Volkswagen Group Research Works with Altair and Uses Nvidia Technology on AWS to Accelerate Aerodynamics Concept Design

"The hardware and software combination we explored with Altair on AWS is, in our opinion, ideal for generating training data sets for machine learning methods. It will be the enabling technology for a systematic transition from individual simulations to interactive optimization of entire design spaces–with obvious advantages for the efficiency of our development process and the quality of our products."

– Dr. Henry Bensler, head of CAE Methods at Volkswagen Group Research

Improving the Aerodynamic Design of a Vehicle While Accounting for Style Modifications

Designing a fuel-efficient yet stylistically bold and beautiful vehicle requires the cooperation of teams with competing priorities, visions, and deadlines. As vehicle manufacturers seek to increase the aerodynamic performance of vehicles, they create aerodynamic concept designs and run transient aerodynamic simulations to understand the impact of a particular design on performance.

The problem? Many traditional simulations take too long to complete and weaken a car manufacturer's ability to successfully engineer for optimal aerodynamic performance and flow physics while also designing for style. Aerodynamicists face a short allowable timeframe to assess a new design and provide feedback for change requests from stylists.

Forward-thinking car manufacturers such as Volkswagen AG have turned to technology to address the inherent conflict between the resources and time required to complete a transient vehicle aerodynamics simulation versus the response time that's allowable from a design and styling perspective in the early stages of a vehicle development process.

"The ever-increasing interdisciplinary challenges of vehicle development require innovative, disruptive computational technologies to shorten development cycles to continue to satisfy customer needs," says Dr. Henry Bensler, head of CAE Methods at Volkswagen Group Research. The company chose to accelerate its virtual aerodynamic design process by using Reduced Order Models (ROMs), which provide a tool capable of predicting aerodynamic performance and flow structures in real time.

As the team focused on converging the work of aerodynamicists and stylists earlier in the development process by taking advantage of ROMs, they turned to the experts at Altair to trial the use of a Computational Fluid Dynamics (CFD) solver using NVIDIA GPUs on Amazon Web Services (AWS).

Exploring New Technologies to Improve the Accuracy and Efficiency of Aerodynamics Concept Design

Engineering excellence and technological innovation are at the heart of the work Altair, an Advanced AWS Technology Partner, does every day for clients around the world. Altair strives to deliver superior Computer Aided Engineering (CAE) applications and High Performance Computing (HPC) software solutions to engineers, scientists, and administrators and engages with clients at the beginning of a project to help them get started.

About Volkswagen AG

Volkswagen AG, known internationally as the Volkswagen Group, is one of the world's leading carmakers and the largest car manufacturer in Europe. The Group operates 120 production facilities in 20 European countries and in eleven countries in America, Asia, and Africa.

Challenge

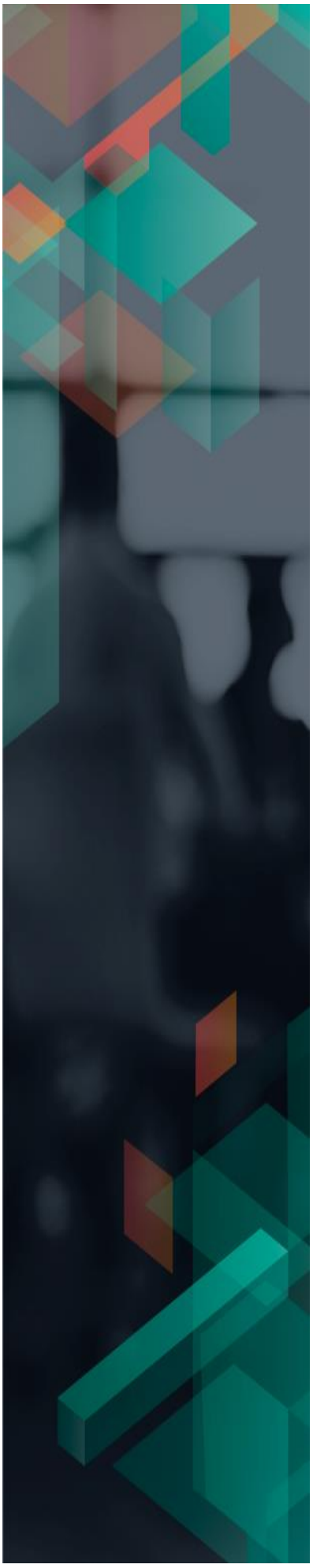
Many traditional simulations take too long to complete and weaken a car manufacturer's ability to successfully engineer for optimal aerodynamic performance and flow physics while also designing for style. To address this challenge, Volkswagen Group Research decided to explore new computational technologies to shorten its simulation and development cycles.

Solution

Volkswagen Group Research turned to Altair to trial the use of a Computational Fluid Dynamics (CFD) solver using NVIDIA GPUs on Amazon Web Services (AWS), specifically by using Altair's ultraFluidX solution. Altair conducted a comprehensive Proof of Concept (PoC) for Volkswagen Group Research, conducting two Design of Experiments (DoE) cycles, consisting of 100 simulation runs each to be turned around within five business days.

Benefit

Following the successful PoC, the CAE Methods team at Volkswagen Group Research gained confidence in the capabilities of running ultraFluidX on AWS. The PoC resulted in not only high-quality CFD results produced by ultraFluidX, but also impressive robustness, degree of automation, and turnaround time demonstrated by the solution. The team was able to run 200 car shape variants in a time frame that would typically correspond to only a few runs with its current operational tools.



“Altair does a lot of consultancy work related to simulation services,” says Dr. Bastian Schnepf, Business Development Manager - CFD at Altair. "The company's workforce is comprised of a diverse group of creative minds, and many of our software architects have a background in engineering. Altair started as an engineering service company in 1985, and we've kept that as a part of our DNA throughout the evolution into a leading developer of simulation software."

After engaging with Volkswagen’s research team and learning more about the company’s use of ROMs and willingness to experiment with GPU solvers, Altair recommended the company turn to the cloud and run simulations using Altair ultraFluidX. ultraFluidX is a CFD solver exploiting the power of NVIDIA GPUs using a state-of-the-art Lattice Boltzmann approach. Altair felt the solver could help Volkswagen accelerate its simulation time from days to hours and therefore make it possible to turn around larger design studies and training data faster.

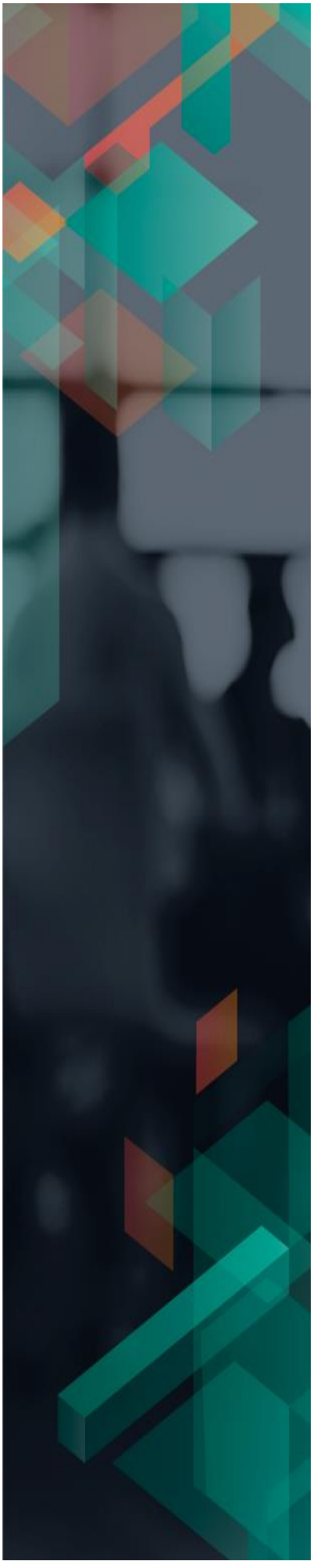
As a first step, Altair ran a smaller blind benchmarking test for Volkswagen. Altair was provided a car model to run an aerodynamics analysis on using the ultraFluidX solution and provided results to Volkswagen. Encouraged by accurate results, the Volkswagen research team chose to participate in a broader and more complex simulation run Proof of Concept (PoC) using ultraFluidX on Amazon Web Services (AWS).

By conducting a comprehensive PoC using ultraFluidX on AWS, Altair believed it could demonstrate its ability to improve Volkswagen research team’s aerodynamics analysis of the Jetta. “We feel AWS is an ideal cloud provider for Volkswagen AG to use to run large-scale aerodynamic simulations,” says Schnepf. “AWS provides optimal GPU resources for peak-demand applications such as this one. Using AWS, we can take advantage of Amazon Elastic Compute Cloud (Amazon EC2) p3.16xlarge instances which feature eight latest-generation NVIDIA Tensor Core V100 GPUs and deliver the fastest parallel compute capabilities in the cloud. These instances are ideal for machine learning and high performance computing applications.”

The company outlined the parameters it needed to conduct two Design of Experiments (DoE) cycles, consisting of 100 simulation runs each. To be deemed successful, each DoE cycle needed to be turned around within five business days. To meet this requirement, the team chose to use 10 parallel 8x NVIDIA V100 GPU servers on Amazon EC2 p3.16xlarge instances. The goals for Altair were straightforward. In addition to improving the overall turnaround time for the analysis as compared to Volkswagen Group Research's existing practices, the process should prove to be robust and, once submitted, should be able to finish without further user interaction.

Taking Advantage of Amazon EC2 P3 Instances and Conducting a 200-Run Simulation PoC to Test ultraFluidX on AWS

For the first DoE cycle of 100 simulation runs, 10 p3.16xlarge Amazon EC2 Instances were used to host one simulation per instance at a time; overall, 10 simulations were run in parallel across the mini-cluster, which were managed by Altair's PBS Works job scheduler. Out of these 100 simulations, 92 finished successfully, while 8 simulations terminated early with a solver error in ultraFluidX. From an HPC perspective, all instances functioned properly at a constant speed of approximately 1500 million node updates per second (MNUPS), per instance in the solving step. By investigating the failed runs, Altair was able to identify and fix the root cause for the 8 failed runs in the solver and completed them properly. The results of DoE 1 were then sent to and analyzed by VW to derive the second set of 100 simulation runs.



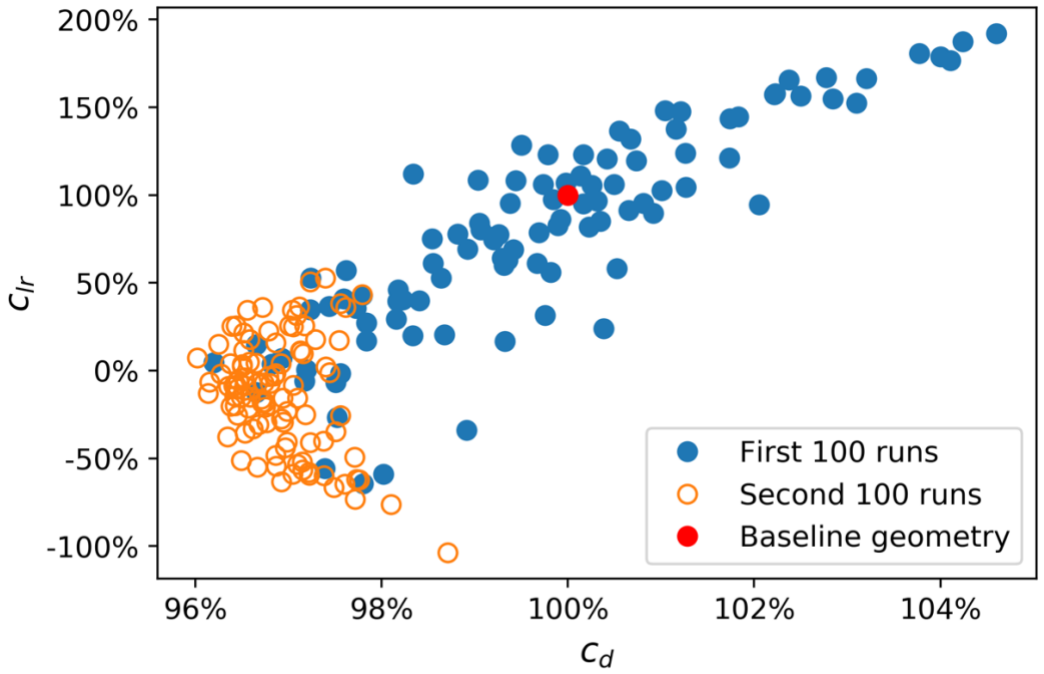


Diagram: Rear lift coefficient C_{lr} vs. drag coefficient C_d for the Jetta PoC

The second DoE cycle was executed similarly to the first cycle and completed without simulation errors in less than four days. The robustness of the solution was proven when one node experienced a system issue during the DoE, but then restarted itself and resubmitted the job automatically, and then ran and finished at 40 percent reduced speed. The remaining 9 instances continued their operation properly and compensated for the slow node. So, even with an occurring system issue, the study was able to finish within four days without user interaction–-meeting the criteria outlined for successful PoC execution.

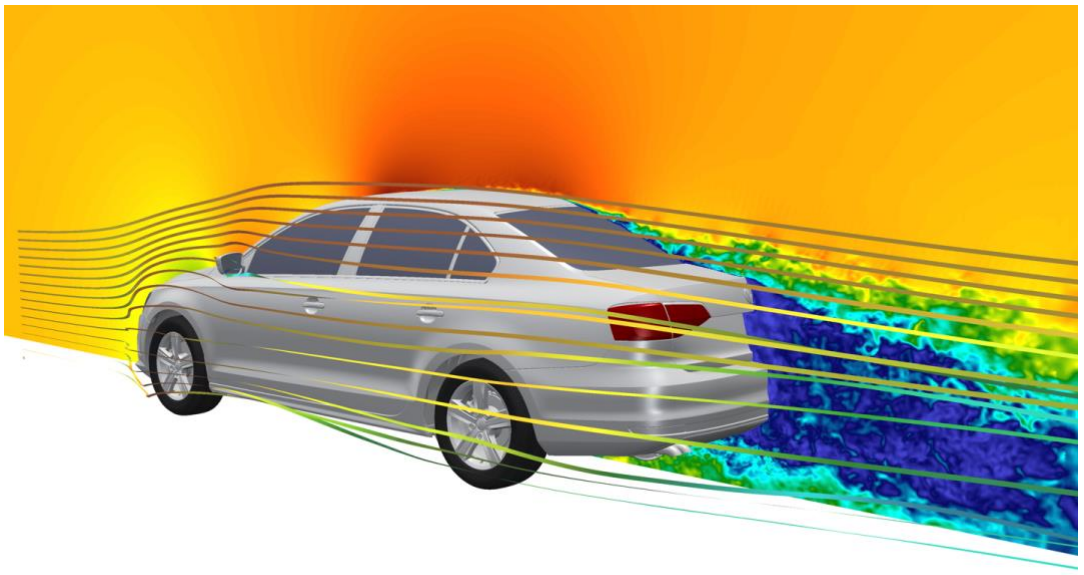
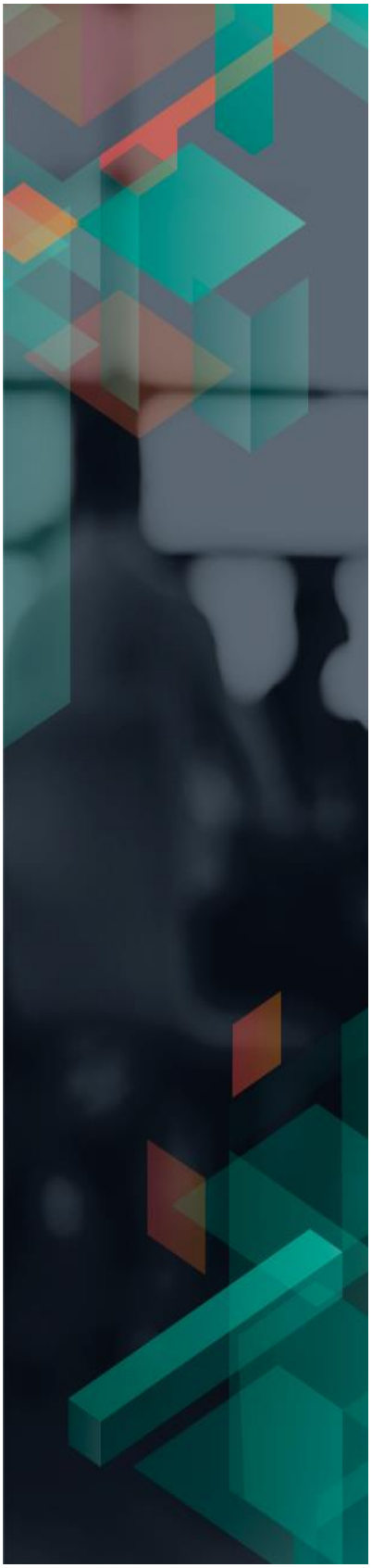


Image: Altair ultraFluidX transient flow simulation results supporting the Jetta DoE Cycle Analysis



Designing Energy Efficient and Aesthetically Optimized Vehicles in Real-Time Using a NVIDIA GPU Solver Running on AWS

Simulation on NVIDIA GPUs on AWS is a game-changer for aerodynamic development in the automotive industry. The team at Altair believe this evolution in development will help to optimize fuel efficiency further and improve the range of electric vehicles while allowing for flexibility in the choices and changes made by stylists. The resulting computational cost savings that can be achieved are also significant: Based on initial testing, Altair estimates that by using ultraFluidX on GPUs instead of a CPU-based CFD solver, Volkswagen could save up to 70 percent of its existing hardware cost – at a scale of 100 simulation runs, this corresponds to a significant 5-digit USD amount.

For the CAE Methods team at Volkswagen Group Research, the PoC instilled in its team confidence in the capabilities of running ultraFluidX on AWS. The PoC resulted in not only high-quality CFD results produced by ultraFluidX, but also impressive robustness, degree of automation, and turnaround time demonstrated by the solution.

“We were able to run 200 car shape variants in a time frame that would normally correspond to only a few runs with our current operational tools,” says Dr. Bensler. “The hardware and software combination we explored with Altair on AWS is, in our opinion, ideal for generating training data sets for machine learning methods, like Reduced Order Modeling. It will be the enabling technology for a systematic transition from individual simulations to interactive optimization of entire design spaces – with obvious advantages for the efficiency of our development process and the quality of our products."

Learn more about running HPC workloads on AWS.

Altair

Altair transforms design and decision making by applying simulation, machine learning, and optimization throughout product lifecycles. Its broad portfolio of simulation technology and patented units-based software licensing model enable Simulation-Driven Innovation for its customers. With more than 2,000 employees, Altair is headquartered in Troy, Michigan, USA and operates 71 offices throughout 24 countries. Altair serves more than 5,000 customers across broad industry segments.

aws partner network

Advanced Technology Partner

Learn more at https://aws.amazon.com/partners/