LightHinge+: possible thanks to additive manufacturing

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Sector: Automotive

Challenge: Substantial weight reduction, fewer components, fewer assembly steps and integrated pedestrian protection for a cover hinge made using additive metal manufacturing.

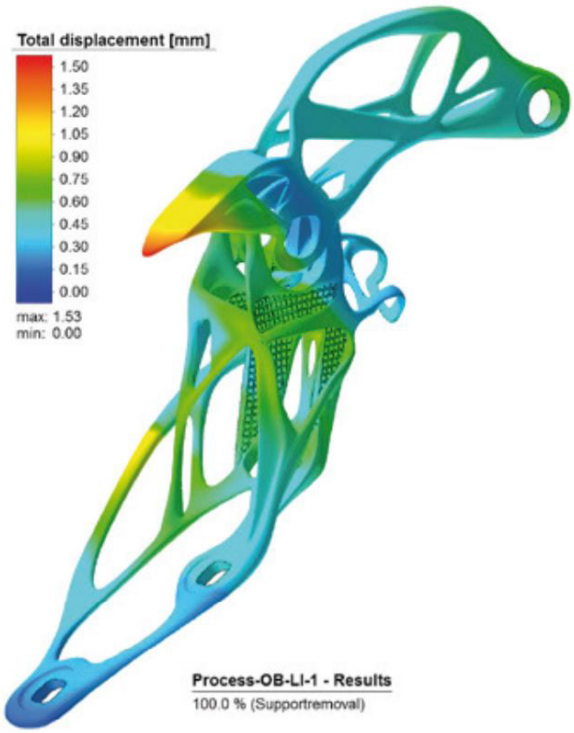
Solution: The distortions were simulated to reduce the number of testing steps. Thanks to countermeasures applied to compensate for deformation, part production times were reduced while meeting the quality goals.

CHALLENGE

In an innovative common project known as LightHinge+, EDAG Engineering, the Additive Manufacturing Center of voestalpine and Simufact Engineering jointly developed a new cover hinge. The project team redesigned the component to produce it subsequently with additive manufacturing methods. The design was obtained using topological optimisation techniques, resulting an a highly bionic appearance with a light structure.

One of the initial challenges was to establish "appropriate" support structures, that is, the ideal number and shapes of the supports so as few as possible were used. The reason is that the material required for these support structures makes the building process long and expensive and the removal of the support more difficult.

Another challenge consisted in minimising deformation and residual stresses generated in the printed component due to concentrated thermal effects caused by high heating and cooling cycles during the manufacturing process.



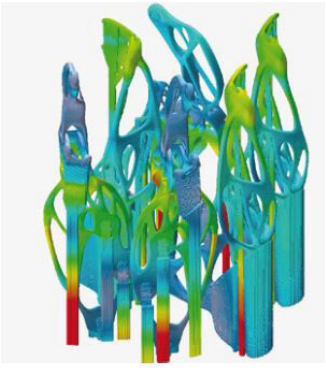
SOLUTION

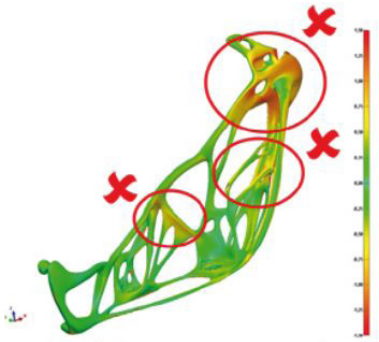
Both structure support and deformation problems were solved by process simulation.

A complete chain of additive manufacturing processes was simulated, thanks to Simufact Additive. The process chain can also include a thermal treatment process and a Hot Isostatic Pressing (HIP) process for aerospace parts. The behaviour of the support structure and the seating plate should also be borne in mind, a well as releasing the part from the seating plate and eliminating deformation. The LightHinge+ used a macroscopic approach based on the inherent stress method, to simulate deformation. The advantage of this technology is that it reduces simulation time.

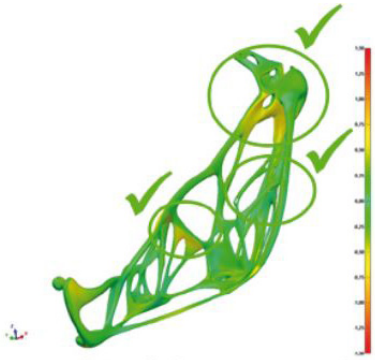
A special functionality of Simufact Additive is active compensation of deformation. Since 3D manufacturing technology does not require moulds, no tools need to be reprocessed or redesigned to compensate for part deformation. Additive manufacturing only requires editing the CAD geometry files (support parts and structures) of the printing machine. Simufact Additive has a compensation function for this purpose that changes the target geometry of the process. After the manufacturing process, final cooling and extraction of the seating plate and support structures, total deformation is similar to the first method and much closer to the required CAD geometry.

These compensation process can be repeated several times, until the required quality criteria are met. In the LightHinge+ project, compensation was successful after the first simulation loop. It was therefore possible to use the compensated CAD geometry to print the optimised part with less deformation.





Original – Distortion not compensated



Optimized – Distortion compensated

ADVANTAGES

EDAG Engineering, the Additive Manufacturing Center of voestalpine and Simufact Engineering have proven to be the ideal partners to manufacture a new and innovative cover hinge. LightHinge+ uses complex kinematics that reduce the weight of several individual parts, but achieves an additional degree of freedom in movement kinematics by obtaining a bionic structure combined with a manufactured rupture structure. The rupture structures and ultra-lightweight printed kinematics interact with the activated components like fireworks, raising the active cap in the hinge area to protect pedestrians in the event of collision.

As a result, the new hinge was built with 50% less weight than the original part and with the additional advantage of maintaining nearly all the functional properties for pedestrian protection integrated in a single part. The new cover hinge can be built with fewer components and requires fewer assembly steps.