Evolving Automotive Design From Traditional Methods to Modern Innovations with Complete Virtual Validation

Virtual Manufacturing Solutions | Brochure

Traditional car body design relied heavily on forming and standard steel parts, which made up over 80% of the materials used. Manufacturing was tightly controlled, ensuring parts were delivered within specified tolerances. Assembly teams, with extensive experience, could effectively address any issues, guaranteeing vehicle performance through well-established processes and a deep understanding of material and connection behaviors.

CO2 emissions and CO2 regulations increased competition in the EV market, stringent safety regulations, and budget cuts are driving significant changes in the automotive industry. These pressures have led to the rise of electric vehicles (EVs), with a focus on reduced overall body weight to compensate for the added weight of the batteries and to extend the range, while increasing percieved quality and crash performance. To achieve these goals, automotive OEMs have shifted towards innovative materials that are both strong and **lightweight**, while placing greater emphasis on styling and vehicle quality.

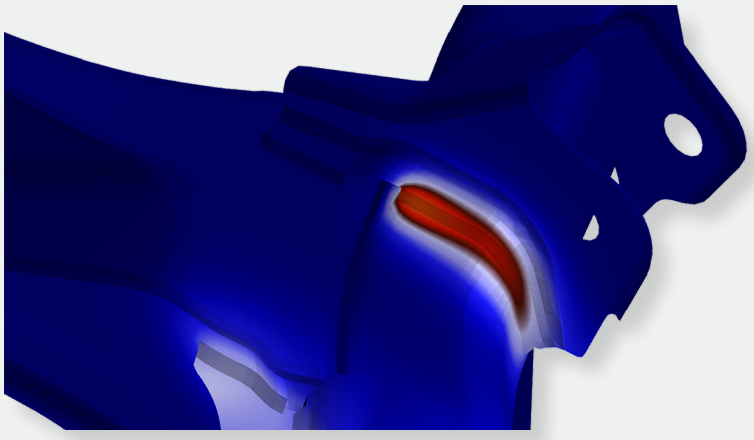
Addressing all these challenges within ever shorter development cycles would not be possible without a drastic rise of digitalization, as new materials respond differently to traditional manufacturing and assembly methods due to their unique compositions and properties.

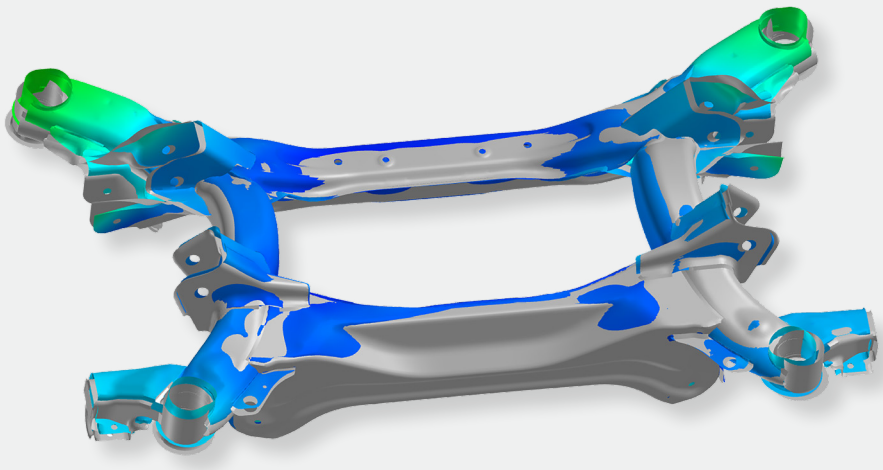
Therefore, it is essential not only to understand the manufacturing of these innovative components but also to evaluate their impact on existing assembly processes and, ultimately, how they affect the vehicle's overall performance.

Get Early Confidence through Virtual Engineering

Virtual body and chassis manufacturing simulation offers early confidence in selecting the right materials, manufacturing, and assembly processes before any physical production begins. This proactive approach ensures that the final product meets all quality and performance standards efficiently and cost-effectively.

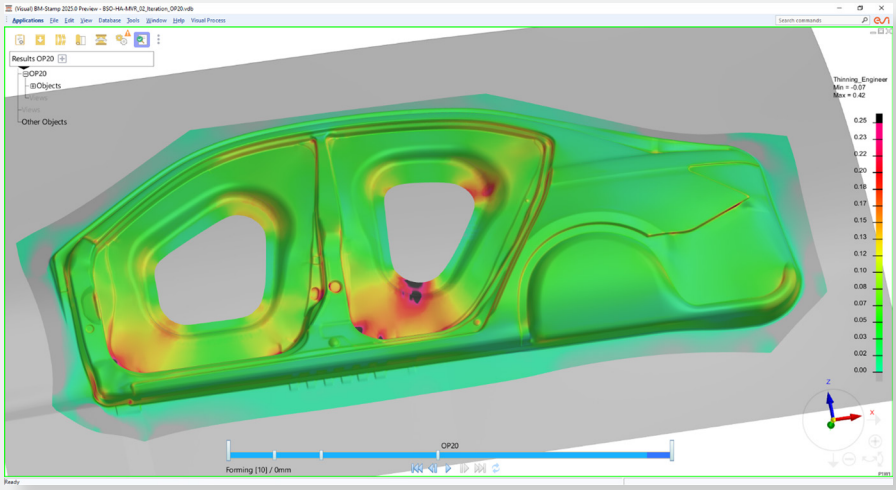
By exploring both common and novel materials and processes, **virtual engineering** ensures components meet specified (quality) criteria, including geometrical tolerances, strength, surface quality, cost, and robust manufacturability. This significantly reduces physical try-out time, cost, and effort.





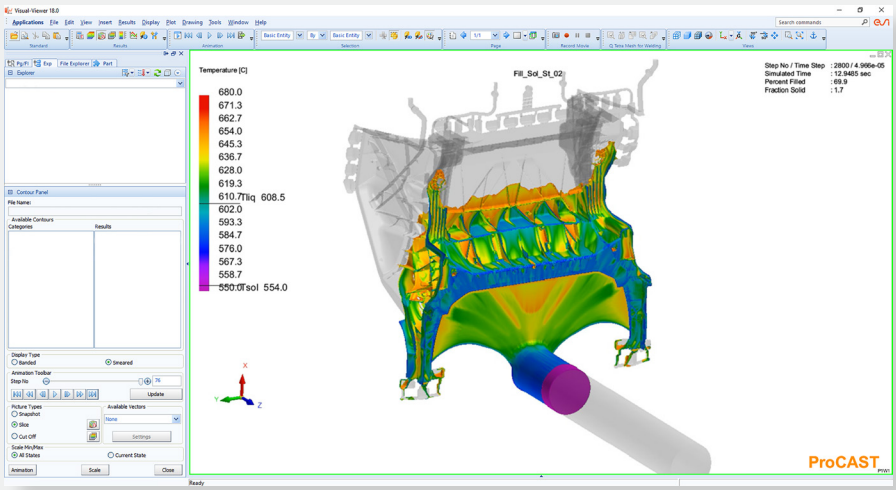
Key Applications of Simulation for Body and Chassis Manufacturing

Stamping Process Validation: Effectively validate sheet metal formability with a dedicated tool for modeling the key stamping processes used in the automotive industry, including line & transfer die processes and press hardening processes. **Predict, control, and optimize** component formability, geometric distortions (springback), and cosmetic surface quality during the stamping process validation phase.



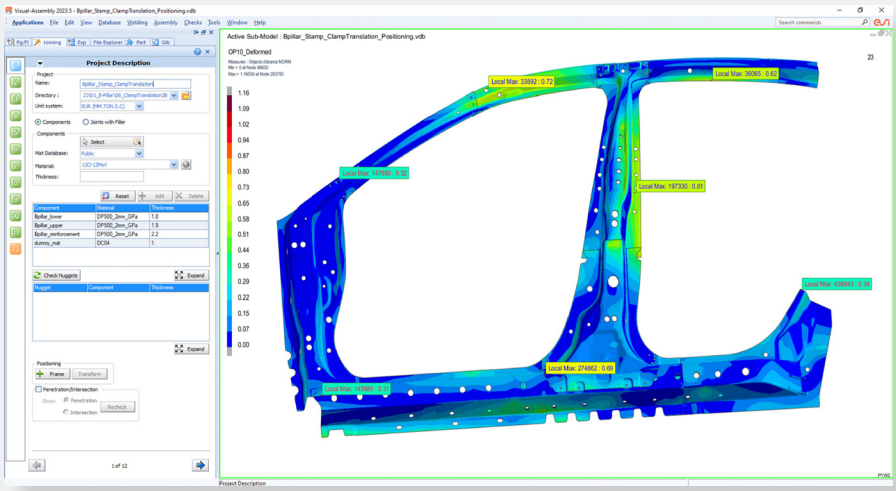
Identified cracking during the draw operation

Body Casting Process Validation: Simulate the entire aluminum (high pressure) die-casting process to create sound quality castings, from small structural parts to large **Mega/Giga casting** components. Engineers can evaluate multiple design alternatives early on, align die temperatures with reality, design and optimize the injection system, avoid shrinkage porosity during solidification and misruns, and virtually check dimensions and part performance both as-cast and after heat treatment. This process also forecasts mechanical properties and die fatigue life.



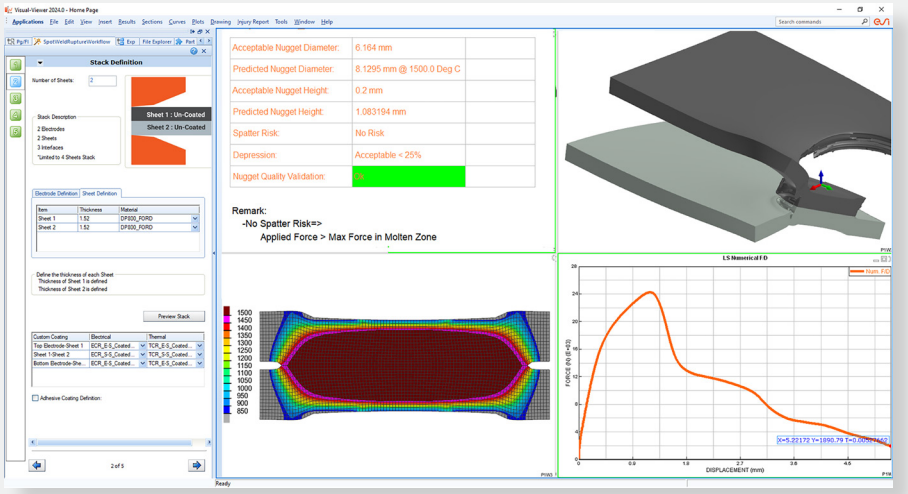
Temperature distribution during filling of a Mega casting

Assembly Distortion Engineering: Ensure welding and assembly designs of the highest quality and within dimensional tolerances. Analyze every step of the assembly process, from initial design checks based on nominal CAD data to pre-production optimization using scanned component data. Virtual assembly engineering allows to predict, control and **minimize distortions** resulting from gap closing and joining processes through adjusting clamp sizes and positions, optimizing clamping and joining sequences and/or compensation of the most influential parts to non-nominal geometry in order to force the entire assembly to be within tolerance.



Simulated assembly distortions of a bodyside assembly (vs. reference)

Local Joining Performance Validation: Ensure strong, durable spot welds by virtually predicting weld quality and strength. Simulation enables engineers and cross-disciplinary teams to explore, validate, and resolve real-world manufacturing and crash issues. **Predictive multi-physics simulations** allow unlimited try-outs for finding the optimal welding process parameters for both similar and dissimilar material combinations, provides a detailed assessment of the valid operating process window (weld lobe) and enables validation of the connection strength.



Accurate prediction of the weld connection strength based on 'as-welded' conditions

Benefits of using Simulation for Body & Chassis Manufacturing

Increase Innovation Power: Through virtual prototyping, it is possible to create virtual process chains that enable the **exploration of new materials** and their related manufacturing processes, as well as their effects on assembly and overall vehicle performance, without incurring costs for materials, tools, or equipment.

Competitive Advantage: By ensuring robust, high-quality production processes resulting in **defect-free components and optimized assemblies**, virtual prototyping enhances reliability and product quality, positioning manufacturers as leaders in their industry. This technological edge supports competitive differentiation and market leadership.

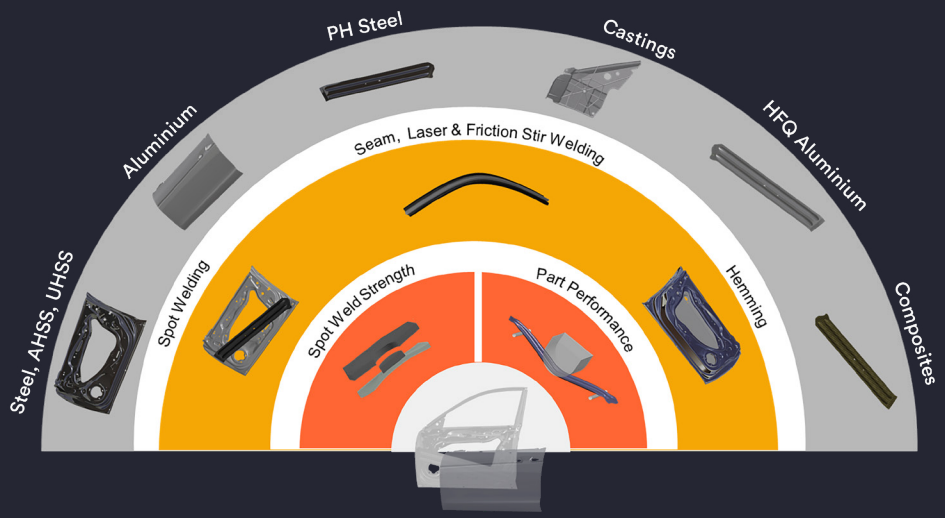
Weight Optimization and Material Efficiency: Virtual prototyping enables the exploration and **validation of lightweight manufacturing and assembly processes**, optimizing the design for reduced body weight without compromising on strength or performance. This leads to more efficient and sustainable vehicle designs.

Cost and Time Efficiency: Virtual prototyping significantly reduces the need for physical prototypes and iterative testing, resulting in substantial cost and time savings. It allows for **early identification** and resolution of manufacturing defects and process inefficiencies.

Discover how ESI's Body and Chassis Manufacturing Simulation software can be used to support Automotive manufacturing engineering process.

Body and Chassis Manufacturing Simulation:

Learn more



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