

CHALLENGE:

- Avoid additive manufacturing issues (distortion, residual stress) and establish a “right first time” manufacturing process.

SOLUTION:

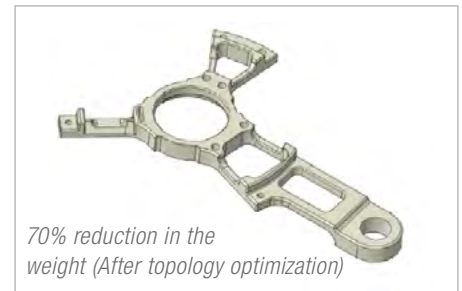
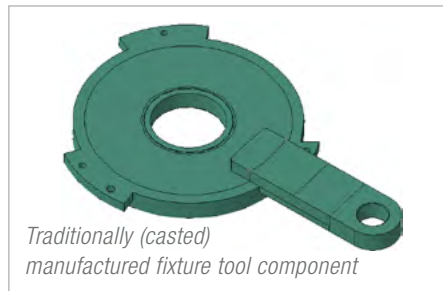
- Build process simulation helped Bosch to predict manufacturing issues and to find the right countermeasures to optimize the AM build process.

PRODUCTS USED:

- Simufact Additive

CUSTOMER:

- Robert Bosch Engineering and Solutions Pvt Ltd



Overcome additive manufacturing issues by process simulation

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

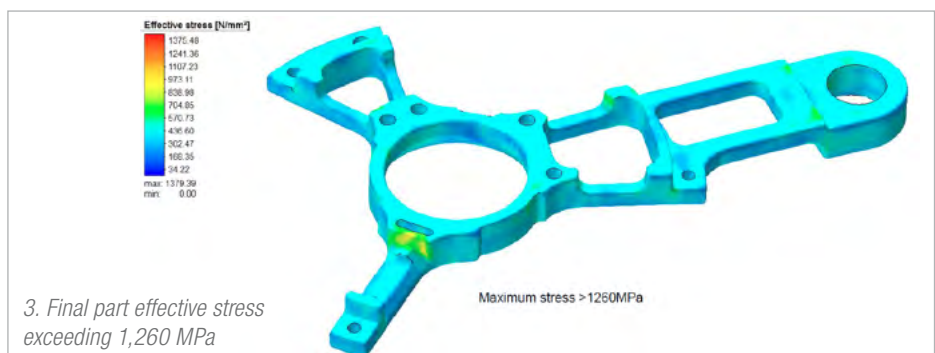
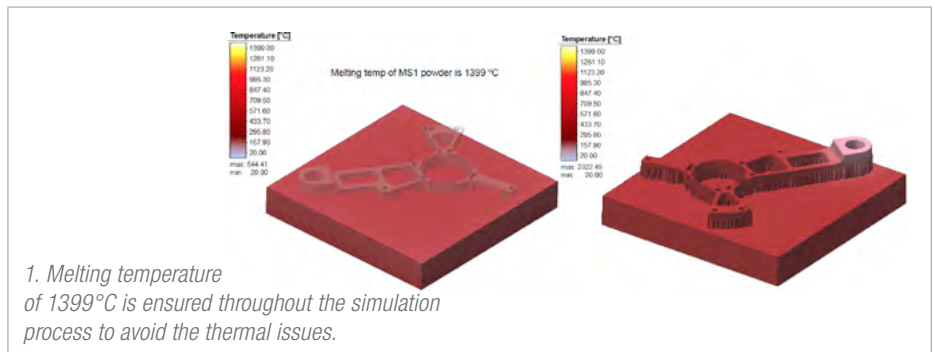
By applying topology optimization methods, using TOSCA and Abaqus, Bosch engineers re-designed the parts – following the objective to develop a lighter Fixture tool with adequate stiffness, aiming at a cost reduction by lowering material usage and power conception.

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

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.



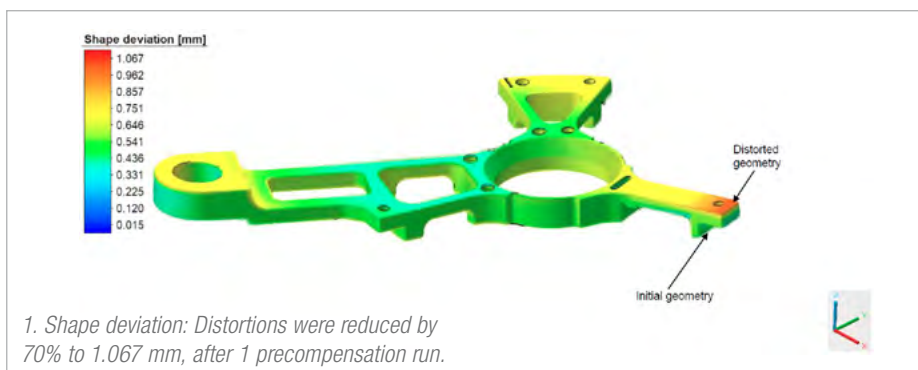
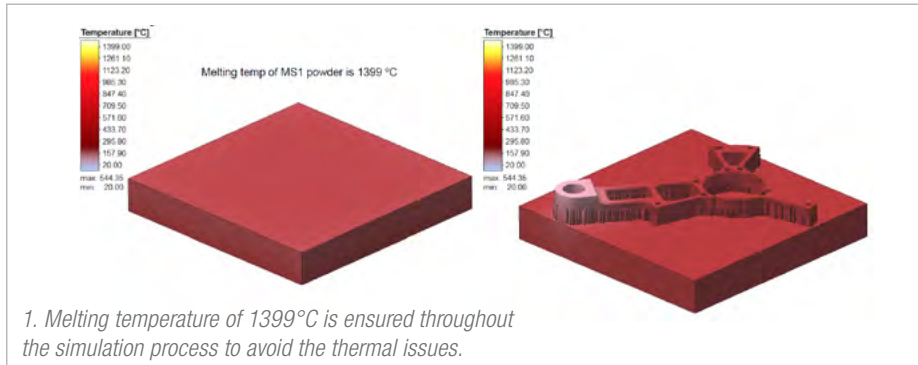
Additive Manufacturing process simulation

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.

Results:



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

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