Mastering Assembly Distortion Engineering in Body & Chassis Manufacturing
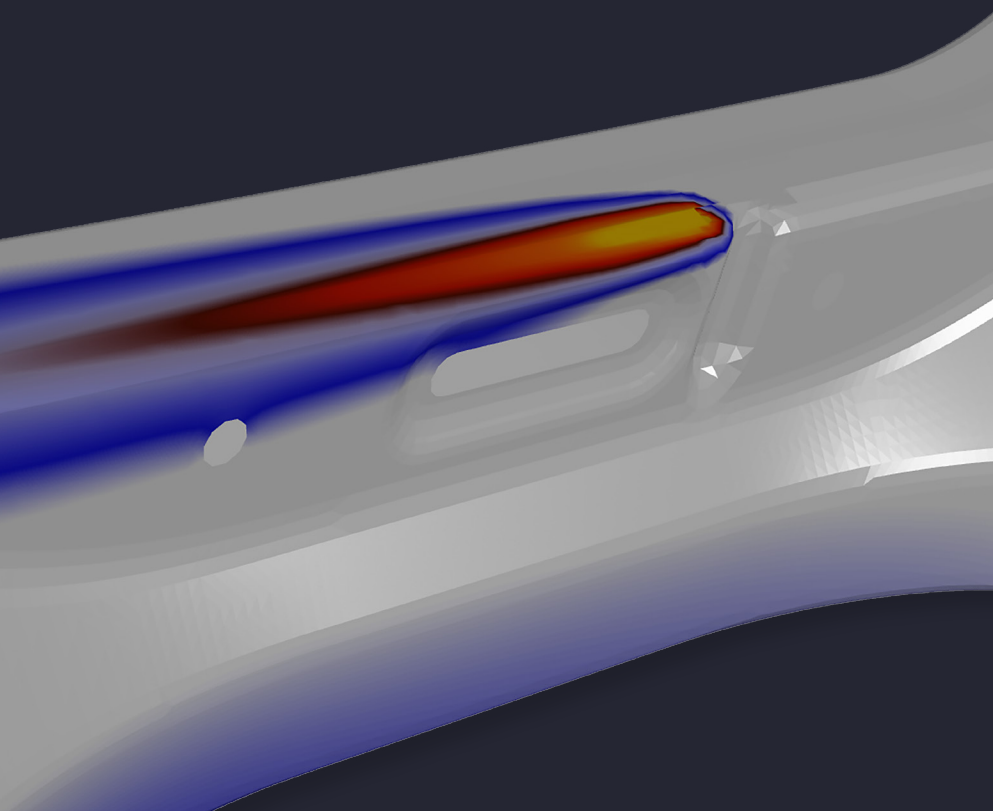
Keeping the Assembly Within Tolerance!

Assembly distortion engineering focuses on the precise alignment and fitting of components to ensure overall structural integrity and performance, and involves predicting, analyzing, and mitigating distortions that occur during the various welding, joining, and assembly processes. Effective assembly distortion engineering not only ensures the manufacturability, durability and safety of the final product but also contributes to cost savings and improved efficiency in the manufacturing process.

Elevate Assembly Precision and Efficiency with Simulation

For designers and assembly process planners, simulation allows **virtual testing of assemblies** long before physical components are produced. Simulation supports each step of the assembly process, from early design checks using nominal CAD geometry and early simulation data, to assembly process validation with validated simulated components, and pre-production optimization using scanned (physical) part data.

From resistance spot welding of body components to arc welding of chassis and suspension members, and from hemming of doors and closures to friction stir welding and laser welding for battery boxes, each process has unique characteristics that impact overall assembly geometrical quality. Simulating these processes enhances the **predictability** of final dimensional distortions and enables effective countermeasures, ensuring the final product meets stringent geometrical quality specifications.

By engineering an assembly process that ensures that the final product meets the geometrical specifications by accounting for unavoidable geometrical deviations from the nominal shape for manufactured individual components, the gap-closing effects during the positioning and holding stage, the clamping and welding sequences and the heat effects induced by the various welding processes enhance both **efficiency and precision** in the manufacturing process.
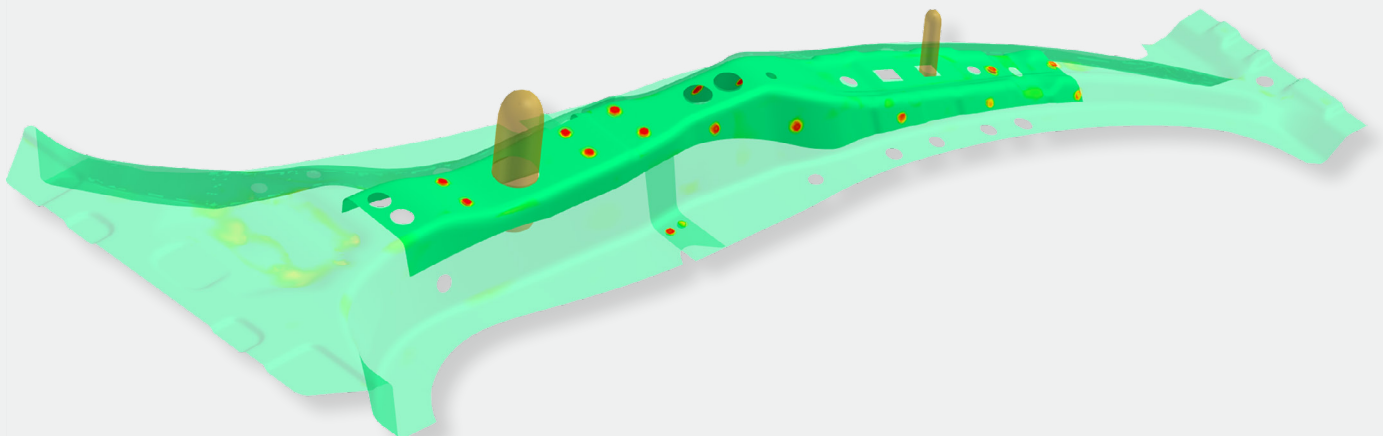
Key Applications

Analyze and **minimize distortions** during the pre-positioning and clamping stages by **adjusting locating and clamping sequences.**
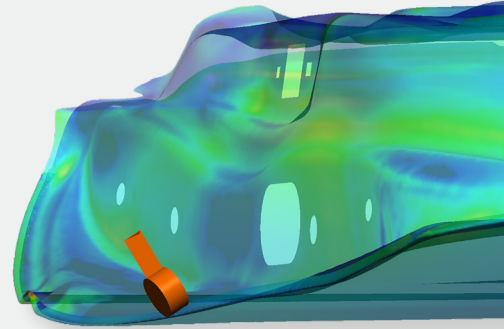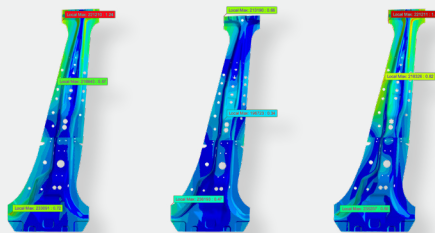
Progressively **upgrade your input data** when it becomes available: replace nominal CAD with simulated geometries and/or scanned parts.

Optimize the **location, shape and number of clamps.**

Minimize the distortion after welding by **optimizing the weld sequence.**

Analyze **gap distance** after closing.

Check for overall distortions after unclamping and compensate through **part compensation or clamp position & join sequence** (shimming and teaching).

Minimize residual stresses, **increasing operational life.**

Virtually optimize the weld process parameters to **minimize distortions while ensuring high weld quality.**

Spot and eliminate typical hemming defects, such as excessiveroll-in, gap and flush quality and wrinkles.
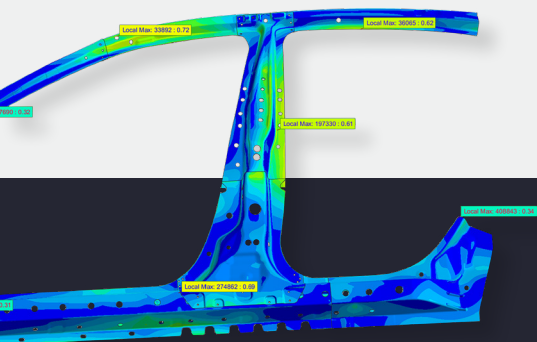
Validate the design of the **positioning fixture** (RPS).

Determine minimal required **clamping forces.**

esi

Achieve Perfect Alignment: Key Values of ESI Joining & Assembly Simulation Software for Assembly Distortion Engineering

Ensure the Final Assembly is Within Specified Tolerances: Predict and minimize final assembly distortions, by predicting the impact of process settings and gaps between components on the overall assembly distortions by applying **fully virtual engineering**.

**Minimize Overall Assembly Engineering Cost and Time:** Detect assembly issues at early stages where the cost of changes is still low. Explore lower-cost assembly process alternatives through **unlimited virtual tryouts**. Order fixtures with fewer iteration loops.

Minimize the Number of Physical Prototypes: Save on time, cost, and waste through virtual modeling and achieve **higher predictive confidence** in the engineered assembly process.

Avoid Over-Engineering of Single Components: Single components perfectly within tolerances do not guarantee an assembly within tolerances! Instead, apply a **manufacturing-for-assembly** strategy and find the best shape to guarantee the final assembly to be within specifications.

Support Evidence-Based Countermeasures: Provide simulation results that **validate and enhance** the assembly engineer's intuition and experience.

Shorten Lead Time in Pre-Production: As testing can be done **fully virtual** based on the available scanned data, there is no parts or production lines to become available for testing.
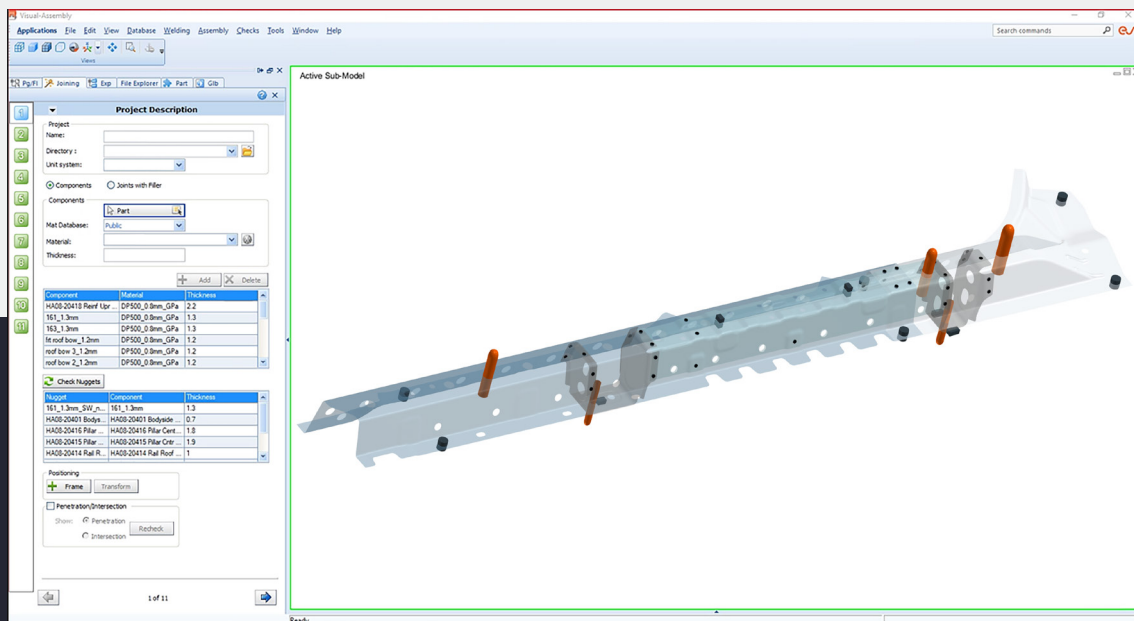
Intuitive **process-oriented workflows** enable the exploration of numerous weld and joining process alternatives and the management of tolerances from planning to fabrication validation before manufacturing any physical jigs or tools.

By combining **accurate physics modeling** with powerful parallel computation capabilities, simulation enables fast turnaround times and unlimited virtual try-outs, ensuring an optimal assembly process.

Discover how ESI's Joining & Assembly Simulation software can be used to support in the assembly distortion engineering process.

Welding & Assembly Simulation Software:

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