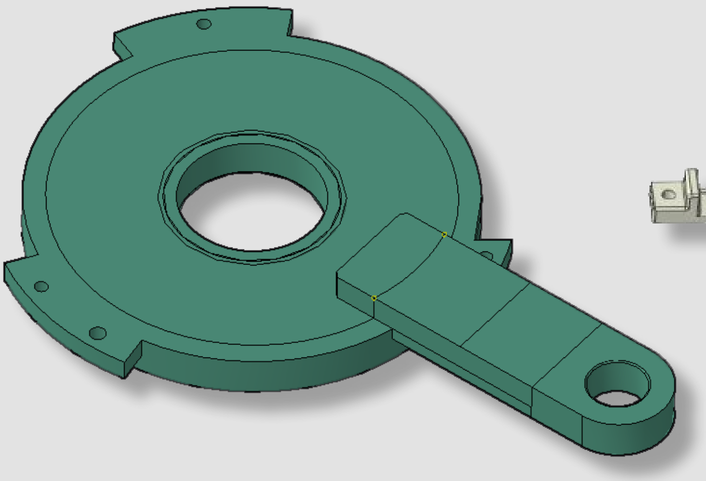
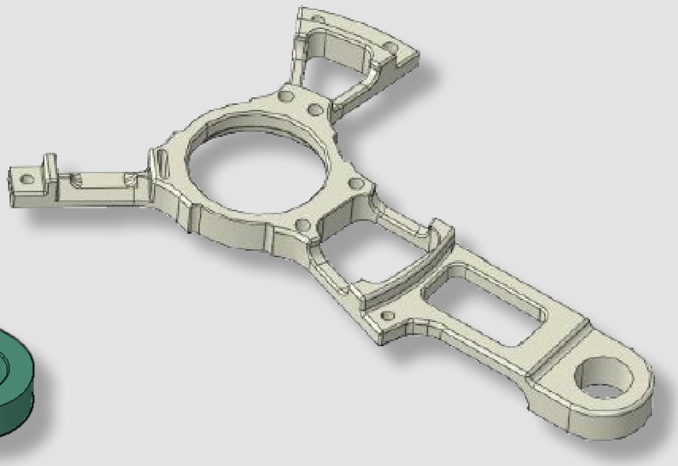
Case study

Overcome additive manufacturing issues by process simulation



Traditionally (casted) manufactured fixture tool component



70% reduction in the weight (After topology optimization)

Project scope

Robert Bosch employs a fixture tool, which is used in manufacturing industries for many applications.

- Yearly 200 units of fixture tool need to be produced for assembling various parts. Until recently, fixture tool used to be manufactured by a conventional casting process. To save tooling costs and time, the idea was born to produce the parts by additive manufacturing methods.
- Main objective: Replace formerly casted parts by an additively manufactured part
- There is a scope for making lightweight structures for this process.

Solution approach

Topology Optimization

By applying topology optimization methods, using TOSCA and Abaqus, Bosch engineers re-designed the parts – following the objective to develop a lighter Fixture tool with adequate stiffness, aiming at a cost reduction by lowering material usage and power conception.

As a result, the Bosch engineers managed to integrate the formerly 2 parts into just one part and to reduce the weight by 70%.

Challenge:
Avoid additive manufacturing issues (distortion, residual stress) and establish a "right first time" manufacturing process.

Solution:
Build process simulation helped Bosch to predict manufacturing issues and to find the right countermeasures to optimize the AM build process

Products used:
Simufact Additive

Customer:
Robert Bosch Engineering and Solutions Pvt

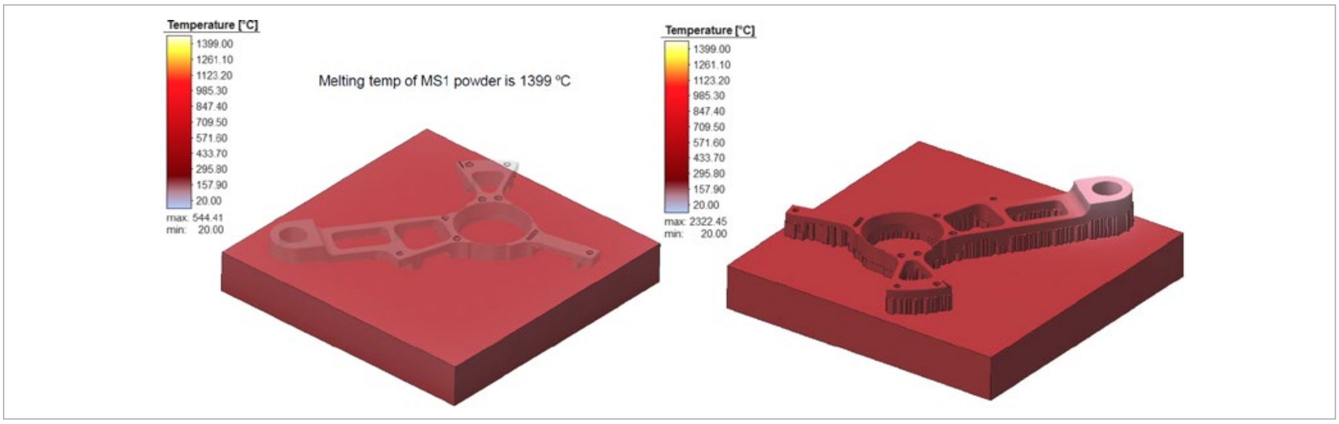
Additive Manufacturing challenges

- The magnitude and distribution of the residual stress from additive manufacturing varies with the process details, such as process type, build rate, build sequence, amount of constraint, etc.
- Highly localized heating and cooling during the process produces non-uniform thermal expansion and contraction, which results in a complicated distribution of residual stresses in the heat affect zone and unexpected distortion across the entire structure.
- The residual stresses may promote fractures and fatigue and induce unpredictable buckling during the service of printed parts.
- Therefore, it is vital to predict the behavior of materials after the process and to optimize the design/ manufacturing parameters.

Additive Manufacturing process simulation

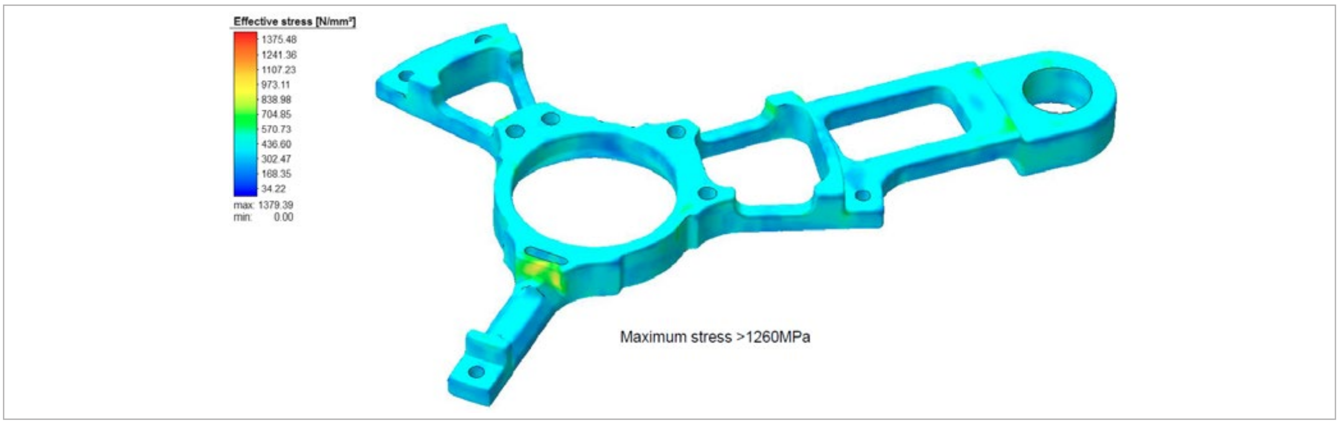
Bosch engineers employed Simufact Additive process simulation software to model the AM build process and the subsequent post-processing steps. The initial virtual try-out predicted severe manufacturing issues:

For the optimization of the build process, the engineers used the pre-compensation method aiming at a part geometry within distortion tolerances. In addition, Simufact Additive optimization methods for the build process (e.g. support structure optimization) and post-processing (e.g. cutting strategies, support removal strategies) have been used to improve the manufacturing process.



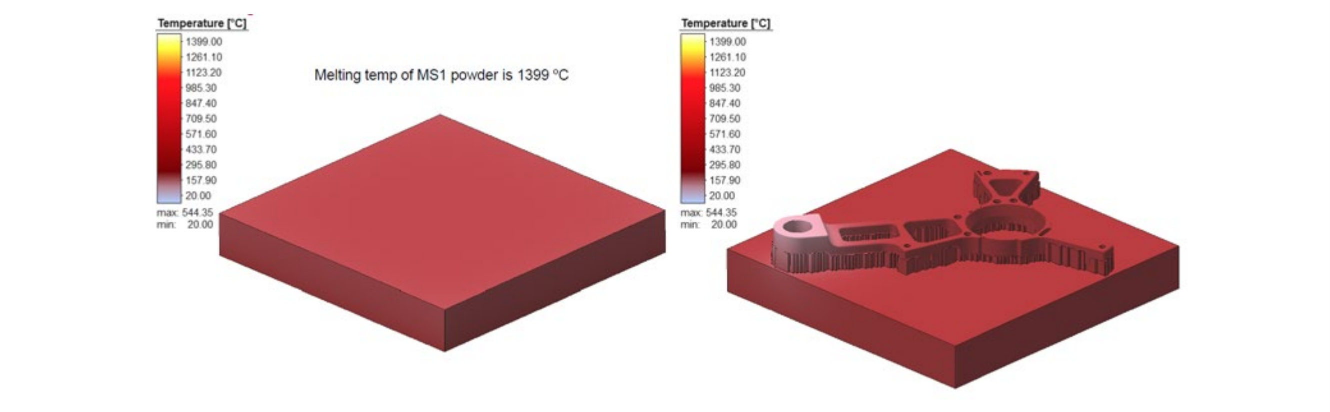
1. Melting temperature of 1399°C is ensured throughout the simulation process to avoid the thermal issues.

2. Final part distortion running out of tolerances, exceeding 3.5 mm



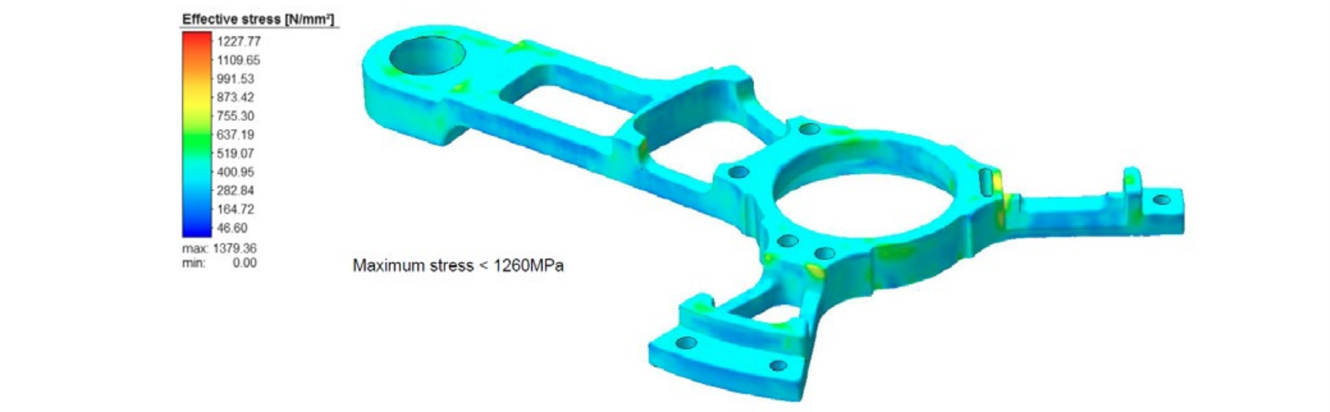
3. Final part effective stress exceeding 1,260 MPa

Results:



1. Melting temperature of 1399°C is ensured throughout the simulation process to avoid the thermal issues.

2. Final part distortion running out of tolerances, exceeding 3.5 mm



2. Effective stress: Maximum stresses are below the yield strength limit of 1260MPa

At a glance: Benefits from AM simulation

1. Identify and reduce residual stress and distortion
2. Predicted influence of several components in build space
3. Determine best build orientation by performing sensitivity studies
4. Reduce physical iterative process
5. Higher productivity and reduction of total time for AM

Summary:

Bosch India has replaced cost-expensive low-volume tool production (casting) by tool-less additive manufacturing. By re-design and topology optimization, the Bosch engineers managed to integrate functionality of formerly 2 parts into 1 part and at the same time reducing the weight by 70%. Process simulation with Simufact Additive helped the engineers to overcome additive manufacturing issues (distortion, residual stress) and to establish a manufacturing process "first time right".

"Additive manufacturing simulation methods helped in achieving a lightweight structure, distortion-free model, without residual stresses, which is more helpful to the AM designers to print the parts physically first time right."

Radhakrishnaiah Bathina,
Technical specialist, Bosch India

Robert Bosch Engineering and Business Solutions Private Limited is a 100% owned subsidiary of Robert Bosch GmbH, one of the world's leading global supplier of technology and services, offering end-to-end Engineering, IT and Business Solutions.

With over 19,000 associates, it is the largest software development center of Bosch, outside Germany, indicating that it is the Technology Powerhouse of Bosch in India with a global footprint and presence in US, Europe and the Asia Pacific region.

simufact engineering gmbh
Tempowerkring 19
21079 Hamburg, Germany
Phone: +49 40 790 128-000
info@simufact.com

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Simufact, part of Hexagon's Manufacturing Intelligence division, applies simulation and process knowledge to help manufacturers optimise metal forming, mechanical and thermal joining and additive process quality and cost. Learn more at simufact.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.