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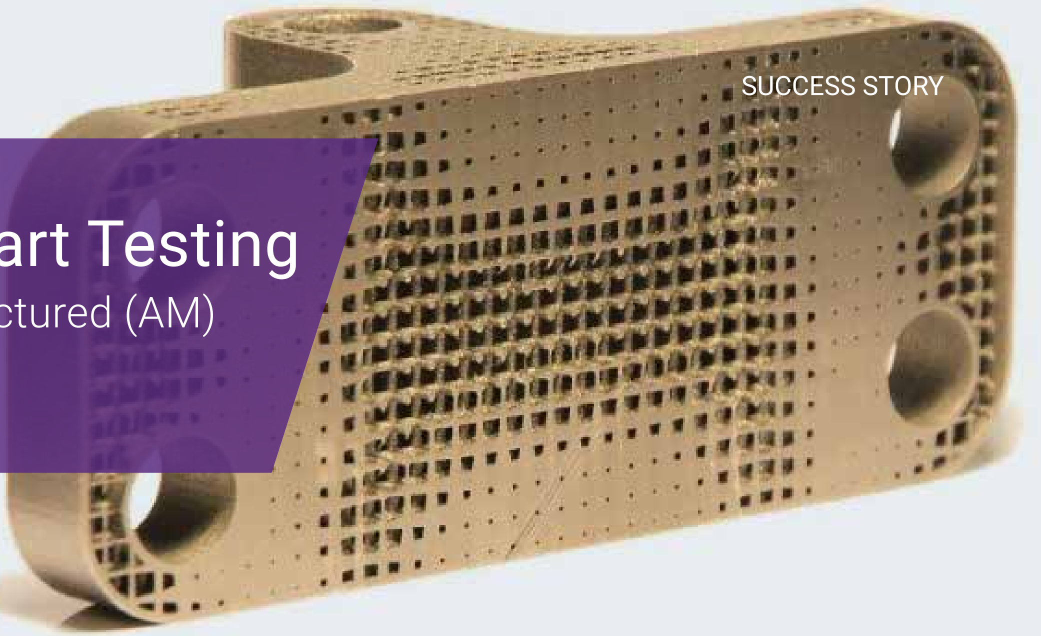


Optimizing AM Part Testing

Verifying Additive Manufactured (AM) Parts from 3D CT Scans

“The Simpleware model reconstruction provides an essential solution to assess the usability of an AM produced part. The effect of a defect or geometry deviation in a critical location can be quantified. Based on a comparison to the nominal CAD geometry the impact on structural integrity and fatigue life can be evaluated. This workflow provides a key solution to determine the disposition of an AM produced part with deviations from the nominal design.”

~Paul Badding, Mechanical Design Section Head at Moog

Thanks to: NORTH STAR IMAGING NSI AN ITW COMPANY, ANSYS®, MOOG

At a Glance

- Workflow enables validation and inspection of high-value AM parts
- Go from computed tomography imaging to computer simulation
- Compare reality and as-designed part through metrology and multiphysics simulation
- Increase your understanding of AM capabilities for extremely complex designs
- Evaluate impact of manufacturing defects on part performance to better inform design decisions

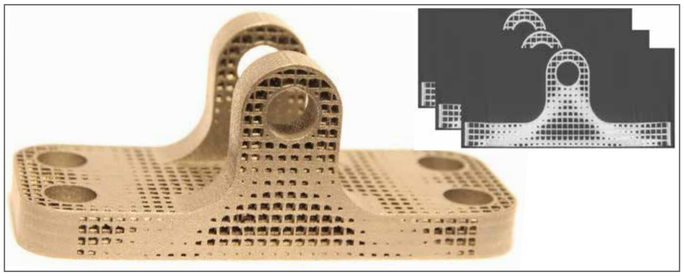
Overview

Additive Manufacturing (AM) enables optimized parts to be created, for example with lattices that save weight. Finite element analysis (FEA) is valuable for simulating the performance of parts at the design stage. After manufacture, scanning components allows inspection of defects. However, while many manufacturers and designers use some of these methods, they typically lack a straightforward workflow to combine all of them and close important gaps in production.

North Star Imaging (NSI), Synopsys, and ANSYS have developed a methodology that solves this problem. Going from a 3D computed tomography (CT) scan of an AM part to a completed simulation is achieved by using Synopsys Simpleware™ software as a crucial bridging technology that generates high-quality meshes from CT scans. Results from test workflows show the differences between as-designed and as-manufactured parts, catching unexpected defects early in the design stage and saving on long-term costs caused by manufacturing errors.

Capturing the Part Geometry

This workflow was successfully tested with a project involving the University of Pittsburgh. Albert To's team at Pittsburgh used ANSYS to re-design a bracket geometry with a weight-saving lattice. An EOS direct metal laser sintering (DMLS) printer was used to create physical titanium and aluminum models. NSI then used a CT scanner to obtain high-quality images of the models, with work completed in less than 2 hours.



Additively manufactured titanium alloy bracket built for the University of Pittsburgh, and stack of CT image data generated by NSI

CT Data Processing

The CT data was imported to Simpleware software for processing and model generation. The software captures the 'as-manufactured' aspects of a design and segments out regions of interest from the part. An optimized 3D surface, with no gaps or overlaps, was exported as a high-quality volumetric finite element (FE) mesh, avoiding the time-consuming need for remeshing in another software package.

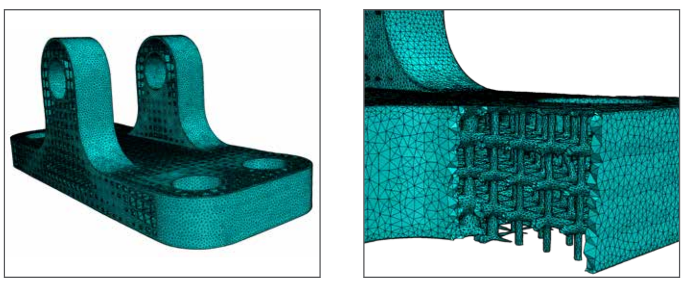
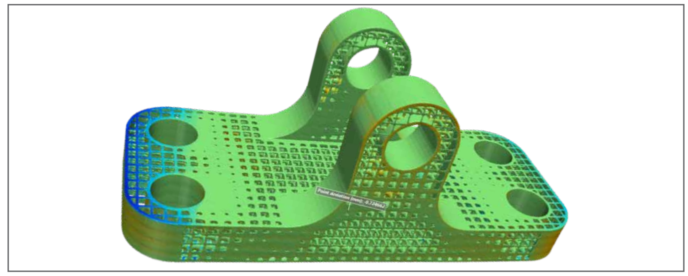


Image-based segmentation and meshing in Simpleware software

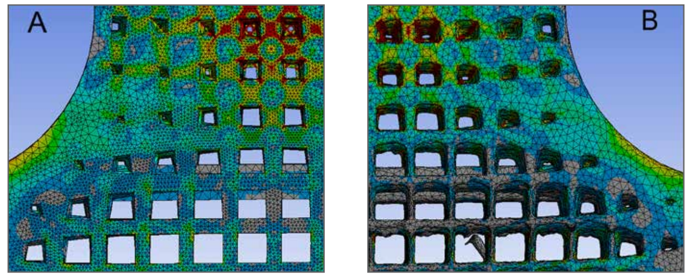
Inspection and Simulation

Landmark and automatic registration tools in Simpleware software were used to compare the deviation between the scanned part and the original CAD design. Results allowed the detection of unexpected errors at an early stage of the design process.

The volume mesh was directly imported from Simpleware software to ANSYS Mechanical to carry out structural simulation. Results showed that the printed component still performed well compared to the CAD model and met testing requirements. The method was therefore successful at understanding how identifying defects at the design stage can help increase confidence in manufacturing decisions.



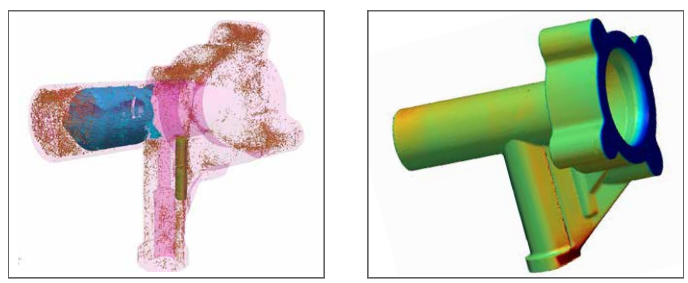
Deviation analysis in Simpleware software between original CAD geometry and image-based STL using color mapping



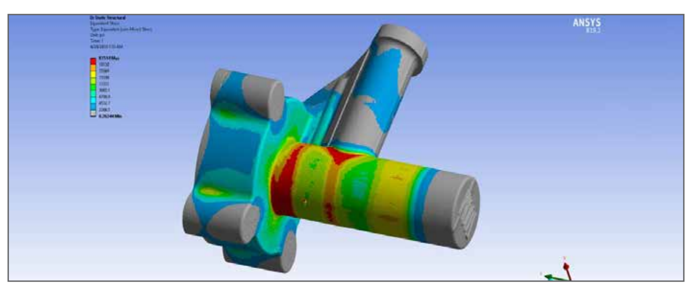
Comparison of stress in CAD model (A) and scan model (B) in ANSYS Mechanical

Case Study: Moog

This workflow has been used by Moog, Inc. for part inspection. Moog optimized the design of an impulse pressure manifold for a specific material and hydraulic fluid configuration. The AM manifold was CT scanned by NSI and the 3D images processed in Simpleware software. Inspection revealed pores, cracks, and other defects in the AM part compared to the original CAD design. FE simulation in ANSYS Mechanical then detected stress deviations that allowed Moog to re-evaluate their original CAD design and quantify fitness-for-purpose.



Visualization and processing of CT data and deviation analysis between CAD and CT data in Simpleware software



Simulation of maximum principal stress in ANSYS Mechanical