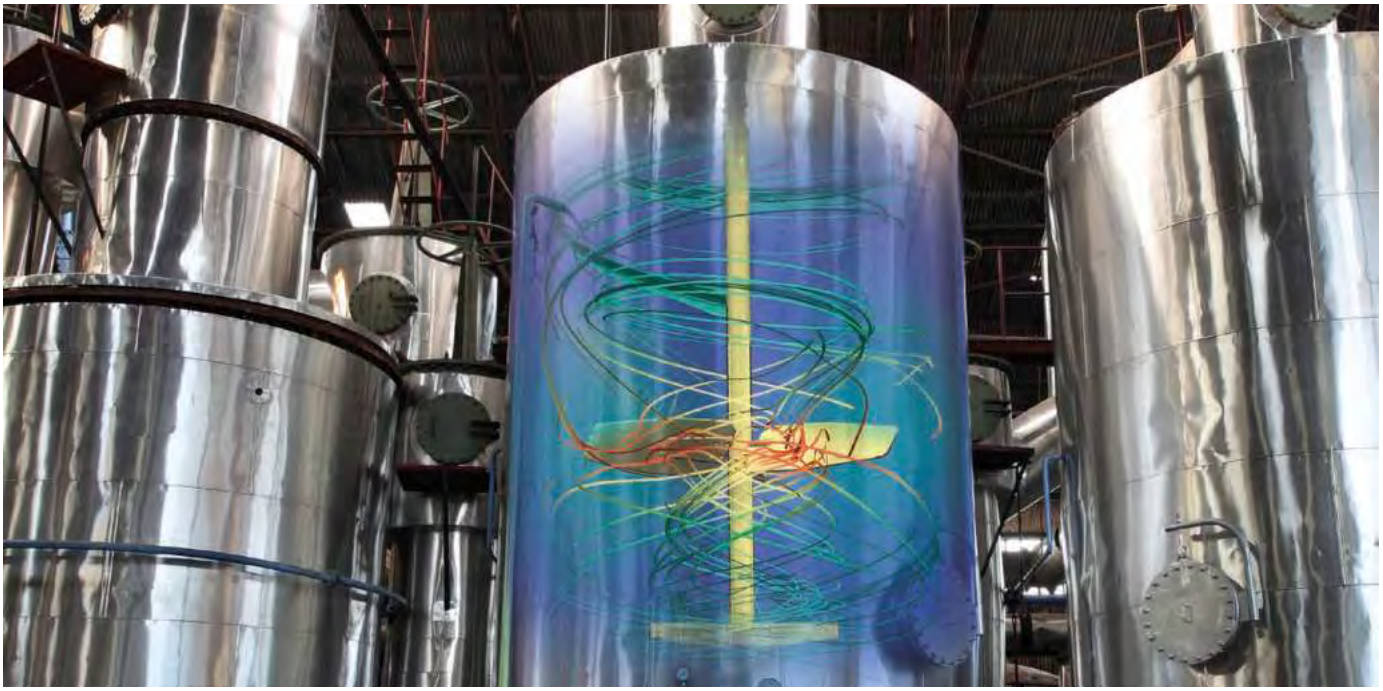
Once an engineer has created a simulation model, it should be easily re-deployable to investigate a full range of design configurations and operating scenarios, with little or no manual effort. This allows your highly-skilled engineer to focus on making design decisions, rather than performing mundane simulation tasks.

STAR-CCM+ enables you to build every simulation using a repeatable and robust workflow, with a pipeline approach that allows you to reuse and update every simulation model with minimal manual effort. This pipeline includes every step in the simulation process from geometry definition to postprocessing. Simulation models can be templated, allowing your engineers to share and disseminate best practices across your organization.

STAR-CCM+ facilitates building consistent, repeatable simulations that evolve as your product does, automatically updating the simulation pipeline to reflect changes in the design:

- Create and modify computer-aided design (CAD) models of your geometry using a fully parametric 3D feature-based modeler
- Establish a bidirectional link between STAR-CCM+ and CAD/product lifecycle management (PLM) software so that geometry updates are automatically represented in your simulation
- Repair and defeature imported CAD geometry using industry-leading surface wrapping and repair tools, automatically creating a closed surface in as much detail as necessary to ensure the fidelity of your results
- Automatically build a computational mesh on your geometry, no matter how complex, using polyhedral or trimmed hexahedral cells
- Robustly create layers of prismatic cells that allow you to accurately capture boundary layers
- Substitute components of your design as it evolves
- Deploy best practices with tools such as the Simulation Assistant that guarantee consistency between simulations, and eliminate analyst-to-analyst variation

The fully automated simulation process in STAR-CCM+ helps predict the entire product behavior in a short time with consistent, repeatable simulations. In industries like the automotive industry, automated full vehicle simulations shorten product development time and cost.



STAR-CCM+ brings automated design exploration and optimization within the grasp of all simulation engineers. Shown here is a mixer design study starting with a baseline (left) and resulting a improved design (right) with a fourfold decrease in power consumption while maintaining blend time. The final prototype is pictured above.

"We completed an extensive evaluation of different products, but at the end of the day we had a clear winner in the efficiency and flexibility of STAR-CCM+, the new optimization package and the outstanding technical support from Siemens PLM Software."

Rodrigo Azcueta
Land Rover BAR

Design exploration with STAR-CCM+ has helped Land Rover BAR find the best possible compromise between aerodynamics and hydrodynamics for the America's Cup racing yacht.

Innovation through design exploration

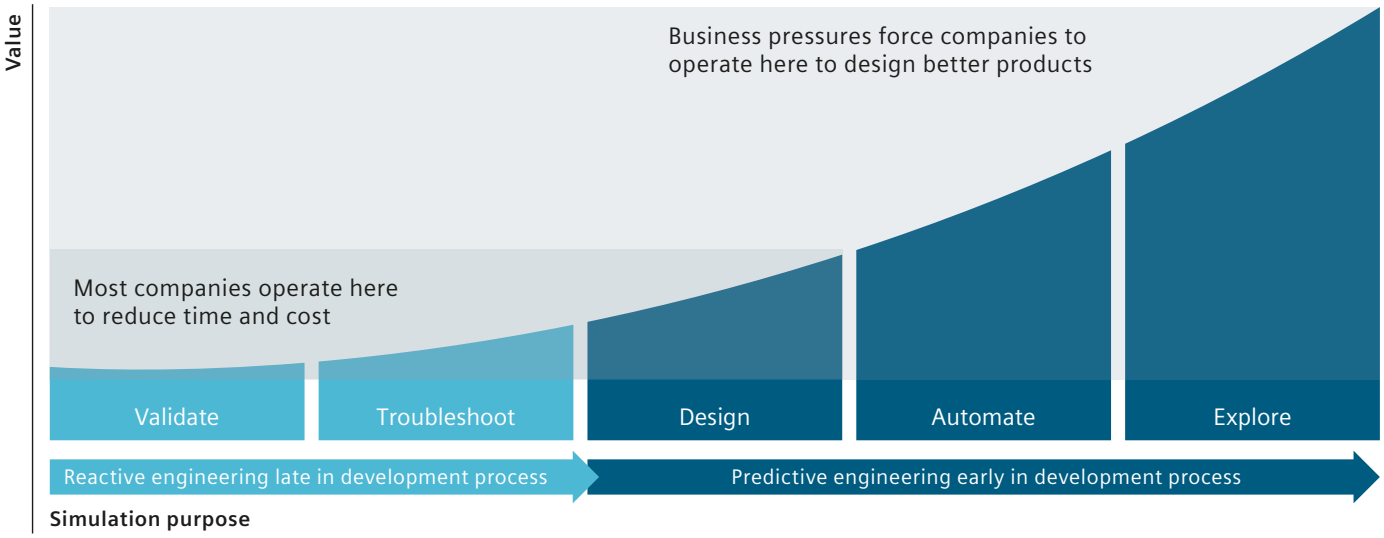
Despite recent advances, many companies are still deploying simulation in a purely reactive manner to validate or troubleshoot designs late in the product development process. More advanced companies are using simulation in a predictive way to look at performance early in place of physical tests. Although there is great value here, in reducing both engineering time and cost, to harness the full power of simulation, you need to take the next step and use it to guide your design process.

Used properly, engineering simulation allows you to see into the future, predicting the effect of a design change on your product's behavior. More than that, it gives you the opportunity to glimpse at "all possible futures," exploring how your product performs over the full range of operating conditions of its working life, and to employ intelligent optimization to find better designs.

STAR-CCM+ brings automated design exploration and optimization within the grasp of all simulation engineers with Design Manager, ensuring that single-scenario engineering simulations are a thing of the past.

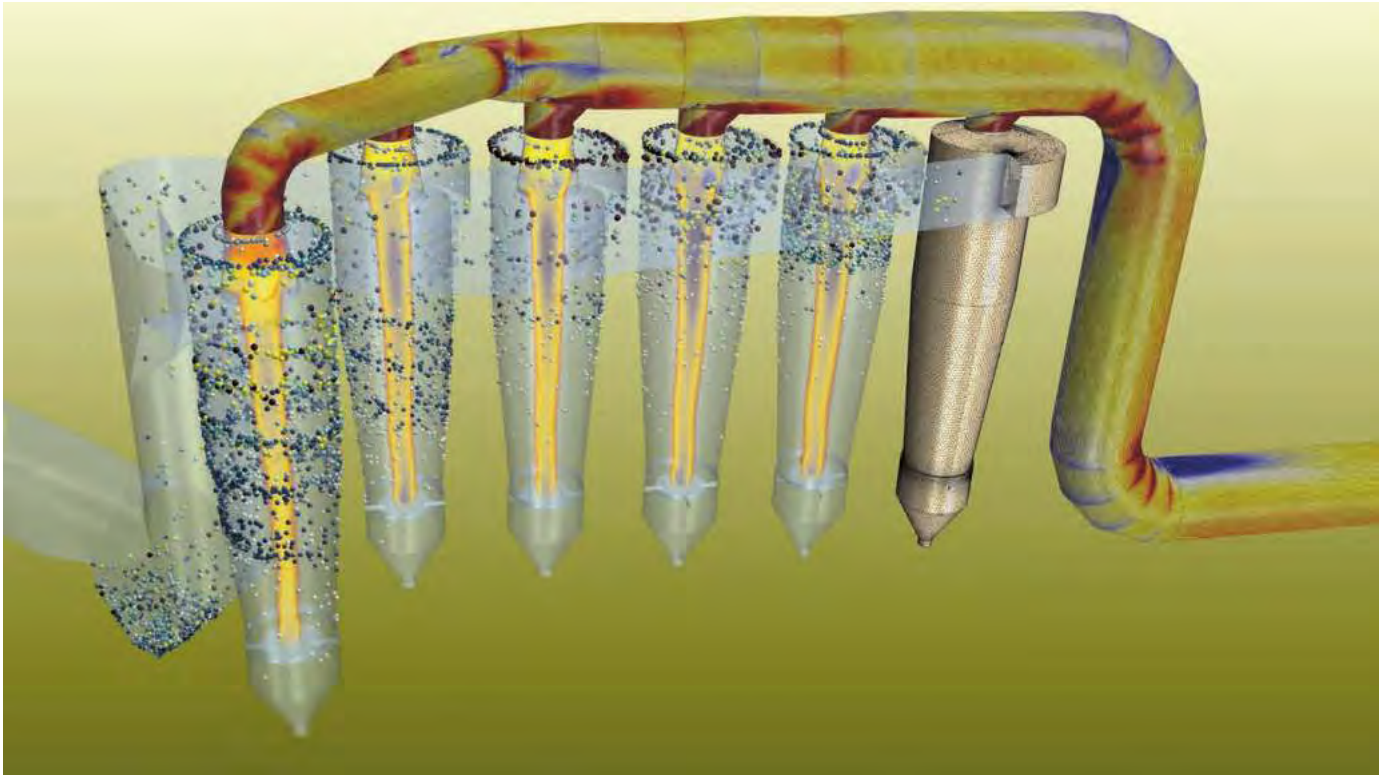
Design Manager enables users to set up and automatically evaluate families of designs directly within STAR-CCM+, including process management and performance assessment. It leverages the all-in-one platform, automated meshing, pipelined workflow and accurate physics to overcome the complexities that have historically prevented engineers from using CFD simulation in this way.

Users can take it one step further and perform single and multi-objective optimization studies to intelligently search the design space using the same time-tested and proven technology found in HEEDS MDO. It also provides stochastic analysis to help engineers determine the sensitivity of their simulation predictions to small changes in input parameters, such as manufacturing tolerances or fluctuations in boundary condition values.



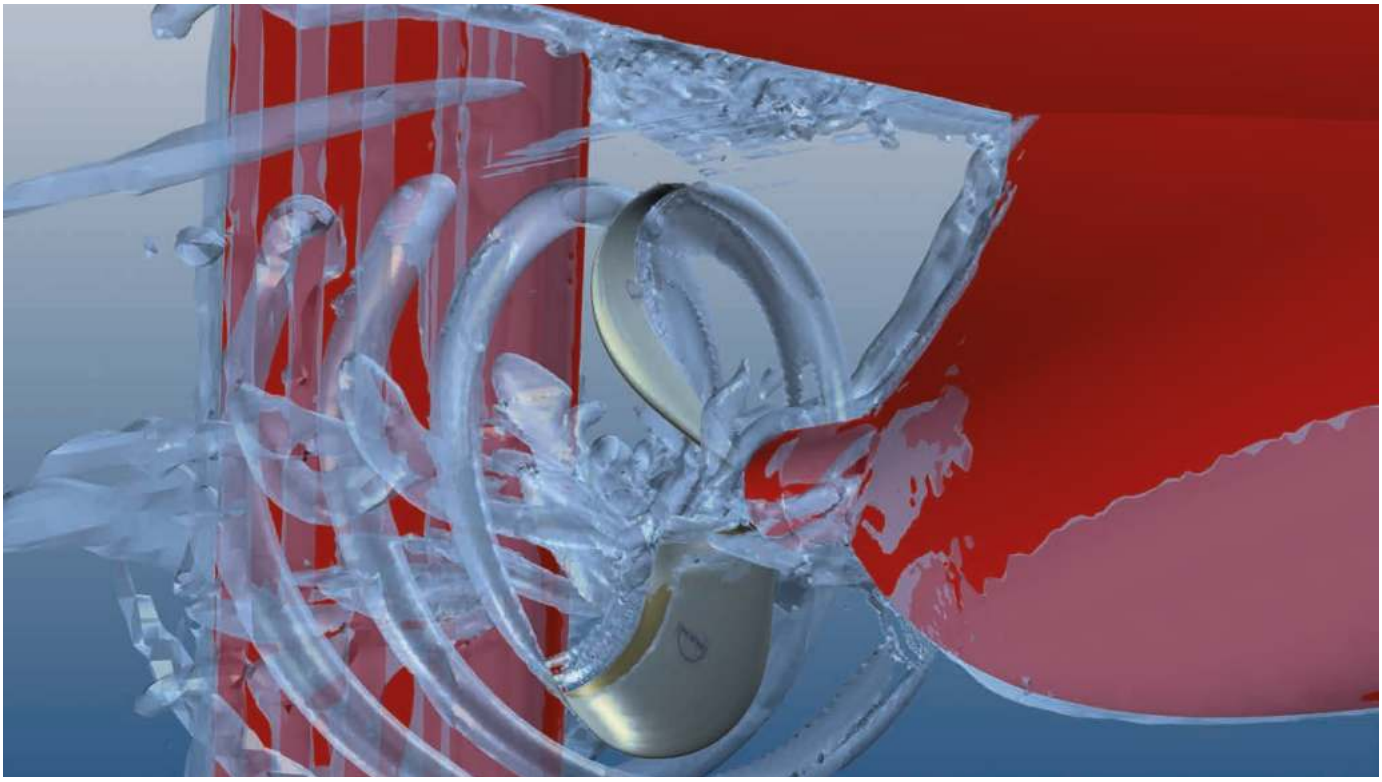
To keep a competitive edge in today's market, companies must use design exploration with simulation to drive innovation in their organization.

Aerodynamic analysis of the new transport bus in London with STAR-CCM+.



Fluid and particle flow simulation to maximize separation efficiency of a cyclone separator
(Image courtesy: Aerotherm).

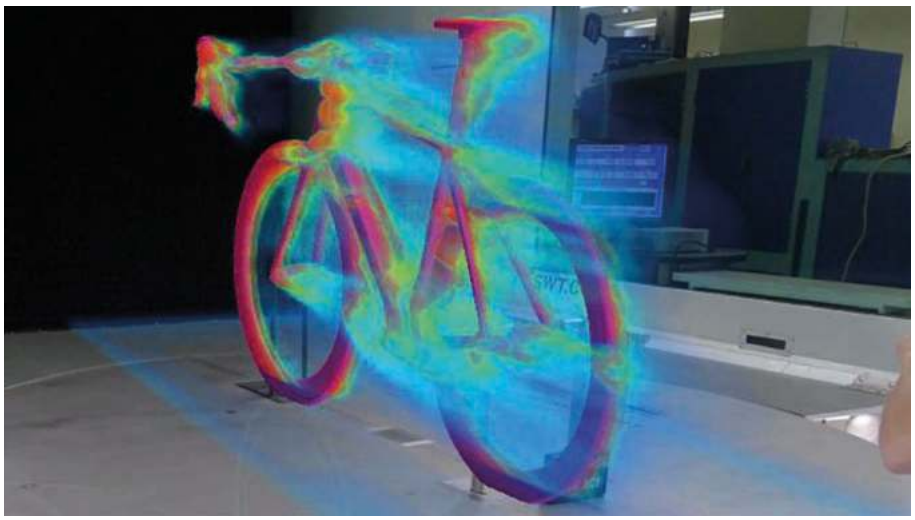
Conjugate heat transfer analysis of gas turbine cooling effectiveness.



Transient simulation of the self-propulsion of a bulk carrier using the tip modified Kappel Propeller.

"Being able to use the Power-on-demand licensing scheme and run simulations on a cloud has been a tremendous help for us in terms of productivity."

Mio Suzuki
Trek Bicycle Corporation



Licensing flexibility allows Trek Bicycle Corporation to cost-effectively and quickly optimize bicycle aerodynamics and ride quality.

Efficiency through high performance computing

Used effectively, engineering simulation consistently delivers a high return on investment. However, traditional licensing schemes make the transition from an experimentalist's mindset of "testing just a few design points" to "investigating the whole design space" prohibitively expensive. This is because most software vendors base their licensing model around the broken paradigm of "the more you use, the more you lose," charging you per core instead of per simulation.

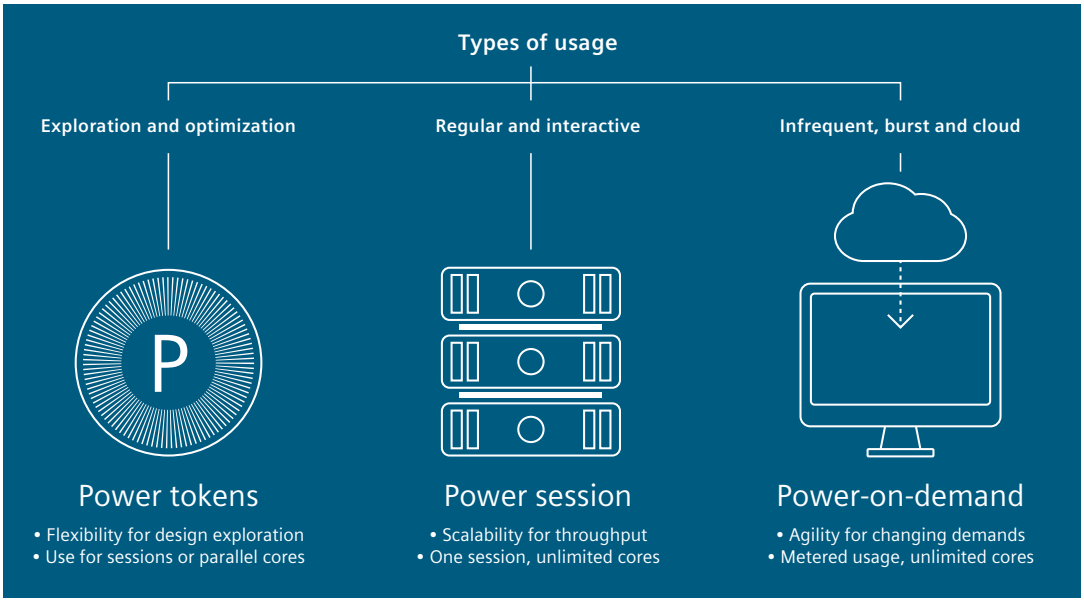
When analysis software is licensed on a per core basis, you can end up with compute resources that are underutilized, restricting your engineering ambitions. Or you might find that your ambitions for design exploration are foiled by having insufficient licenses to simulate multiple design variations of your product.

Since its inception, STAR-CCM+ has been developed with parallel scalability in mind, and tested to over 100,000 cores, ensuring that when such computational power becomes the industrial standard, the code is ready to utilize these resources. STAR-CCM+ offers a range of affordable and customizable license options to meet your simulation needs and throughput requirements. No matter the size or location of your compute resources, our power licensing is designed to ensure that you can maximize the value of your hardware and fully leverage your investment in our simulation technologies.

STAR-CCM+ makes HPC-powered simulations and design exploration studies possible and affordable with three unique power licensing options:

- **Power session:** Helps you reduce turnaround time by allowing you to run simulations on as many processors as needed for a fixed price
- **Power-on-demand:** Allows you to only pay for what you use, giving you agility for changing requirements and ideal for cloud computing
- **Power tokens:** Gives you complete flexibility for design exploration studies by enabling you to simulate any number of design variants concurrently, each on as many cores as needed

You can also choose a customized configuration with a unique combination of power licensing ingredients that meets your specific simulation and throughput requirements.



STAR-CCM+ revolutionized the simulation industry with flexible licensing schemes to address different customer needs.

"Dedicated support and an easily accessible knowledge portal are very useful. With regular releases, new features are always being introduced into STAR-CCM+, which enables us to produce more accurate simulations quicker."

James Bertwistle,
WSP

WSP has successfully used a STAR-CCM+ for performance-based building design on over 100 projects.

Responsiveness through cutting edge technology

Solving your current engineering problems is only half of the challenge. As you build a robust and efficient simulation process, you also need to ensure that the tools at the heart of it continue to evolve at the same rate as the requirements of your industry. It is critical that your process equips you to handle the challenges of tomorrow as well as today.

STAR-CCM+ has a long history of technology leadership, being the first commercial CFD software to introduce polyhedral cell meshing, unstructured overset mesh and discrete element modeling. Unlike other CFD solutions, which are often built upon aging software architecture, STAR-CCM+ was conceived from a blank sheet of paper and built using an object-oriented approach with rapid development in mind.

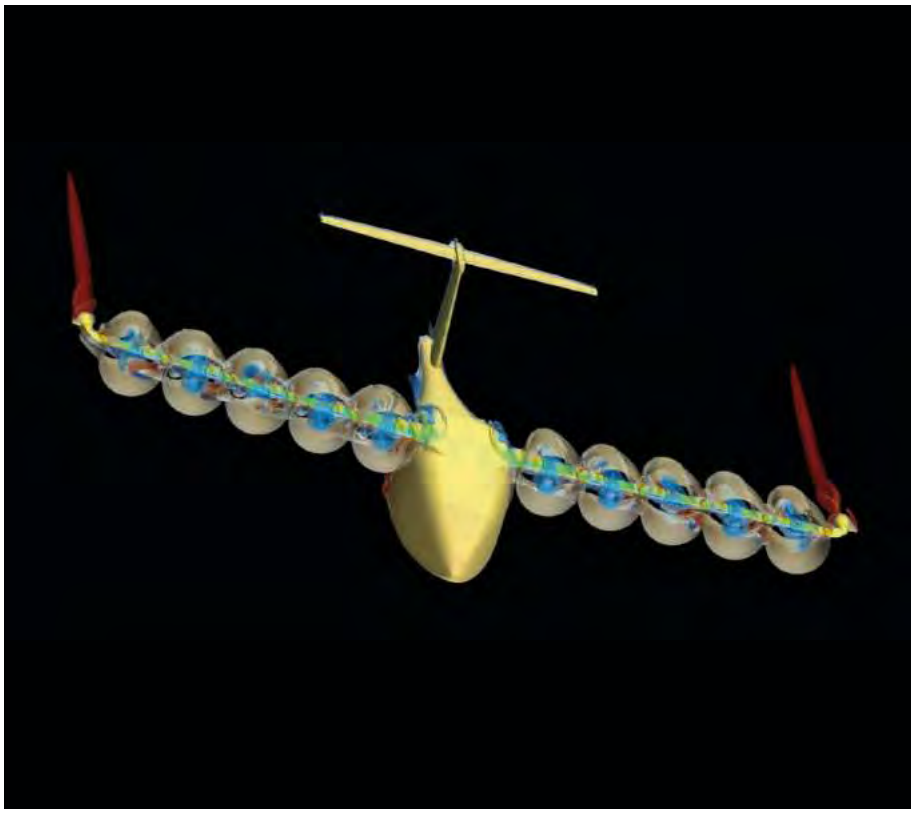
Consequently, STAR-CCM+ is not only the technology-leading multiphysics CFD software, but it also has the most aggressive development schedule, with three major releases a year, continuously delivering innovative technologies to broaden your application scope and respond to your evolving simulation needs.

As a user of our software, you also have the ability to influence and direct the development of new features in STAR-CCM+ through our IdeaStorm innovation forum, which enables you to submit, vote and comment on new product development ideas.

With three releases every year, STAR-CCM+ delivers new technologies and enhancements requested by customers faster, bringing innovative capabilities like the electronics cooling module to market.

"Support from the engineers at Siemens PLM is great. It's really nice to be able to call up an expert with a question, and they make you their first priority and help you be successful. Even though we are a small company, I feel we get as much attention from Siemens PLM's support engineers as a big company would."

Alex Stoll
Joby Aviation



The Dedicated Support Engineer model helped Joby Aviation be immediately productive with STAR-CCM+, freeing up engineering time to focus on bringing innovative electric propulsion aircraft to market.

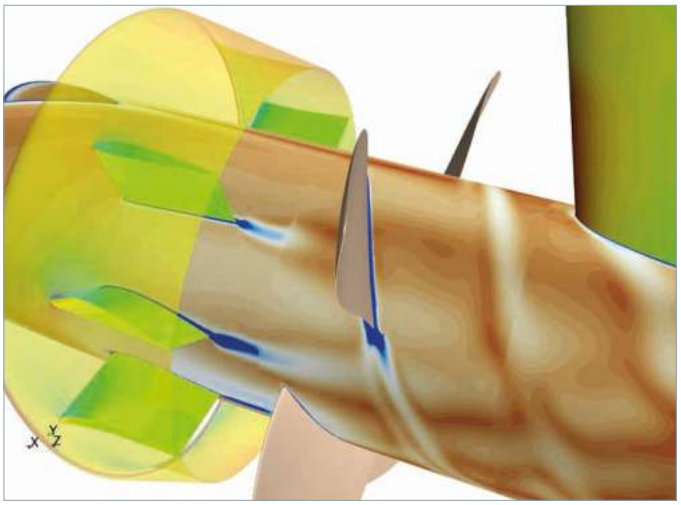
Success through customer support

An uncomfortable truth about modern engineering is that there really are no easy problems left to solve. In order to meet the demands of industry, it is no longer good enough to consider single engineering disciplines such as CFD or stress-analysis. In order to design truly innovative products, engineers are often pushing back the boundaries of what is possible. This is something that can be difficult to achieve in isolation, and often requires competencies outside a person's area of expertise. In order to be successful, your engineers should have ready access to a community of simulation experts and individualized customer support.

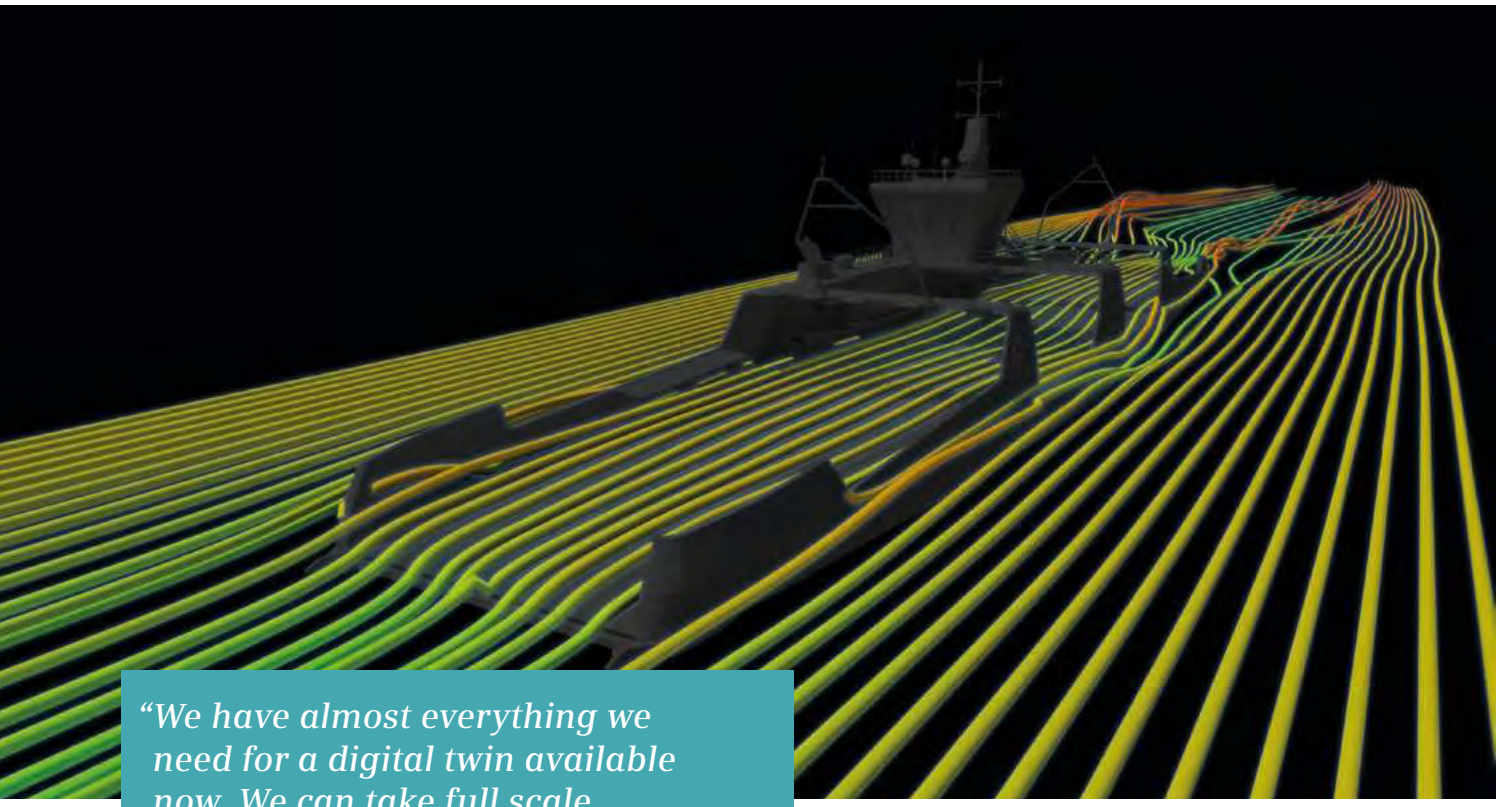
Becoming a STAR-CCM+ user means more than purchasing world-class software; it opens the door to an unrivaled wealth of engineering expertise. Our technological solutions are backed by a global team of engineering analysis specialists, dedicated to helping you meet the challenges of your industry and exceed the expectations of your market.

Each of our customers is assigned a Dedicated Support Engineer, whose mission is to proactively help you succeed. He or she will do this by building a relationship with your engineers, understanding your business goals and challenges, and providing guidance suited for your particular situation. Through maintaining a continual dialogue with our customers, we aim to identify problems before they happen and to provide immediate resolutions when they do. We can put you in touch with an appropriate local expert quickly, to help you deliver top-quality engineering analysis on time, every time. STAR-CCM+ support engineers help you solve more than just technical problems, they help keep your business in front of the competition.

Dedicated Support Engineers and their knowledge are critical for customers to successfully utilize simulation in new, emerging applications like life sciences.



IBMV utilized a STAR-CCM+ digital twin to design the Becker Mewis duct in six weeks, delivering $500k per year per ship in fuel savings.



Wärtsilä uses digital twins throughout the design process to improve operational efficiency of their vessels. Shown here is the use of STAR-CCM+ for the aerodynamic design of a ferry.

"We have almost everything we need for a digital twin available now. We can take full scale monitoring data and our simulation tools and look to model even more of the system. The more we model, the more we understand, and the more efficiencies we uncover."

Norbert Bulten
Wärtsilä

Transforming product design through the digital twin

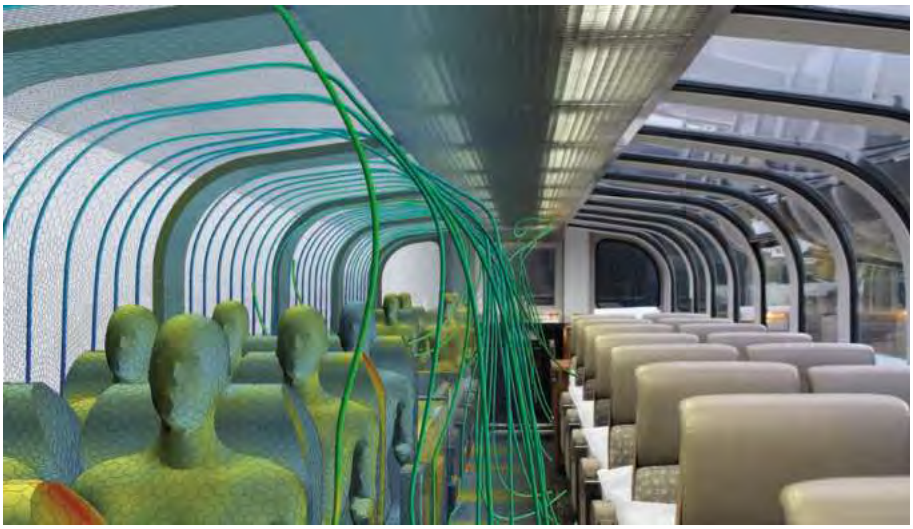
As the complexity of products increases, leading companies are relying on digital twins that predict the performance of products and monitor their behavior throughout their complete lifecycle, from inception, through engineering design and manufacture, to service and disposal.

Realistic and powerful multi-domain simulation, combined with efficient testing is the only way to successfully realize this concept of a digital twin. Additionally, a strong underlying data management structure must close the loop between requirements, design, simulation and usage.

STAR-CCM+ is part of the Simcenter™ portfolio, a comprehensive suite of simulation software and test solutions that helps companies address the engineering challenges of today's complex products. Simcenter combines simulation and physical testing with intelligent reporting and data analytics to produce digital twins that more accurately predict product performance and drive innovation throughout all stages of the product development process.

Managing your simulation data and processes in the context of an overall PLM system becomes critically important when dealing with a significantly increased use of simulation throughout the product lifecycle. Simcenter makes it easy for you to do this thanks to a tight, codeless integration with Teamcenter, our leading solution for cross-domain product design and simulation management in PLM.

We also recognize that your aim is to quickly optimize product designs and improve processes. Siemens PLM Software uniquely combines experience, skills and application know-how in engineering services to help you achieve your complex design goals and deploy innovative engineering processes with Simcenter. Whether you are a first-time user or if you are tackling a difficult problem outside your usual experience, our services organization can support you through hands-on collaboration, technology transfer, onsite projects or customized engineering technology exchanges.



Digital twin of a train cabin developed by Stadler Altenrhein AG in STAR-CCM+ to improve passenger thermal comfort.

About Siemens PLM Software
Siemens PLM Software, a business unit of the Siemens Digital Factory Division, is a leading global provider of software solutions to drive the digital transformation of industry, creating new opportunities for manufacturers to realize innovation. With headquarters in Plano, Texas, and over 140,000 customers worldwide, Siemens PLM Software works with companies of all sizes to transform the way ideas come to life, the way products are realized, and the way products and assets in operation are used and understood. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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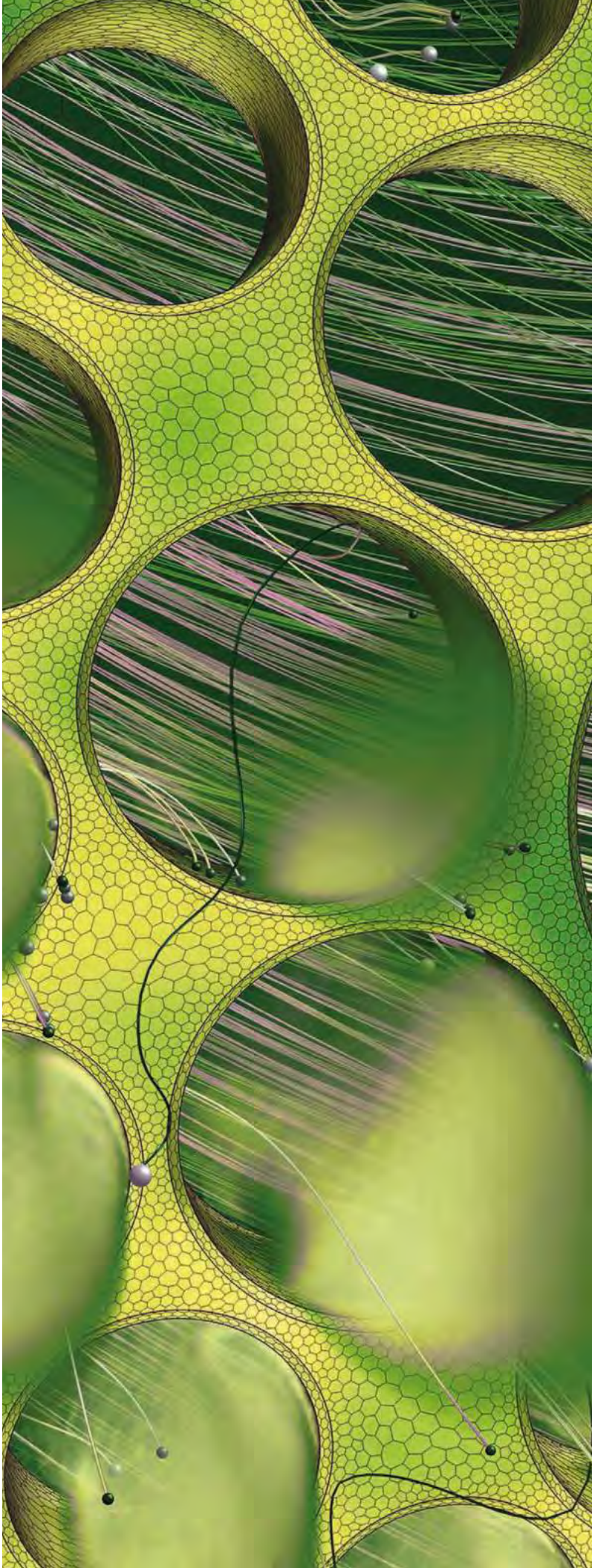
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