AMRC
Design and Prototyping Group

The University Of Sheffield.

Advanced Manufacturing Research Centre

BOEING

Case Study

Correcting CAD models for SLM build defects

The Design and Prototyping Group (DPG) at the Advanced Manufacturing Research Centre (AMRC) has successfully investigated methods of correcting CAD models for selective laser melting (SLM) build defects as part of the Symbionica project. The Symbionica project aims to develop a reconfigurable machine for the hybrid additive and subtractive manufacturing of next generation fully personalised bionics and smart prosthetics.

SLM build defects

The maturity levels of different additive manufacturing (AM) technologies vary. Selective laser melting is an established technology and its usage is gradually increasing in industry, however build defects can still occur. One defect mode is the warping of the component while it is being manufactured. It is caused by the material slightly reducing in size while cooling down. Each sintered layer is heated to a high temperature while the layer underneath is always cooler. As the top layer cools down it contracts. This results in the material from below being pulled and the components warping.

Nominal build analysis

DPG investigated the additive manufacture of the two configurations of a conceptual customisable spinal cage CAD model. A Renishaw AM250 machine was used to manufacture the components using SLM.

Following manufacture, these components were CT scanned using the Nikon XT H 320 CT scanner and compared to the CAD nominal using Vgstudio max 3.0 software.

Configuration 1 printed component (left). Configuration 2 printed component (right).

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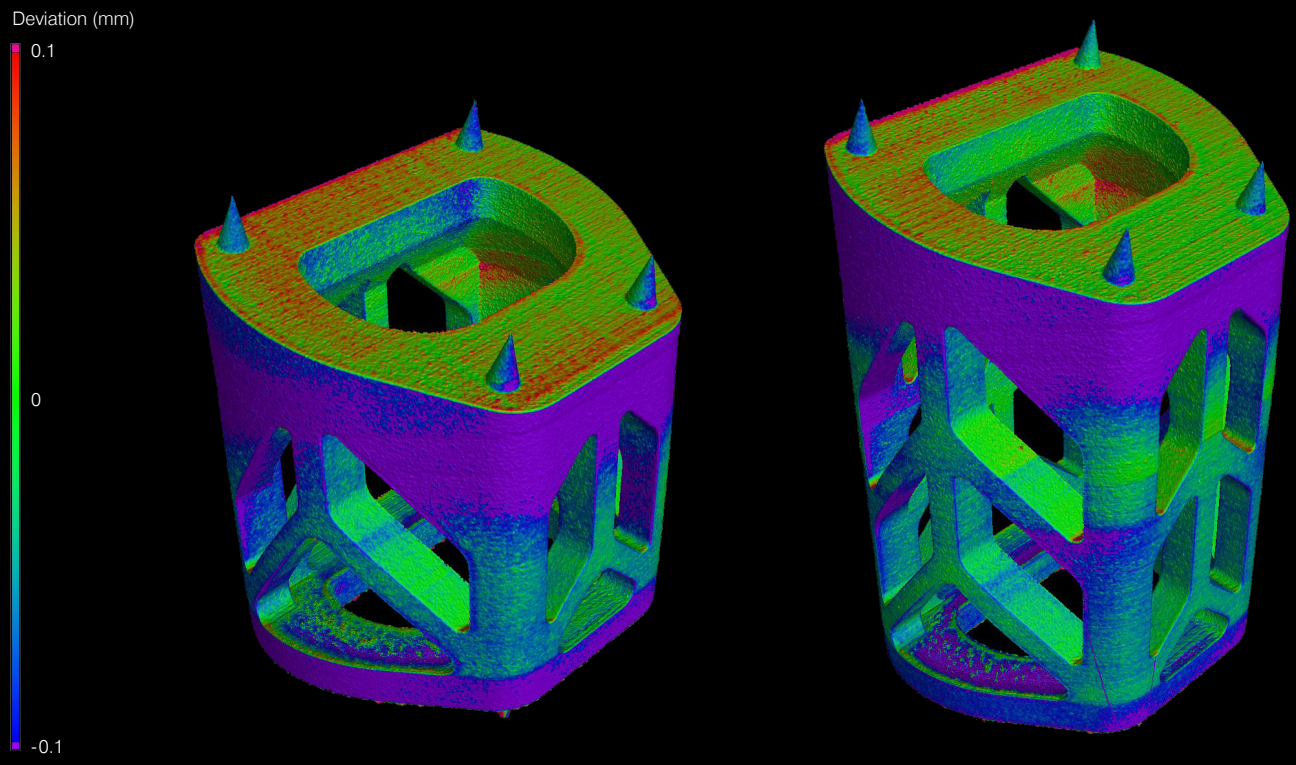
The surface deviation map shows that there is a fairly consistent contraction in the thicker areas of the components. In order to correct this surface deviation three methods were identified. Each method involved manipulation of CAD data prior to manufacture.

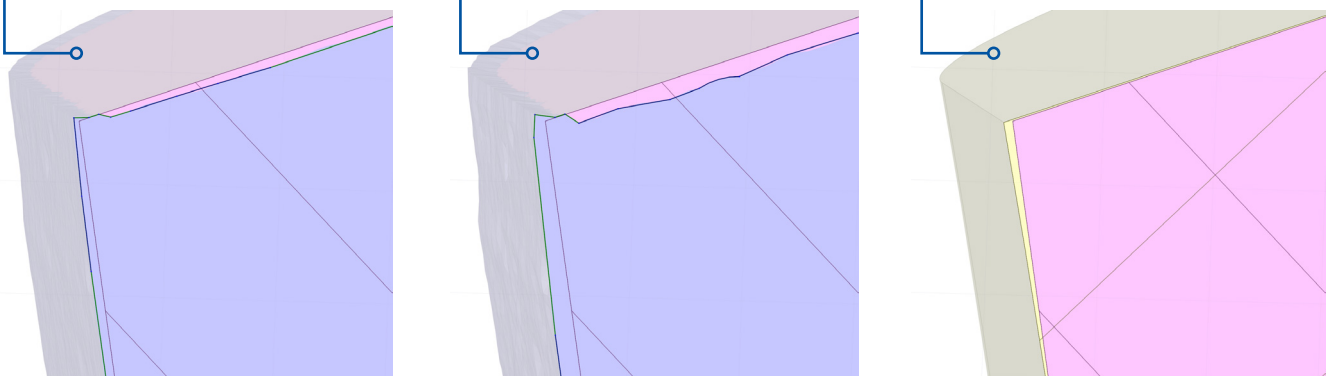


Comparison of actual geometry to CAD nominal. Configuration 1 (left), configuration 2 (right).

Correction methods

The following three correction methods were proposed.

1. The surface deviation was inverted by 50% using the CADfix mesh deformation tools.
2. The surface deviation was inverted by 100% using the CADfix mesh deformation tools.
3. Manual CAD deformation was accomplished using Warp deformation tool within Creo CAD modeller.



Example showing how each corrective method attempted to minimise error at the edges of the configuration 1 component. Method 1 (left), method 2 (middle) and method 3 (right).

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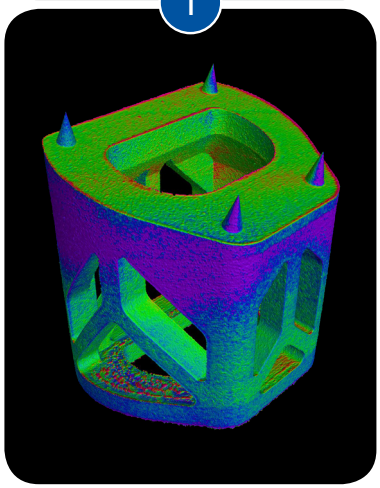
Method comparison – **Configuration 1**

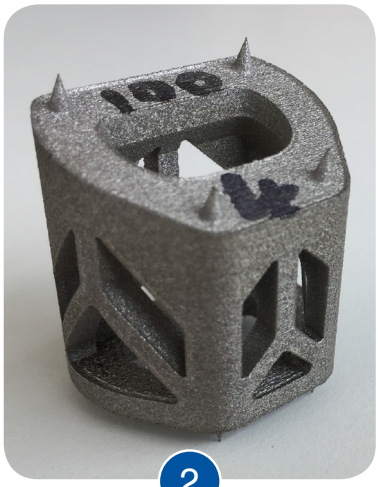
The corrected components were manufactured once more then scanned and compared.

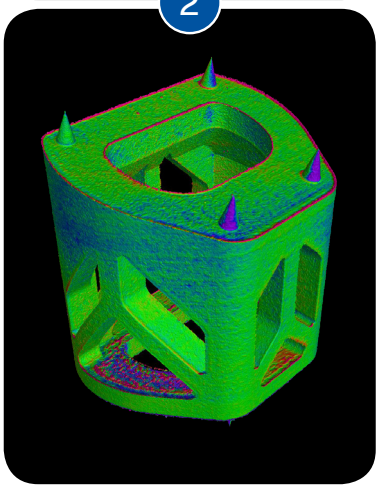
Method 1 component



Method 1 scan

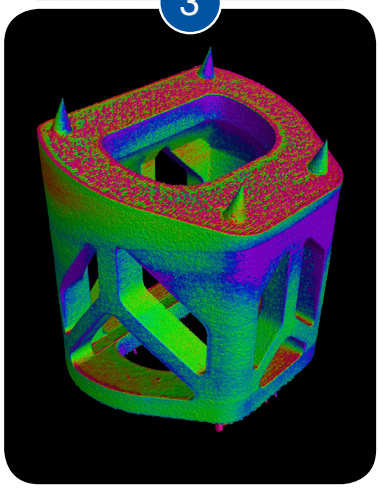
Method 2 component





Method 2 scan

Method 3 component



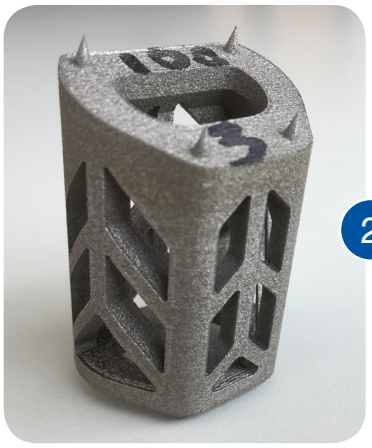
Method 3 scan

All of the correction methods improved the actual geometry produced in comparison to the CAD nominal.

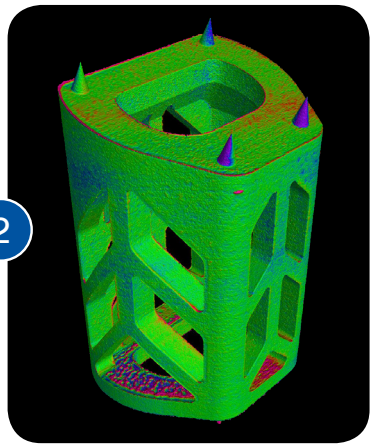
Method comparison – **Configuration 2**

The corrected components were manufactured, scanned and compared as before.

Results for the configuration 2 printed component were similar to those observed for configuration 1.



Method 2 component



Method 2 scan

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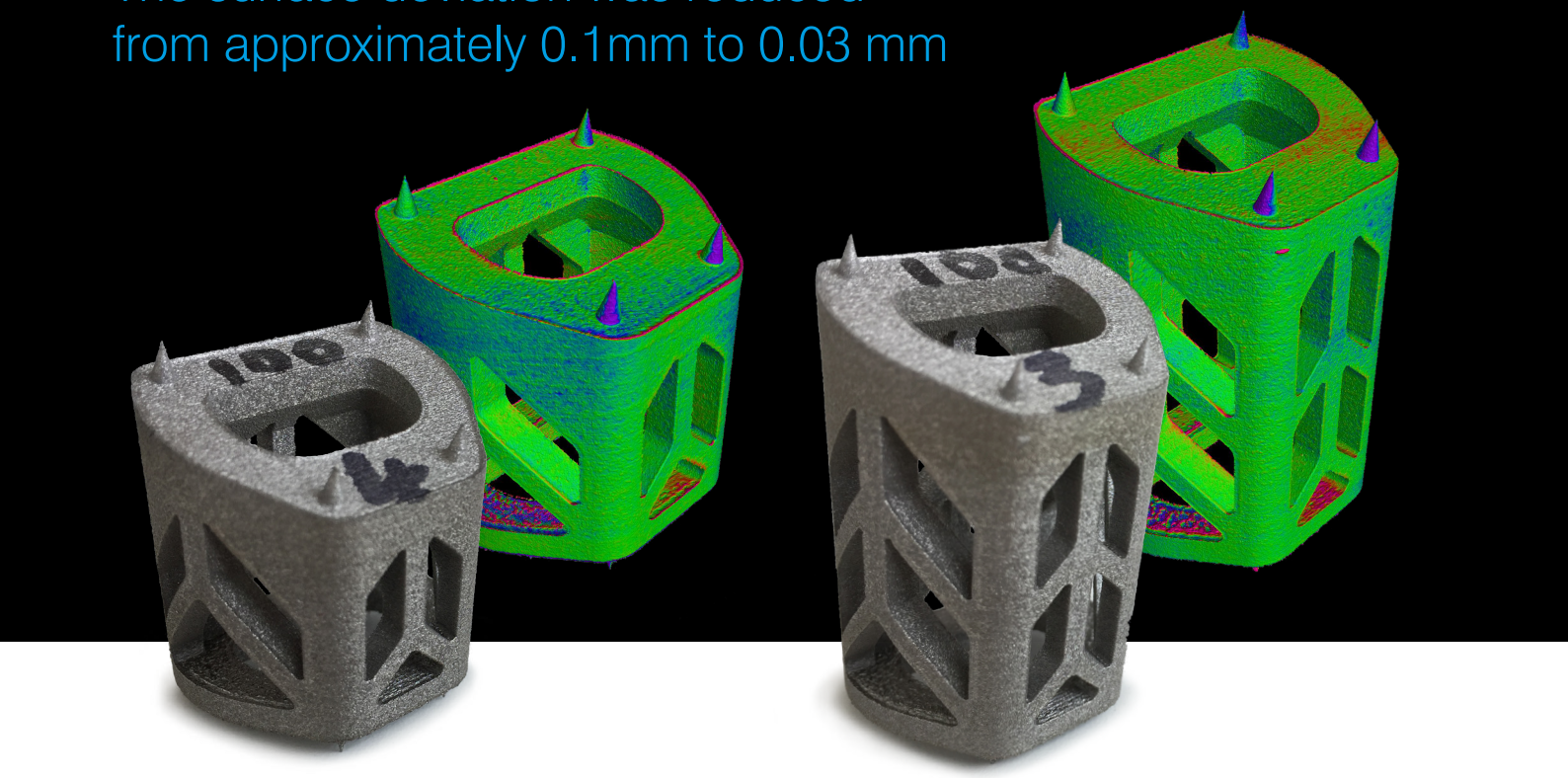
Results

Method 2, of inversing the surface deviation of AM nominal mesh by 100% using CADfix mesh tools, seemed to show the best results for both configuration 1 and 2 components.

The surface deviation was reduced from approximately 0.1mm to 0.03 mm



Discussion

The results showed that CAD models can be modified in order to significantly reduce any SLM build defects. Potentially this offers a way of improving the accuracy of components produced using SLM.

While method 2 offered a significant improvement there are two areas which provide scope to be refined, further improving the process:

1. The top edges of the component are oversized.
2. The build error in the ‘spikes’ on the top of the component is not corrected consistently.

There is potential that this method could be used in other types of AM and once these process improvements are refined, this method could be used effectively in industry to manufacture a conforming part that requires minimal post machining operations, reducing the overall cost of the part build.

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