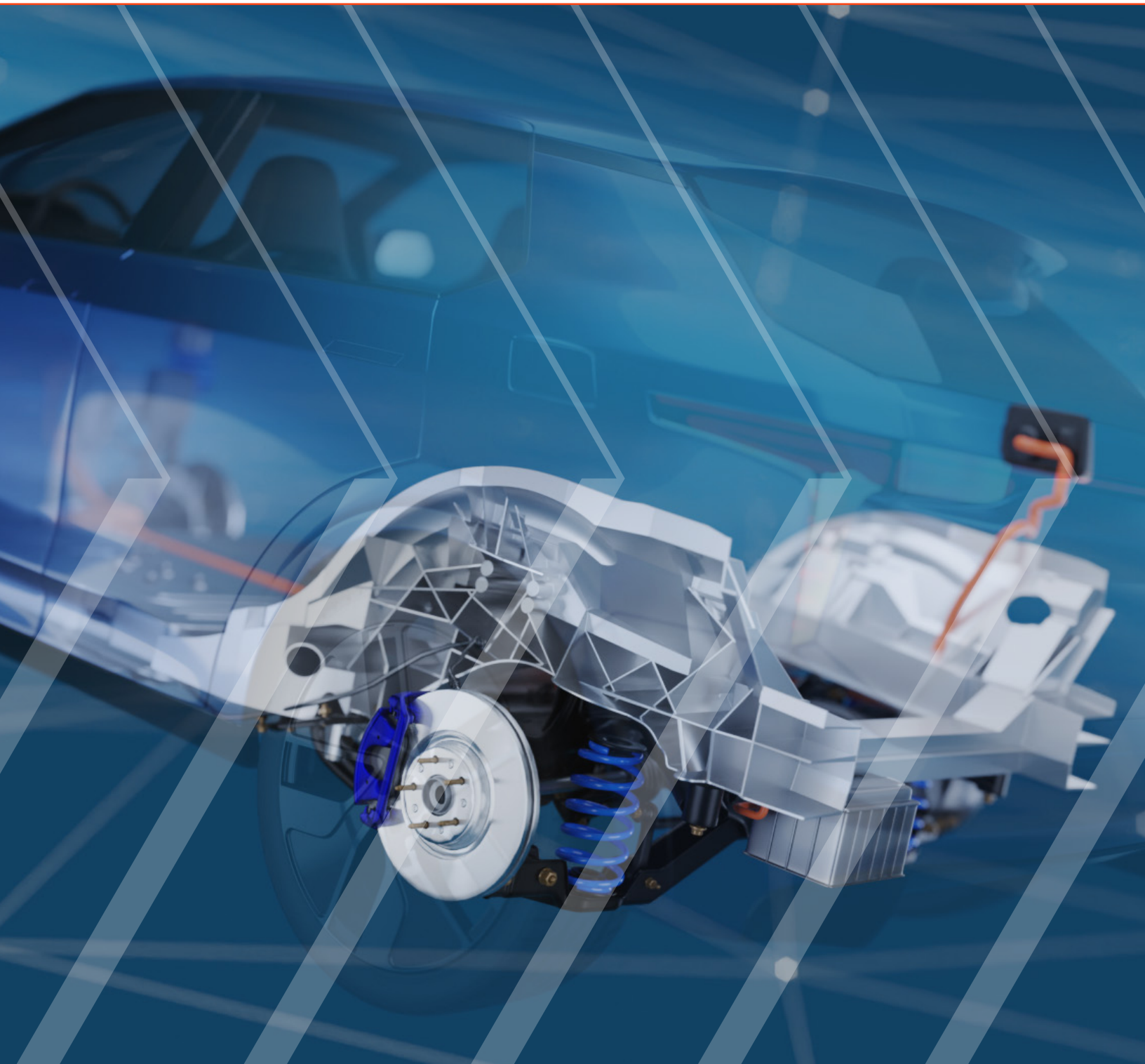
ALTAIR

GUIDE TO MEGACASTING: AI-POWERED GENERATIVE DESIGN



INTRODUCTION

Today's need for sustainable mobility solutions and the emergence of exciting new vehicle concepts has inspired designers to rethink the ways they can minimize weight, lower manufacturing costs, and meet modern performance targets. Altair's comprehensive solutions can help organizations develop reliable and innovative mega- and gigacasting components. Blending industry knowledge and innovative technologies, Altair's artificial intelligence (AI) and generative design approach, validated by advanced simulation, helps deliver better products through multidisciplinary automotive design exploration.

WHAT IS MEGACASTING?

Megacasting, and its evolution into gigacasting, refers to a new approach for the serial manufacture of large, complex geometry, light alloy metal parts using high-pressure die casting (HPDC). Megacasting is of particular interest for large structures within the body in white (BIW) of electric vehicles (EVs). HPDC is a well-established industrial process for making aluminium- and magnesium-alloy based automotive parts such as drivetrain casings, smaller precision parts, or other weight-sensitive structures.

By increasing cast component size, teams can reduce the amount of required individual parts – which are often stamped and welded and made of different materials – thus saving time and resources. This does not come without risk, because the transition from using wrought products to casting at this scale needs considerable investment in new plant and machinery, along with expertise in optimizing the design and assuring high-quality serial manufacturing of these relatively recent megacastings.

How to Unleash Next-Generation Innovation

Here we examine how the challenges being faced by automotive OEMs can be successfully overcome by Altair's bespoke AI-powered generative design workflow solution. Developed by collaboration between Altair and a world-leading automotive OEM, Altair's solution is illustrated by a simulation-driven design of a real-life battery electric vehicle (BEV) body in white (BIW) megacasting component.

To Learn More:
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CHALLENGES IN TODAY'S INDUSTRY

Weight

Attaining an acceptable vehicle range means battery packs are getting bigger and are adding a significant amount of extra weight that automotive manufacturers must consider during the vehicle concept phase. The automotive industry needs to explore new lightweighting techniques to offset this additional weight to both optimize weight distribution and simplify the assembly of the BIW.

Performance

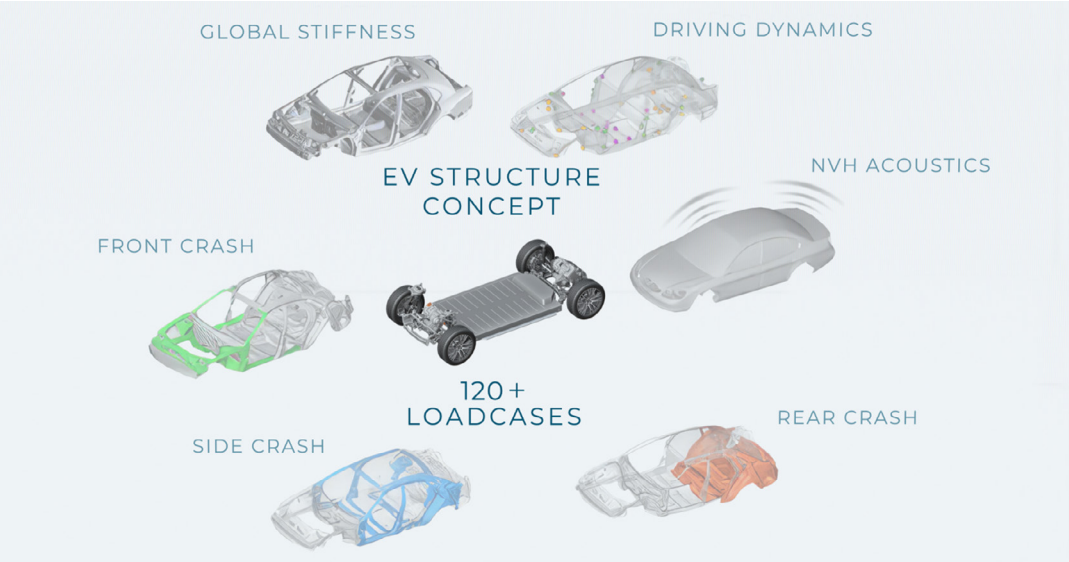
Overall vehicle performance includes stiffness, noise, vibration, and harshness (NVH), durability, and crashworthiness. This last aspect is especially important in EVs; manufacturers must design vehicles in which the battery is as protected as possible to minimize the battery pack's risk of physical damage and/or catastrophic failure during a collision event.

Manufacturability

A product's manufacturability is an essential part of the design evaluation process. While HPDC is well-suited for high-quality parts, the manufacturability challenges posed by the size and intricacy of mega- and gigacasting are entirely new. Here, the feasibility of such a large megacasting component addresses the overall design and optimizing process parameters to assure the quality of the component.

Sustainability

Every automotive manufacturer knows the necessity of implementing a circular economy by developing and exploiting efficient workflows to reduce waste and minimize carbon footprint. While lightweighting improves sustainability, megacasting poses additional sustainability challenges, which can be solved with the evaluation of lightweight structures and alternative materials such as recycled aluminium alloys.



WHAT IS AN AI-POWERED GENERATIVE DESIGN WORKFLOW?

Solution

Lightweighting

Manufacturing

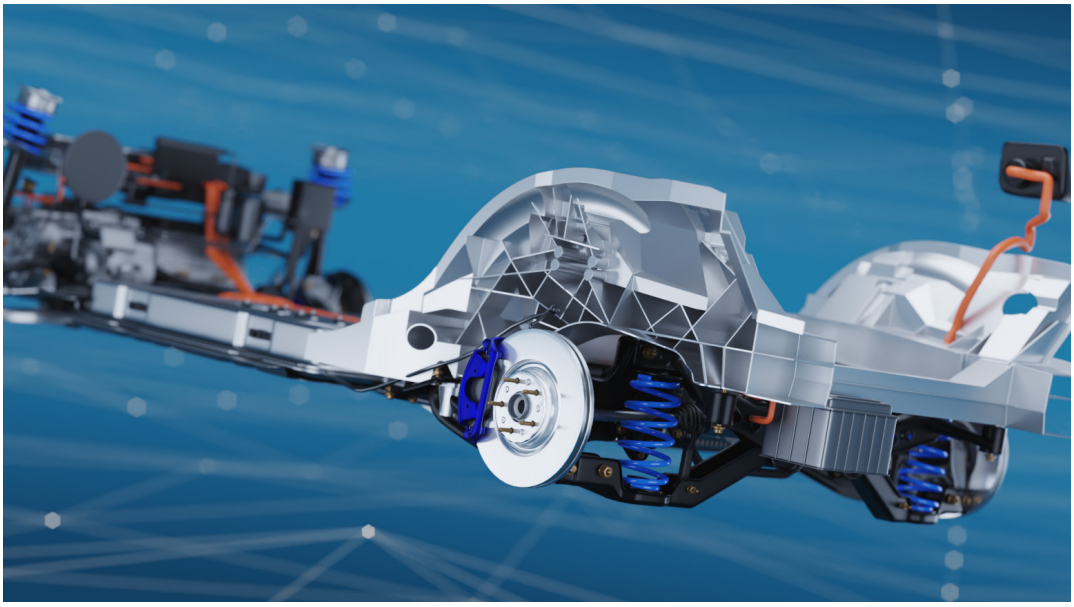
Altair prides itself on its legacy of long, successful relationships with key automotive OEMs around the world. When faced with how to best exploit megacasting's potential, we have addressed the challenges being faced to develop a bespoke solution using a range of tools via our extensive portfolio of AI, simulation, data analytics, and high-performance computing (HPC) solutions.

The solution, which we call an AI-powered generative design workflow, maximizes product efficiency while achieving performance targets and minimizing components' carbon footprint.

For lightweight design, we use topology optimization to generate the most efficient design alternatives and a response surface modeling (RSM) optimization approach that uses AI and machine learning to classify and cluster results of a large multidisciplinary optimization study.

By considering performance and manufacturability together early in the design process, we can assure the part's manufacturability, reduce casting defects, and analyze different product and process alternatives.

MEGACASTING FOR BATTERY EV BODY IN WHITE



The Battery Tray

The battery tray is a crucial multi-purpose component for vehicle safety and performance. In a nutshell, the battery tray secures the battery pack and protects it from in-service conditions that can damage it over time. A weight- and cost-efficient battery tray design increases passenger safety, ensures thermal management, protects the battery from the harsh under-vehicle environment and provides crash protection in an accident. The entire battery pack must also be produced within specified financial and weight constraints.

While BEV battery systems contribute to the vehicle stiffness, they can comprise around 25% of total vehicle weight. In addition, a conventional construction battery tray made of sheet and extruded sections can comprise around 20% of the battery system's cost and the weight. This is why the battery system is such a focus – teams want to reduce its weight without sacrificing its safety or performance.

Multi-Objective Topology Optimization

Employing a multi-objective topology optimization approach increases design freedom, giving designers the opportunity to explore a wider range of geometries, and offering them a chance to evaluate the trade-offs between disciplines and requirements.
To identify the requirements of a real-life BIW design battery tray, Altair's multi-objective topology optimization workflow uses a multi-objective approach to the design of the component's linear static performance, but also the crash performance and the manufacturability. In a recent collaboration with a world-leading automotive OEM, Altair's solution has enabled up to a 20% weight reduction in the battery tray.

AI-Powered Multi-Disciplinary Study

AI and machine learning helps to make sense of the enormous amount of data generated by the multi-objective optimization. This enables designers to understand the substantial number of simulations performed to optimize the design performance of the battery tray and its manufacturability while evaluating different design options very quickly.
Thanks to machine learning and AI-driven expert emulation, designers are able to quickly identify the cluster of designs that offer the optimal balance of weight, safe space, energy absorption, and manufacturability.

Casting Process Simulation and Optimization

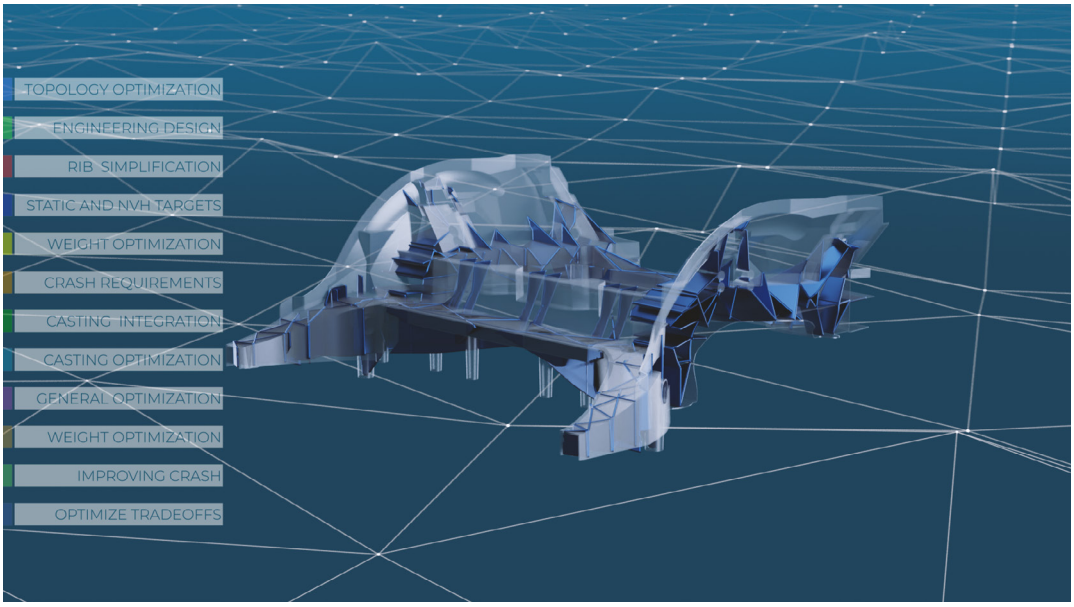
When it comes to the castability of the battery tray, not only can we simulate filling and identify potential manufacturing defects, but we can also optimize process parameters early in the design. As an example, optimizing the gating system – from where the molten material is injected into the mold – increases the part's overall quality and the robustness of the process.

With huge HPDC presses and tools needed to serial manufacture such large, complex geometry components, the ability to explore and understand the process to reduce the risk of tooling rework costs is a significant benefit of a simulation-driven design approach.

READ HOW ALTAIR SOLUTIONS ENHANCE AUTOMOTIVE MEGACASTINGS HERE.

What Did We Achieve?

In the study exemplified here, applying an AI-powered generative design workflow for a battery tray megacasting component achieved high performance for all structural targets, particularly for crashworthiness, which was failing in the baseline study. These results led to a 20% lighter design – which is vital for sustainability – and it was all developed in a much shorter period of time.



MAKING BETTER MEGACASTINGS WITH ALTAIR

Solution

Value

To release the full potential of large HPDC components, Altair combines industry knowledge with its innovative simulation, HPC, and AI technologies to develop a bespoke AI-powered generative design workflow. This workflow is now proven to successfully produce more sustainable parts by increasing design flexibility and improving parts' overall performance – all while assuring the manufacturability of the final casting. This workflow encompasses the multidisciplinary exploration of different design requirements. For automotive, these cover all aspects of mechanical performance, driving dynamics, NVH performance, and crashworthiness.

Being able to handle the thousands of simulations through HPC and cloud resources allows teams to save costs, unleash lightweighting, expand design freedom, and deliver innovative new concepts that meet all performance requirements.

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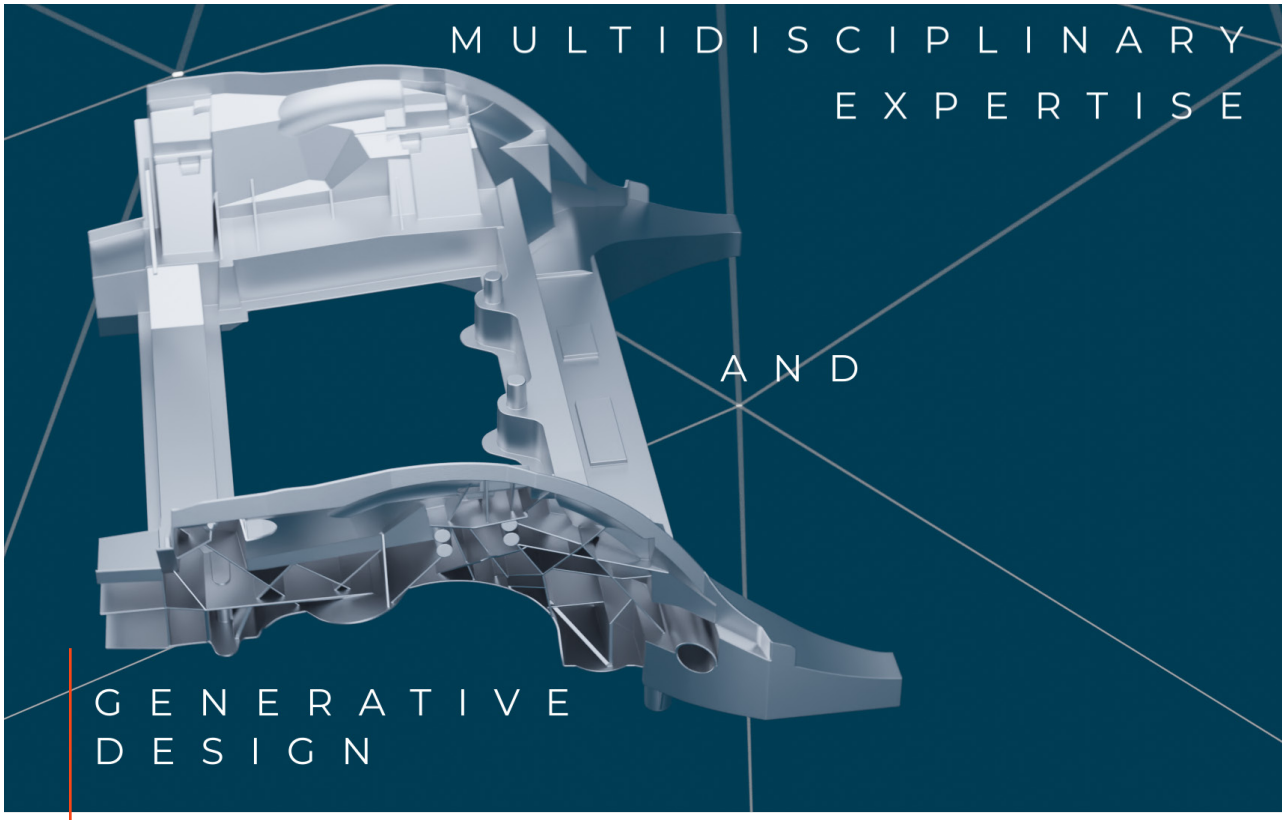

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WHY ALTAIR?

Altair offers a unique, comprehensive toolbox that converges simulation, HPC, AI, and machine learning.

With all the tools at hand for multidisciplinary exploration of design requirements while leveraging HPC for faster throughput, here's why Altair is your ideal partner to develop AI-powered generative design workflows:

Innovation: Altair provides a superior approach to achieve weight-optimized designs, better performance, and faster turnaround time compared with traditional workflows for body-in-white (BIW) automotive structures.

Integration: Altair's industry-ready workflow maximizes the efficacy of established automotive industry methods such as topology optimization and enhanced response-surface based (RSM) optimization by adding AI and machine learning techniques such as clustering and classification.

Customization: Altair's toolkit provides a customizable workflow for anyone exploring the benefits of mega- and gigacasting of complex structural parts via our unified, integrated platform. Discover a complete solution for state-of-the-art engineering simulation, AI, and HPC technologies, including advanced CAE capabilities and specialized solutions for automotive casting.

Learn More at:
altair.com/ai-powered-design

Altair is a global leader in computational intelligence that provides software and cloud solutions in simulation, high-performance computing (HPC), data analytics and AI. Altair enables organizations across all industries to compete more effectively and drive smarter decisions in an increasingly connected world – all while creating a greener, more sustainable future.

To learn more, please visit www.altair.com