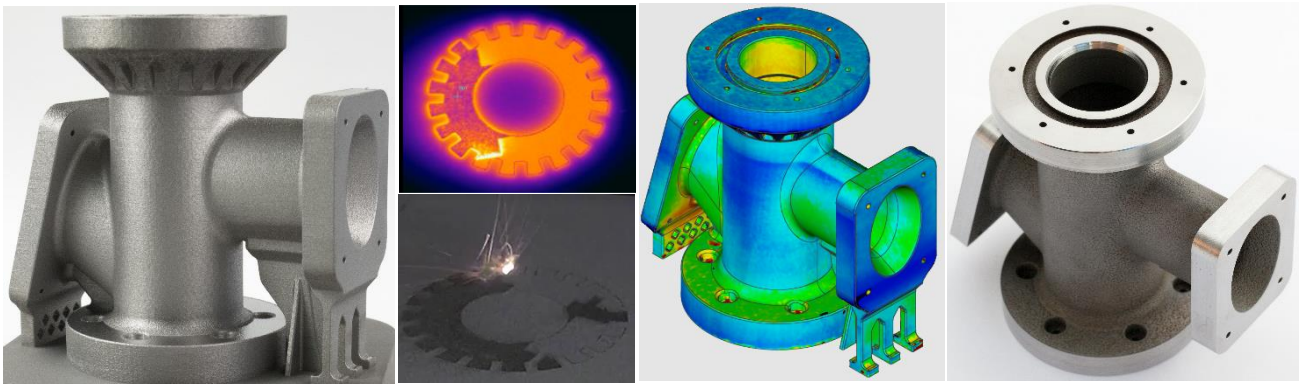
Case study:

Component level simulation of selective laser melting process – VTT Pipe

VTT has been testing AM process simulation tools for inclusion in their design for AM workflow. Through these tests, Additive Works' Amphyon software was found to predict component level geometric distortion values that corresponded well with measurements, give indication of potential print failure due to recoater contact, and is easy to learn and use.



Metal AM at VTT

VTT has been working closely with their customers to help identify advantageous use cases for additive manufacturing (AM) and introducing efficient, simulation-driven design for AM workflows. The objective is always to produce accurate components with "first time right" manufacturing. In order to achieve these goals, VTT is investigating the incorporation of AM process simulation tools within their design workflows. Currently, VTT is conducting a benchmarking study of several commercially available AM process simulation tools. Additive Works' Amphyon software has been included in the initial benchmark tests with promising results.

Pipe component test case

VTT designed a mock-up SLM test component for assessment of printability and geometric accuracy both before and after machining. The part was designed to be representative of a typical industrial component and challenging to print. The inclusion of overhangs and thick sections mean that the part requires carefully designed support structures and controlled thermal input for successful manufacture. The component has been printed several times with variations in material, process parameters, and upper collar support design. Experimental data collected during and after printing includes time-lapse video, FLIR thermal imaging, and geometric accuracy measurements with both Mitutoyo Legex 9106 and FARO laser scanning. More information about the test case can be found on the webpage below.

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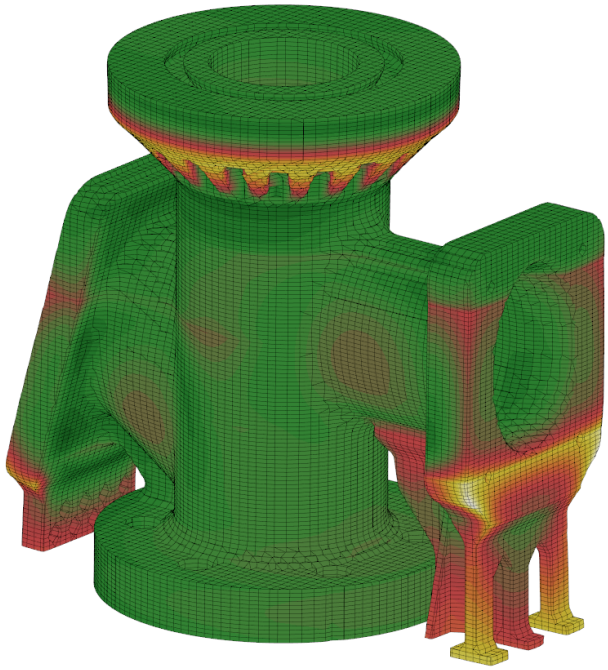
Simulation of the SLM process during the design phase can help ensure accurate components and “first time right” manufacturing.



Simulation objectives

The goal of utilizing AM process simulation tools during design is to improve component performance and reduce the likelihood of build failures. Amphyon process simulation tools can help achieve this objective in several ways:

- Estimation of component-level distortions after the build and support removal; with tools available to compensate for these manufacturing induced distortions to achieve improved geometric accuracy
- Prediction of print-direction distortion during printing to help identify potential recoater interference (common cause of build failure)
- Estimation of component stress state after manufacture

Experimental data

Two versions of the printed pipe component are being utilized for the AM process simulation benchmarking. Denoted with print IDs 171 and 172, the components are identical except for a variation in the collar support for the upper flange. It was found that the design in run 171 was more efficient in conducting heat away from the flange. The result of this was that run 171 printed successfully, while in run 172 the large heat build-up during the printing of the flange caused the part to lift out of the powder bed and collide with the recoater blade.

Simulation result

The two VTT pipe cases (runs 171 and 172) were simulated using Amphyon software to simulate the selective laser melting process. A test cantilever geometry was printed using the exact material and process parameters used in creation of the pipes in order to calibrate the models.

Simulated distortion levels for both print geometries matched the measured FARO values well. Peak mid-print displacement levels in the print direction were predicted where recoater contact was observed in the time-lapse video for run 172. Furthermore, the print-direction displacement was 10% greater in the failed case as compared to the successful design. In summary, it was found that the software was easy to use, simulation times were fast (less than 2 hours on standard PC), and useful information could be obtained to help achieve VTT’s “first time right” goal for design and manufacture of additive manufactured components.

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