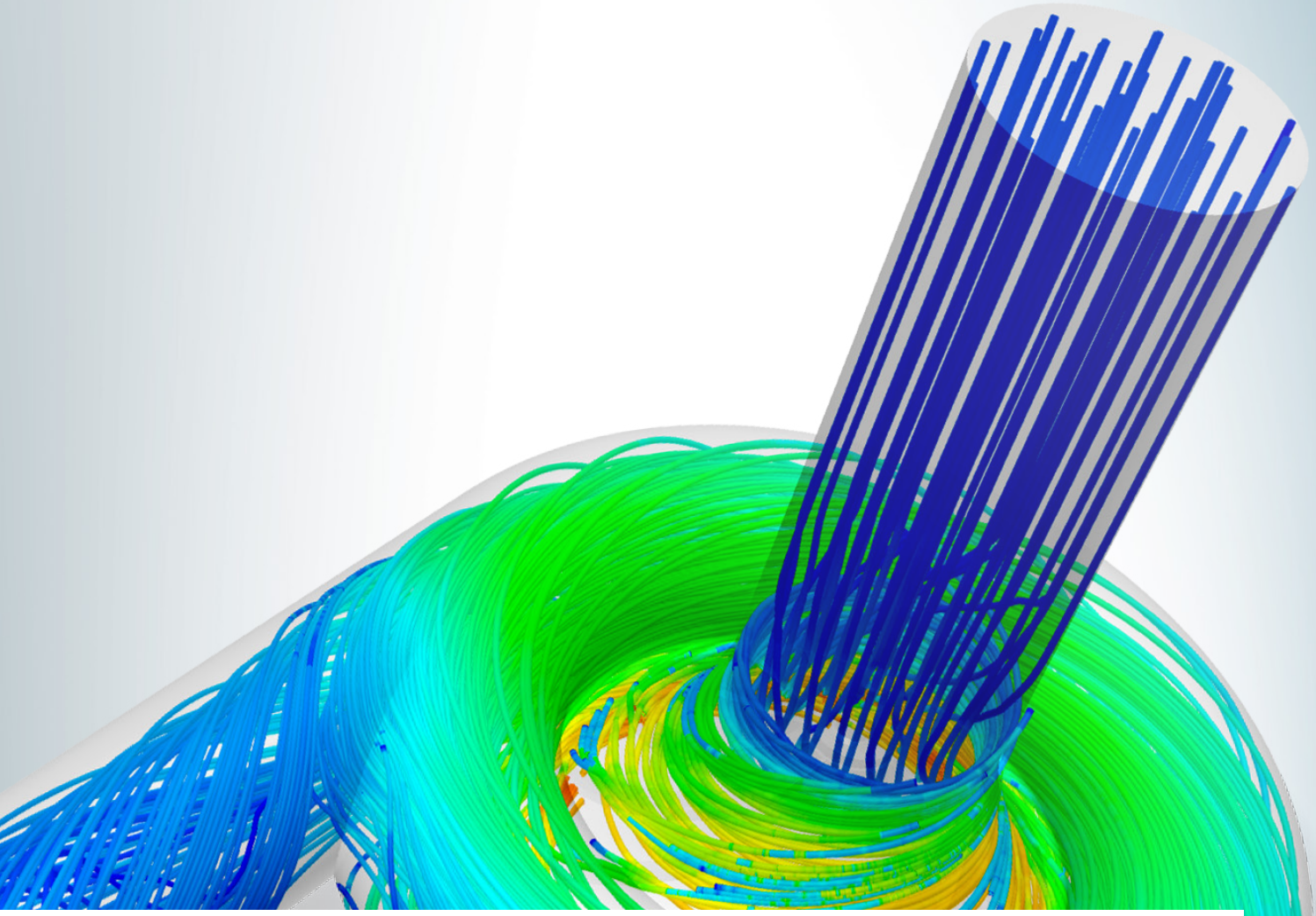

SIMSCALE

WHITEPAPER

Simulating Turbomachinery Designs 10x Faster

Simulate early, simulate more, simulate now with SimScale

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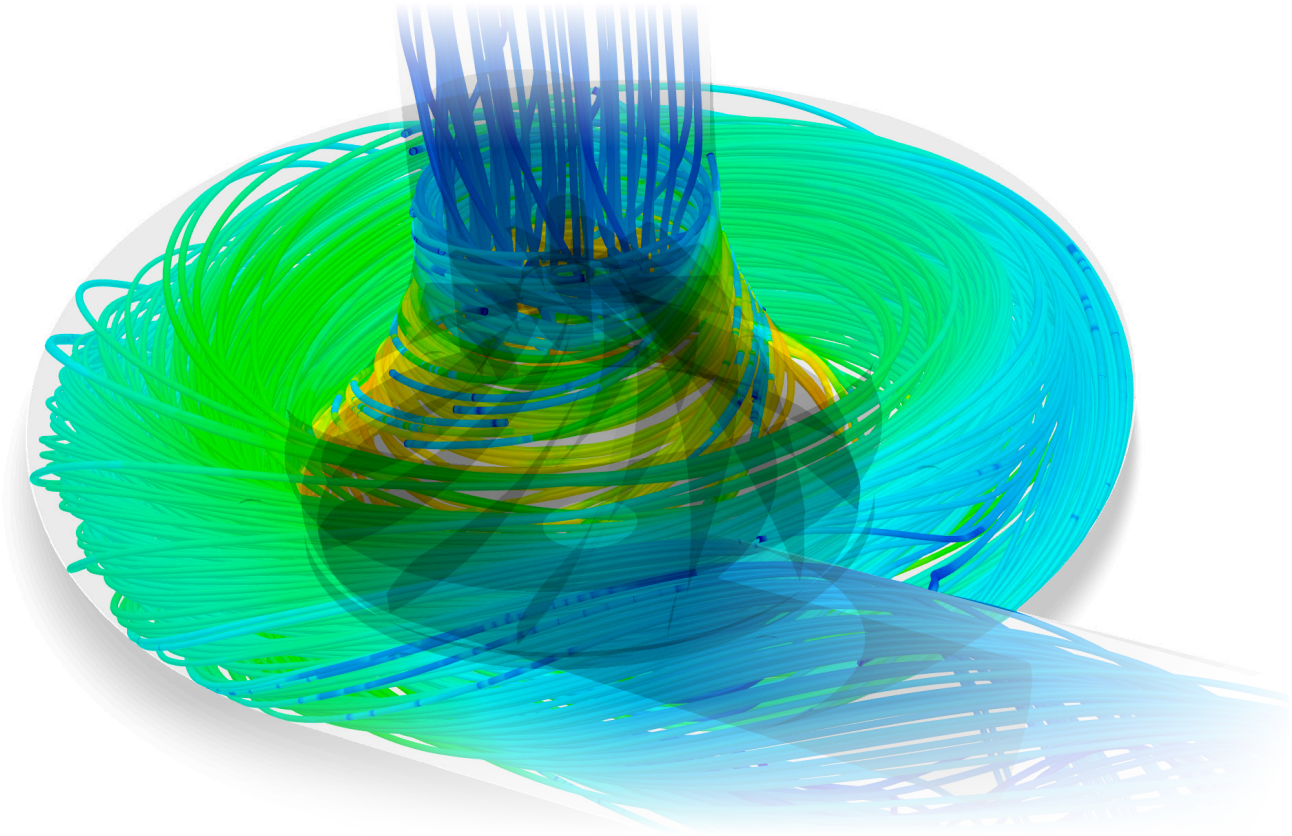
What Is This White Paper?

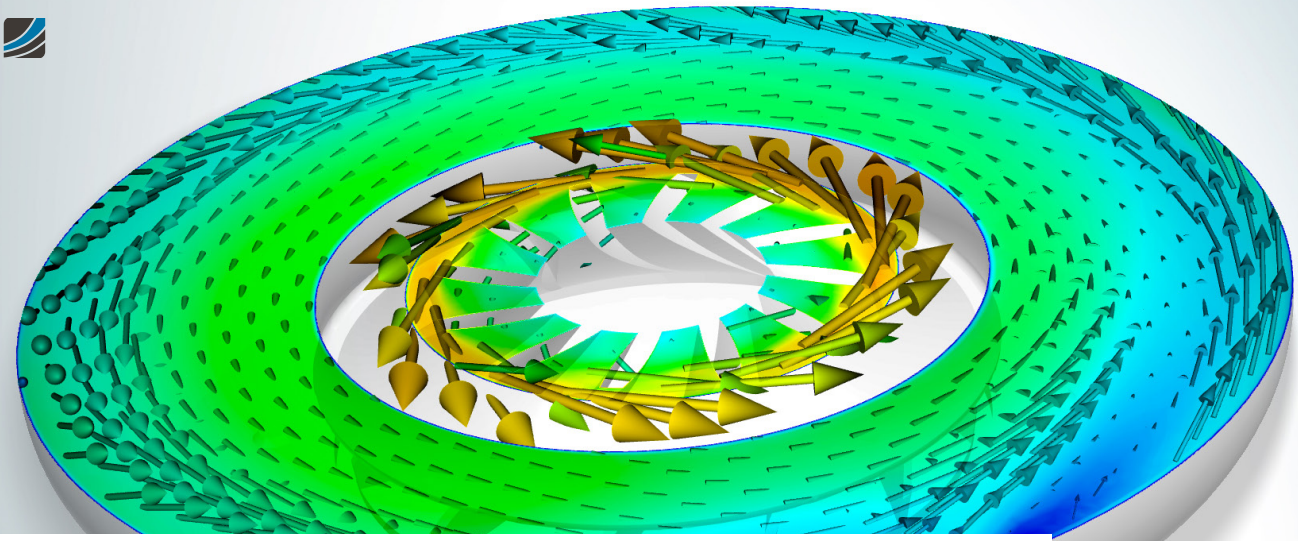
Engineers who design and test high-performance components such as fans, pumps, compressors, and turbochargers require high-fidelity engineering simulation to optimize rotating machinery designs. Access to physics-based solvers in the cloud can enable teams to quickly assess performance and accelerate design iterations by using the power of cloud computing. This white paper highlights the benefits of cloud-native engineering simulation using SimScale and describes the fast and accurate analysis types available to engineering teams by simulating early in the design stage, throughout the entire R&D cycle, and across the entire organization.

Executive Summary

Rotating machinery engineers and designers have traditionally been constrained by legacy desktop simulation software. Adopting digital prototyping to explore the full design space and the need to reduce trial-and-error type physical prototyping has been stifled by local computational resources that do not scale up on-demand, nor offer full-spectrum simulation and analysis capabilities. In this white paper, we discuss how the availability of cloud-native engineering simulation software mitigates these long-standing bottlenecks.

SimScale enables teams of designers and engineers to efficiently collaborate on projects and predict design performance in the early stages of product development processes. A fully cloud-native simulation platform allows engineers to simulate and analyze high-fidelity models with complex physics. By making HPC accessible using the power of the cloud, engineers benefit from unprecedented accuracy in results, efficiency in design collaboration, and versatility in the vast range of rotating machinery applications that can be solved.

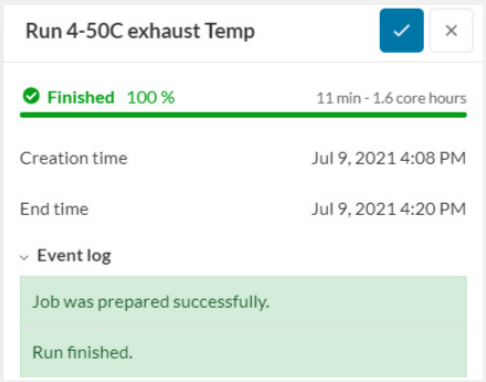


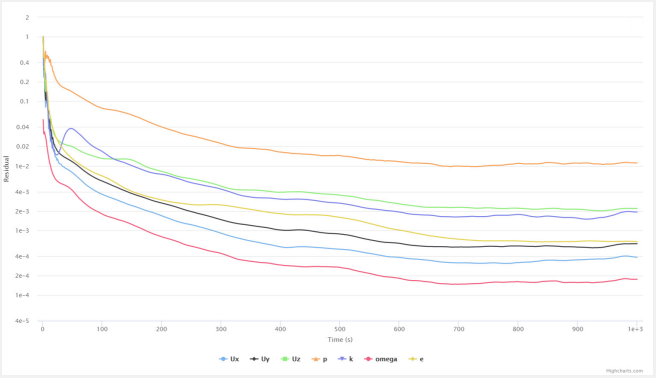


Why Simulate Rotating Machinery on a Cloud-Native Platform?

Rotating machinery components such as fans, pumps, compressors, and turbines are used in many critical applications and industries including automotive, power and energy, electronics, and industrial equipment. Component performance must be carefully designed and tested to ensure reliability, durability, and to make them fit-for-purpose. Access to simulation at the early design stages is therefore essential to achieving the required design performance, a faster time to market, reduced physical prototyping costs, and confidence in overall quality.

SimScale's simulation capabilities are changing the way engineers design rotating machinery. Benefiting from the power of cloud computing, simulation times can be reduced by an order of magnitude, from days or weeks to hours and minutes. A variety of problem types can be solved including optimizing fluid flow, pressure losses, blade aerodynamics, cavitation, testing and predicting pump/fan flow curves, and more.



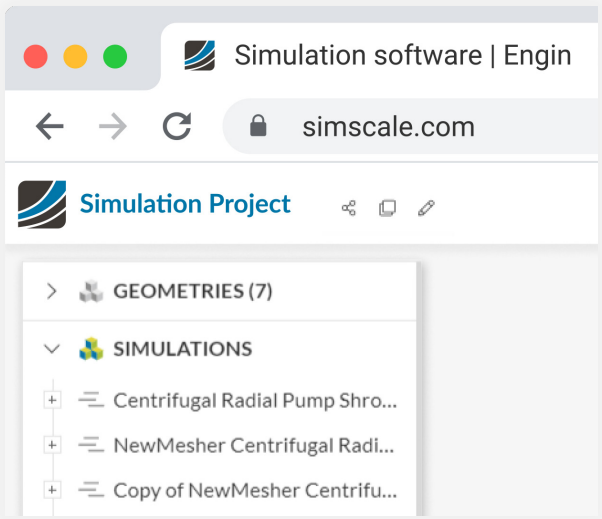


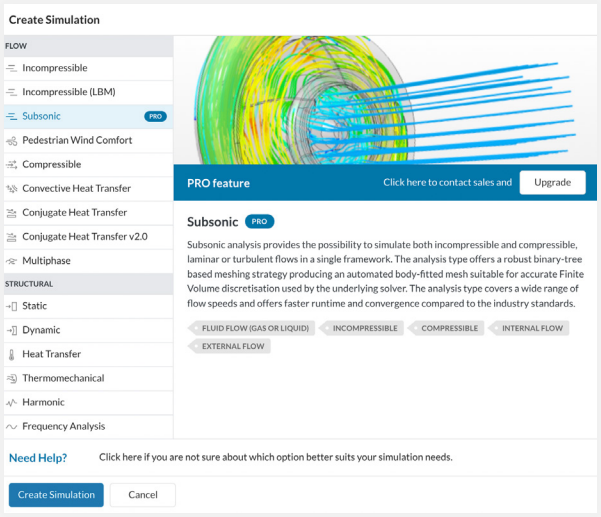
Fast

SimScale's cloud-native proprietary technology for rotating machinery is one of the fastest simulation solutions on the market, with turnaround times up to 10-25x faster than comparable tools, depending on the specific case. Our rotating machinery solution offers robust and automated body-fitted meshing and automated performance curves. The ability to run multiple design iterations in parallel means that simulating an entire pump performance curve takes just 15 minutes.

Accurate

SimScale uses proprietary solver technology specifically designed for rotating machinery applications that have been validated for incompressible and compressible flow. The solver is fine-tuned for the treatment of boundary conditions common to rotating machinery applications and supports rotating zones and automatic meshing. A single operating point simulation with our new technology takes around 15 minutes and is within 2% accuracy for Pressure Head.



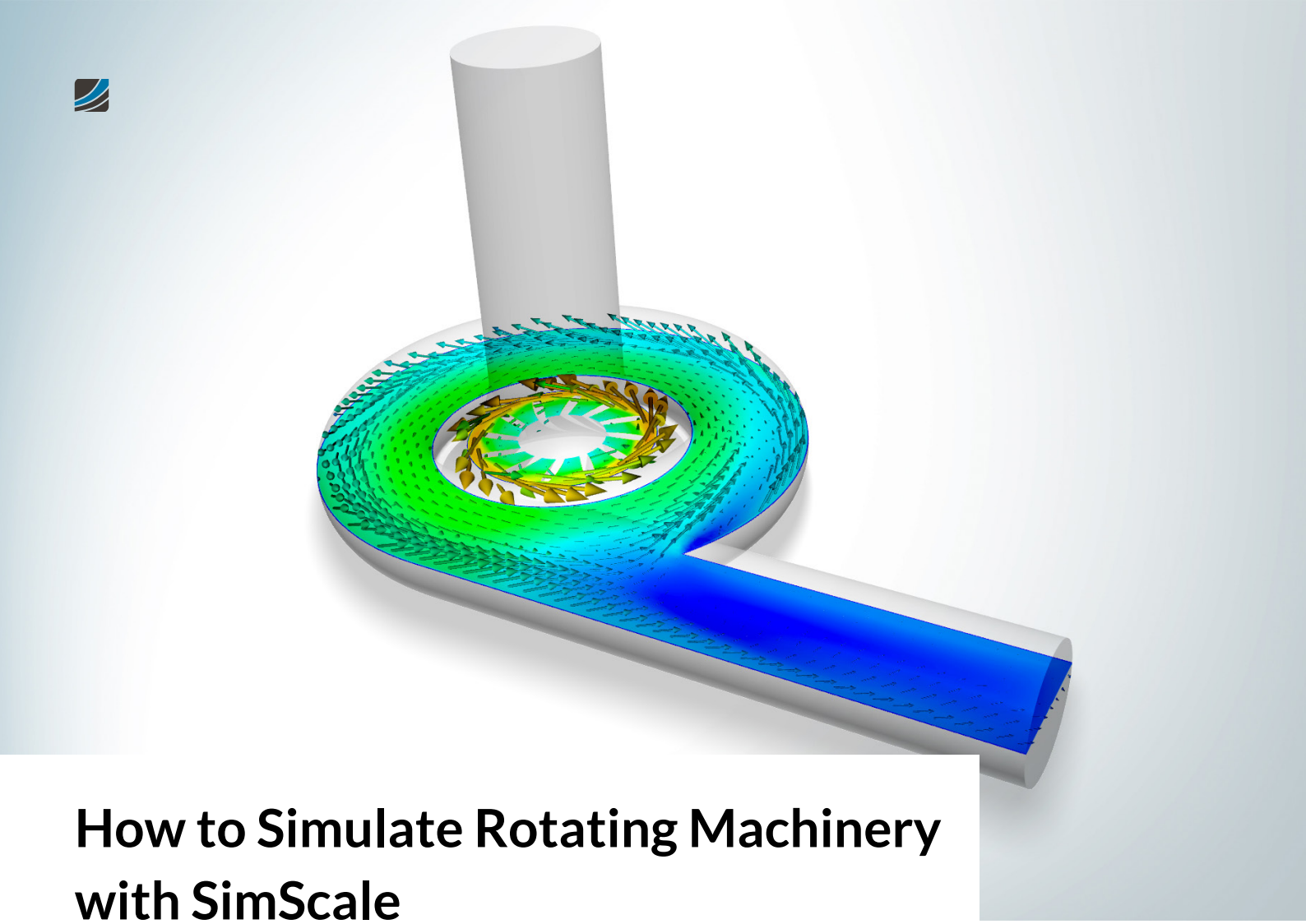


Accessible

SimScale makes engineering simulation economically and technically accessible through an easy-to-use browser-based solution. Users can benefit from an end-to-end simulation stack that can be accessed from anywhere, at any time through your preferred web browser, with a simple login. Users benefit from live technical support and a simple usage-based pricing model that minimizes IT and licensing costs. The SimScale platform easily integrates with your existing workflows and design processes. Users can bring a CAD model to SimScale and leave with robust design decisions.

Versatile

SimScale provides full-stack simulation capabilities all in one platform including automatic handling of HPC in the cloud, CAD editing, meshing, physics-based solvers, post-processing, and data storage. Users can benefit from subsonic and transonic solutions to tackle a wide range of rotating machinery applications that enable engineers to solve complex flow, thermal and structural problems on pumps, compressors, fans, turbines, blowers, propellers, and other types of equipment.

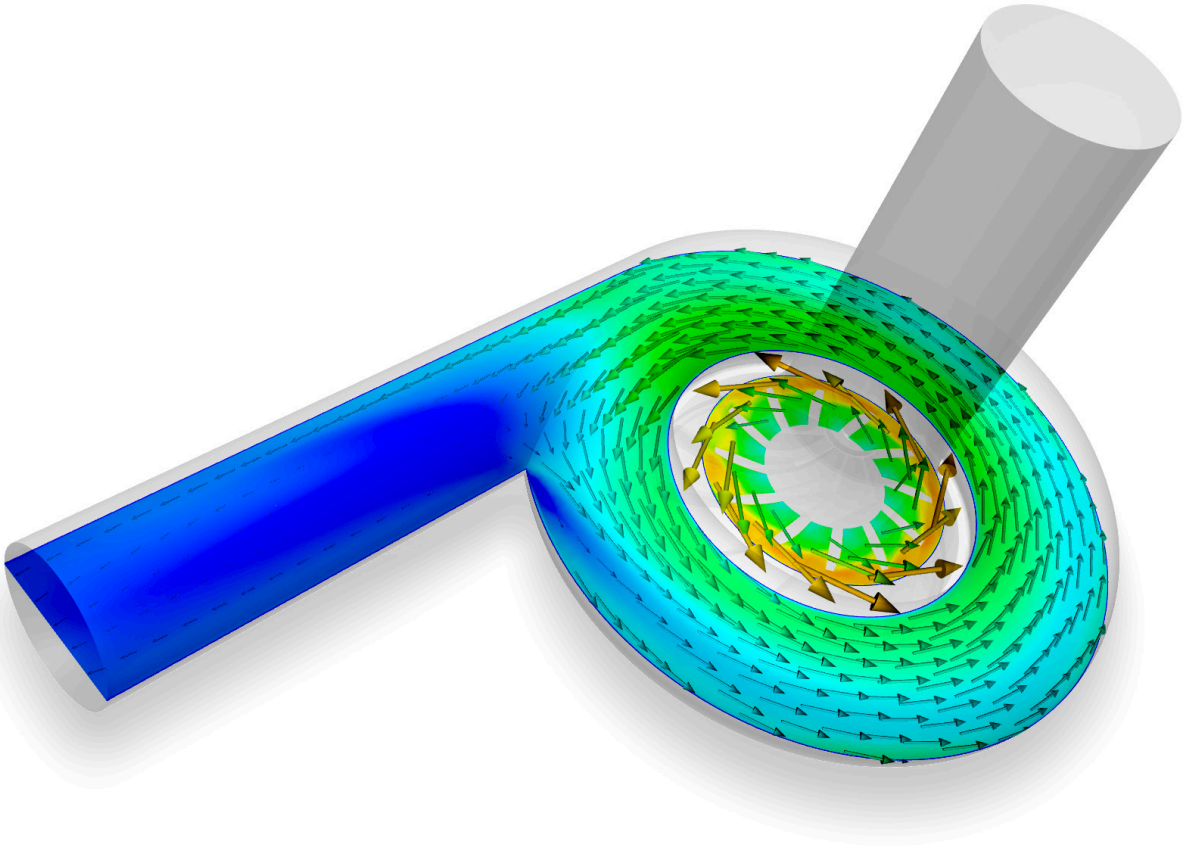


How to Simulate Rotating Machinery with SimScale

Engineers need the ability to predict design performance across an increasingly wide range of operating conditions and design parameters. Design changes made earlier in the process cost less to implement thus having an integrated and streamlined design workflow is essential. As a cloud-native engineering simulation platform, SimScale enables a high degree of collaboration between team members and optimizes the most common steps in any simulation from importing your CAD models all the way to analyzing results and making design decisions.

Import & Edit Your CAD Models with Ease

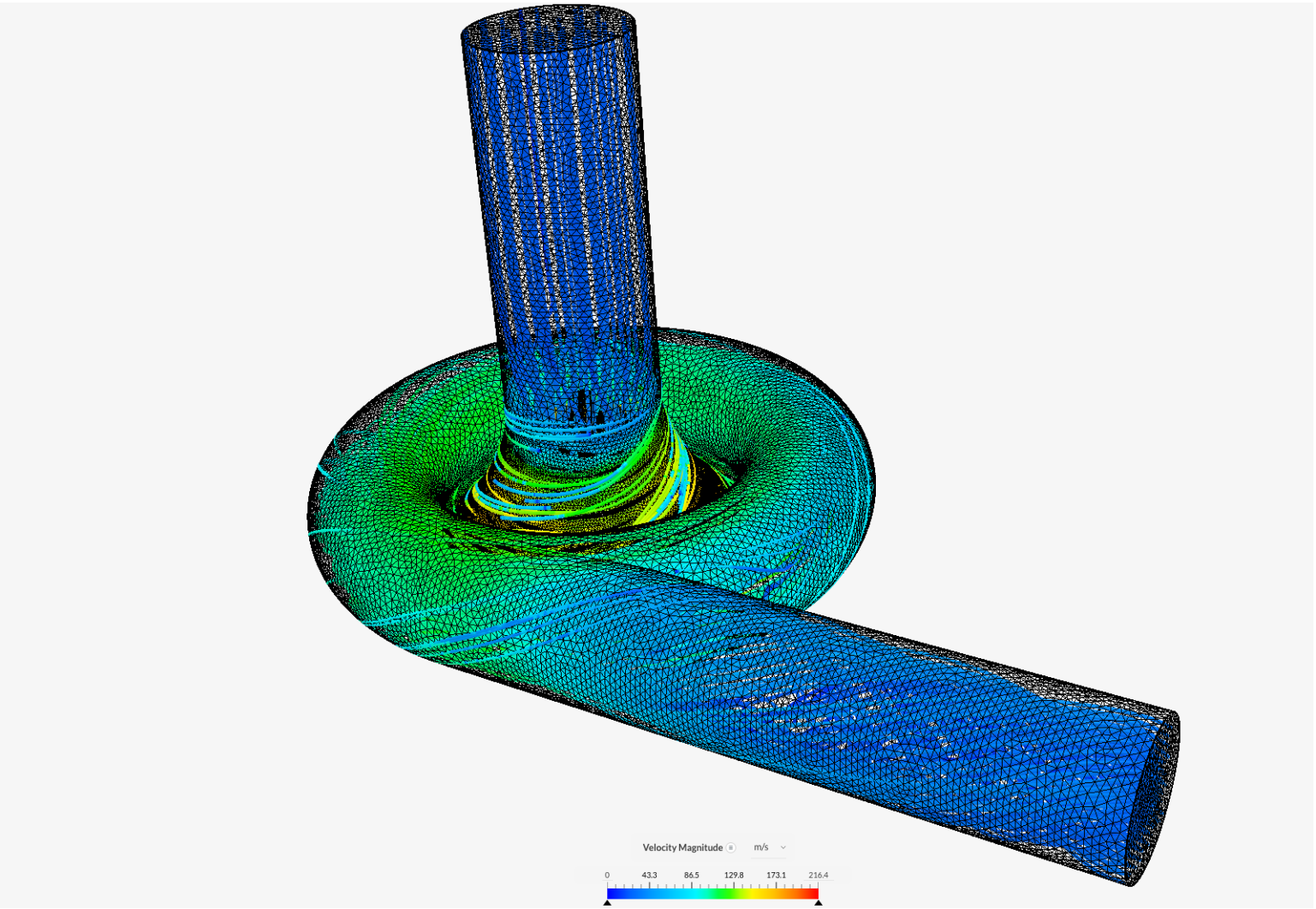
Preparing, uploading, and adapting your CAD model for analysis is the first step in setting up a simulation. SimScale supports the most common geometry formats for importing rotating machinery including Solidworks, Inventor, CREO, STEP, IGES, STL, and Parasolid. Third-party CAD connector apps are available for Onshape and other tools, allowing for more seamless integration. After CAD upload, some additional preparation might be required depending on how the file has been created. SimScale offers a dedicated environment to interact with your model called *CAD mode* that helps users prepare the model within SimScale without having to switch to external CAD software. Users typically need to create the fluid volume. *CAD mode* supports operations like scaling, extrude, body and face delete, surface splitting, flow volume extraction, etc. with new features being added continuously.



CAD model of a centrifugal pump simulated in SimScale.

Quickly Mesh & Solve Complex Designs

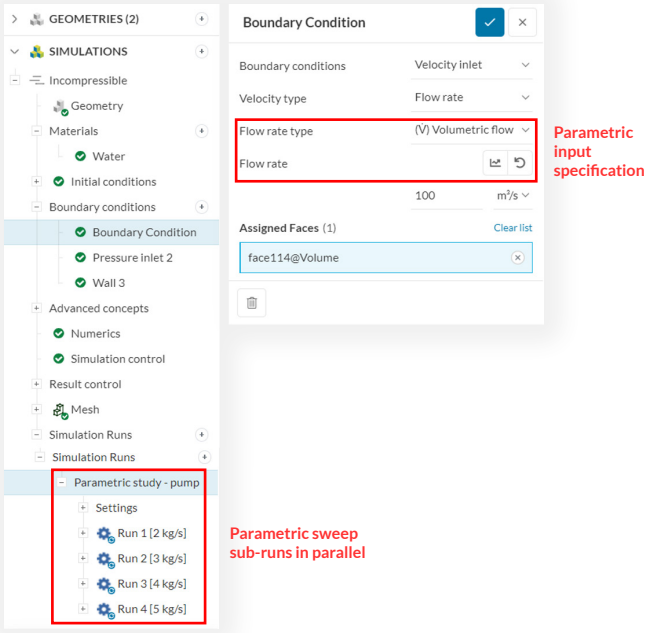
Mesh generation is one of the most labor-intensive and tedious processes of traditional CFD (Computational Fluid Dynamics) software. SimScale provides a quick and effective meshing solution without sacrificing accuracy, by using a body-fitted binary-tree meshing approach which is a flexible means of generating a highly efficient grid. This proprietary technology is harnessed specifically for rotating machinery applications and lends itself to meshing complex geometries. In a single step, engineers can mesh and solve their models in an easy-to-use and intuitive workflow.



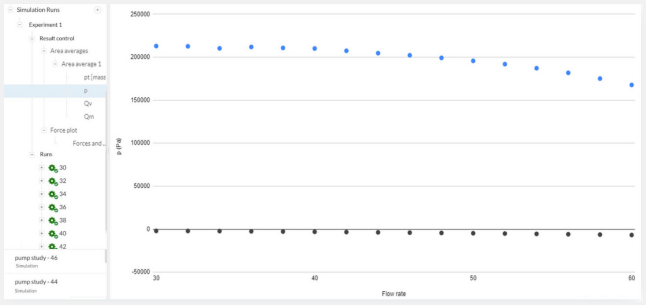
Mesh of a centrifugal pump generated using the body-fitted binary-tree meshing technique.

Automatically Generate Performance Curves

In order to evaluate the performance of rotating equipment, multiple simulations covering a range of operating conditions have to be run. For example, the performance study of a centrifugal pump involves calculating the pump's pressure head and efficiency for a range of outlet flow rates, to generate what is known as the 'pump curve', and requires a minimum of six input data points to plot the curve. Typically, such a study would take a few days or even weeks in traditional CAE softwares. With SimScale's proprietary rotating machinery technology, it is possible to generate a pump curve for a medium sized geometry within 15 minutes. The highly parallelized and cloud optimized solver enables rotating machinery engineers to run a parametric sweep in the same time as a single data point run, without leaving their web browser. The easy-to-use interface simplifies the simulation workflow and automatically collates data from each sub-run to plot the performance curve.



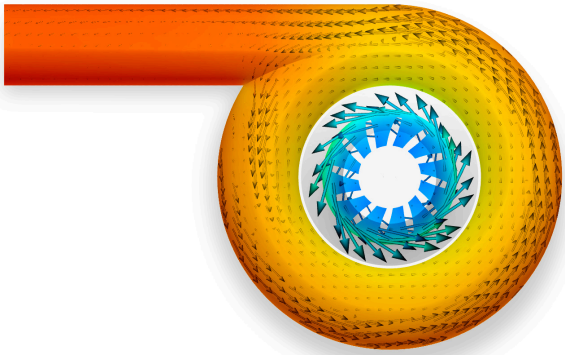
Parametric input specification for pump performance curve.



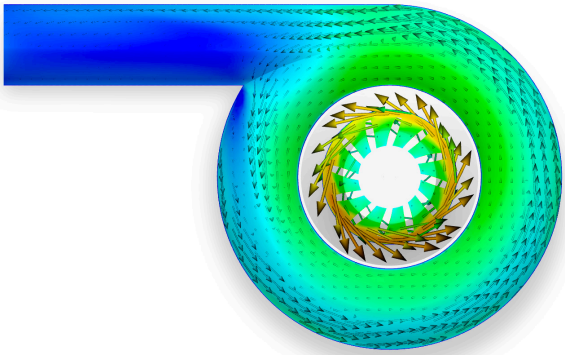
A fully-automated pump curve is generated in 15 minutes.

Visualizing the Invisible

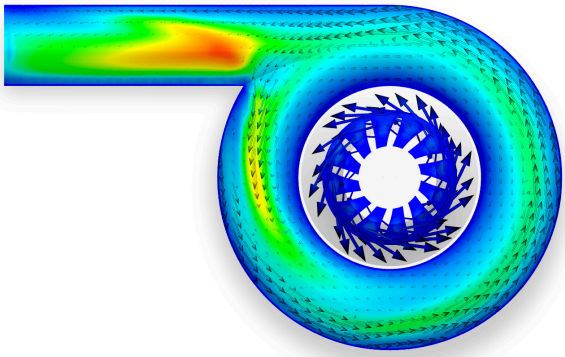
Engineers need to identify performance issues early in the product development phase before they manifest in real-world situations and fail to meet customer expectations. The simulation calculates, for example, flow and heat phenomena inside rotating machinery components and makes them visible. CFD empowers engineers to visualize important quantities, often hard or very expensive to measure in reality, to rapidly gain insight into product performance. Physical variables such as velocity, pressure, temperature, density, Mach number, and cavitation location can be calculated and visualized. Additionally, engineers can post-process further quantities including volumetric/mass flow rate on defined faces, pressure drop, viscous forces, torque, stress, and thermal shock, using the advanced post-processing features in SimScale.



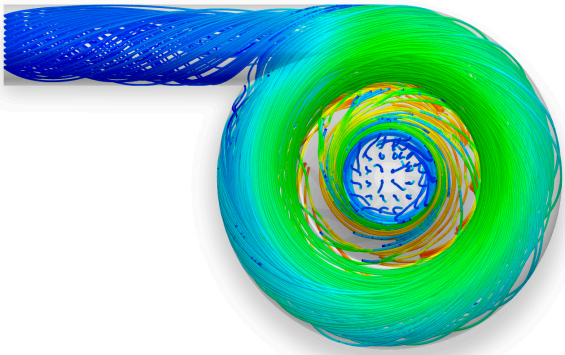
Temperature



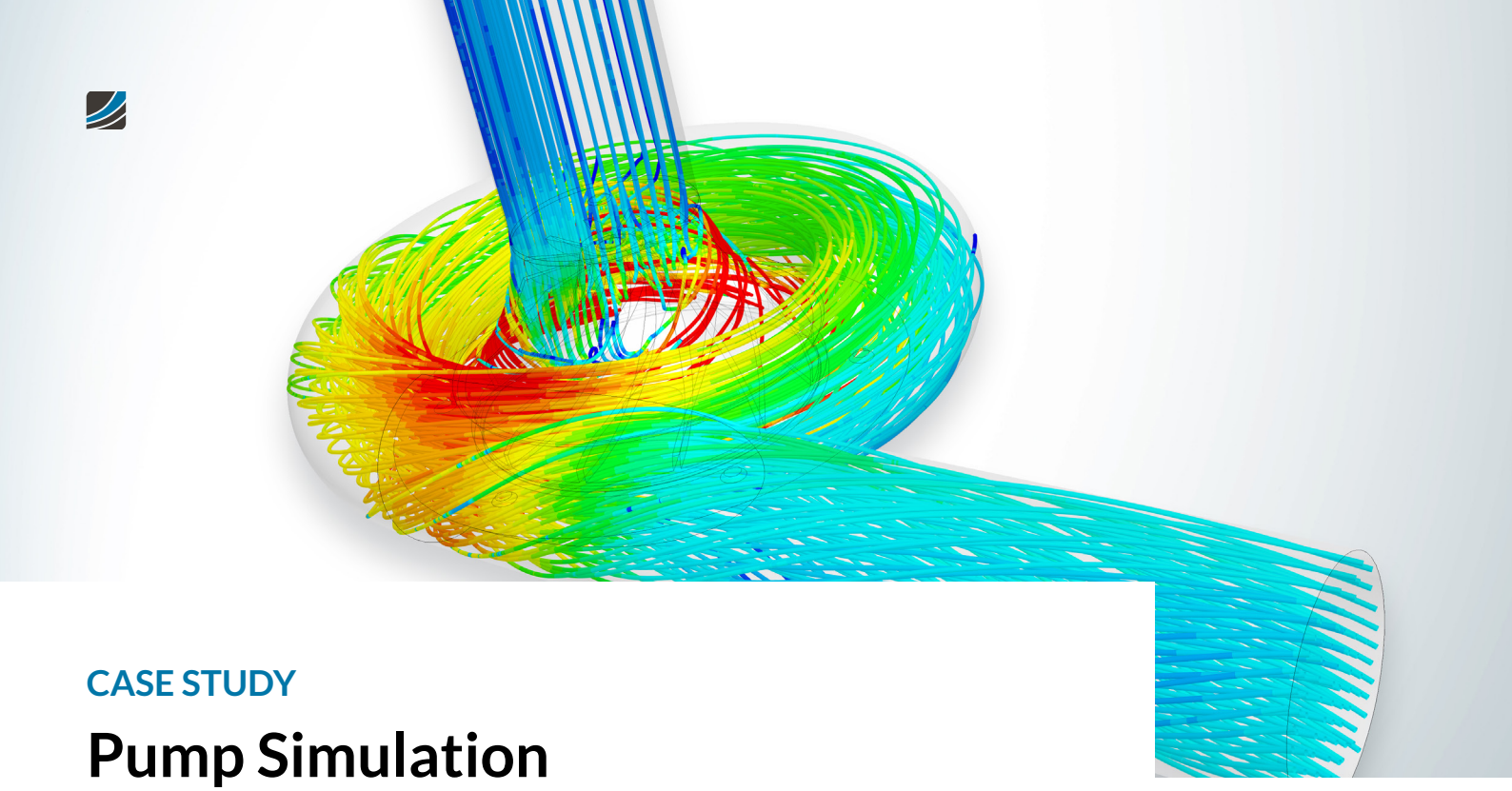
Velocity Magnitude



Dynamic Pressure



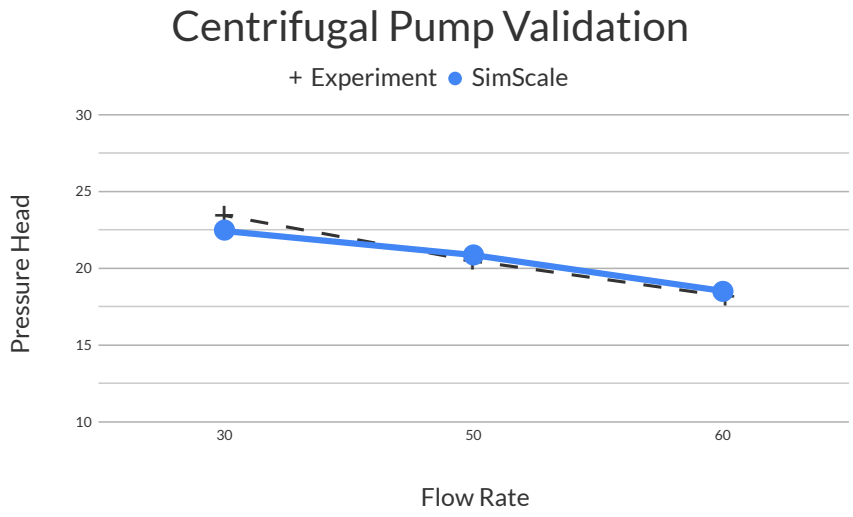
Velocity Streamlines



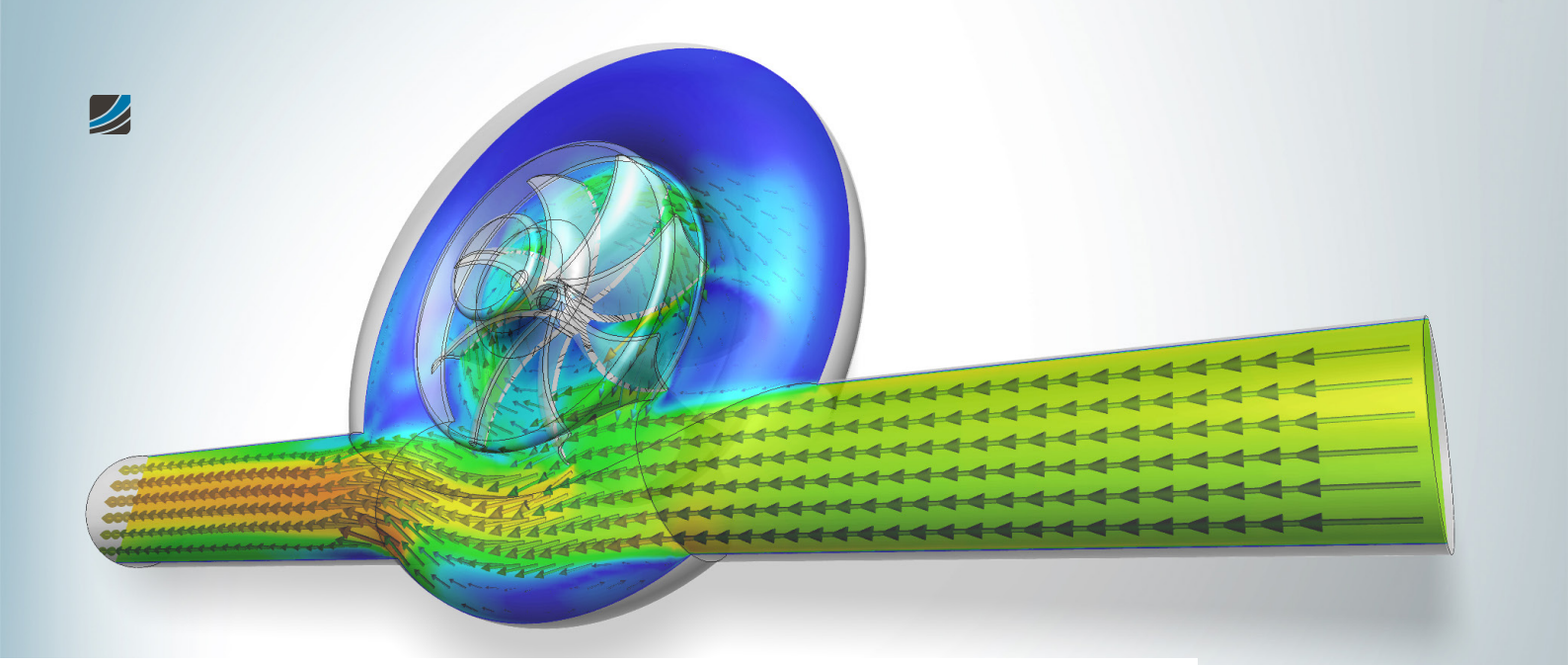
CASE STUDY

Pump Simulation

A centrifugal pump is simulated under incompressible steady-state conditions with fully developed turbulent flow (k-epsilon turbulence model) at three flow rates (30, 50, and 60 m3/h). The geometry was imported as an STL file generated from a common CAD tool. Each flow rate simulation run took 12 minutes to run and consumed 4 core hours of computational resources. The resulting pressure head is compared to published experimental data (Wang & Wang 2007). The differences between simulated and experimental results were within 1%.



Simulation vs. experimental data comparison on pressure-flow characteristics of a centrifugal pump. The data shows an excellent match between simulation and experiments.

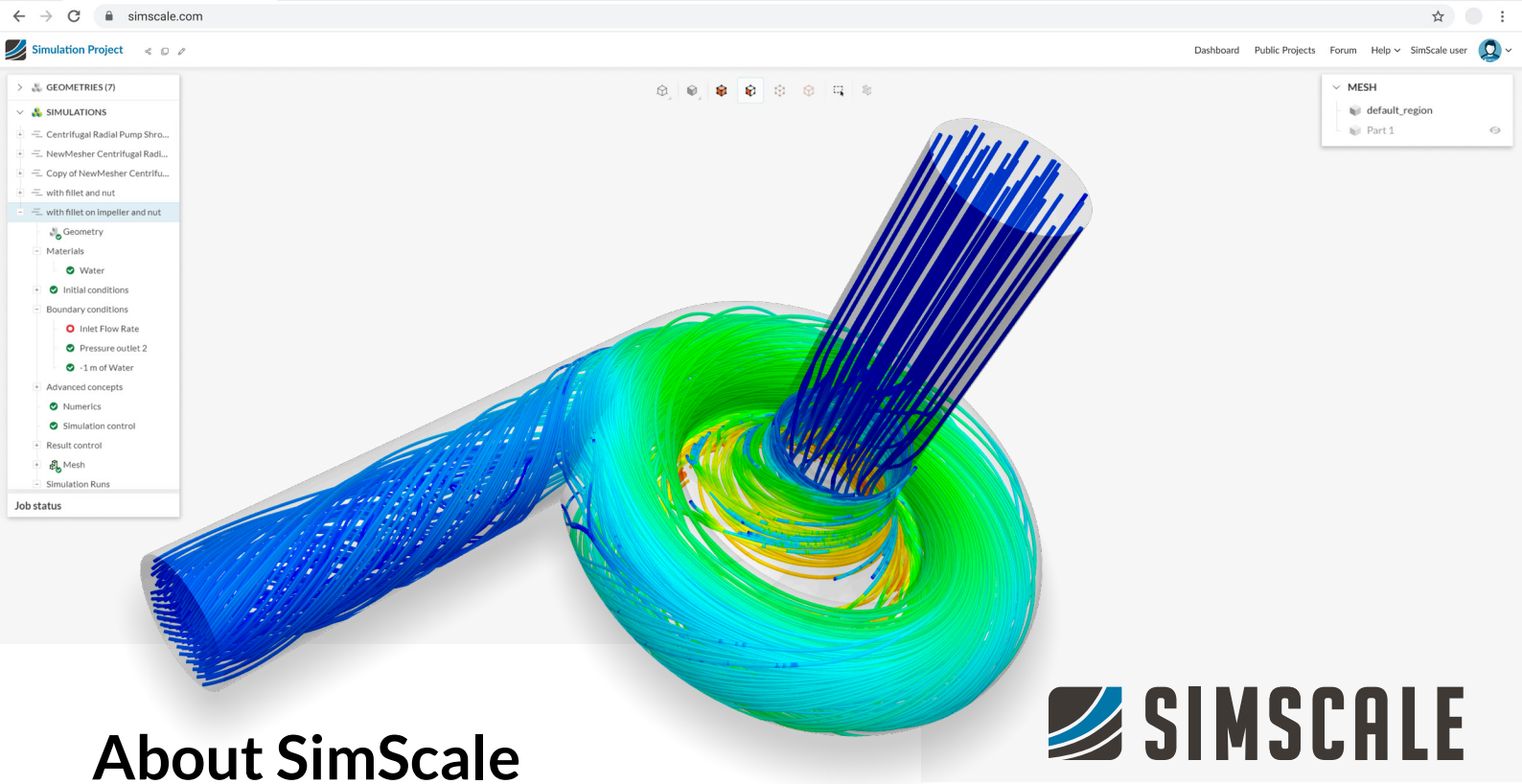


Conclusions and Next Steps

Global engineering organizations recognize the benefits of simulation in the cloud and are rapidly adopting the SimScale platform as part of their product design and digital transformation strategies. R&D leaders and engineering managers rely on the accessibility of cloud-native engineering simulation to provide their team with rotating machinery digital prototyping early in the design stage, throughout the entire R&D cycle, and across the entire enterprise. SimScale provides engineers and designers with the advantage to simulate early, simulate more, and to get started now.

To try the SimScale platform, please

Request a Demo



About SimScale

SimScale is focused on removing the pain of sourcing expensive CAE software licenses, paying for the maintenance and technical support, procuring expensive local HPC hardware, and waiting for IT to deploy and maintain the tools needed to do what matters: designing the best products. With SimScale, engineers and designers have access to fast, accurate, and accessible engineering simulation on the cloud. On the SimScale platform, accessibility translates to a modern usage-based pricing approach and frictionless collaboration between engineers. Learn how leading engineering firms are leveraging the power of SimScale with zero hardware or maintenance investment. Visit simscale.com to learn more.