Project NewStructure: Direct Manufacturing of structure elements for the next generation platform

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The aim of the project "Direct Manufacturing of structure elements for the next generation platform" – initiated and funded by the European Space Agency (ESA) – is to examine the ability of using Additive Manufacturing for producing structural metallic parts mainly used in actual telecommunication satellites. Therefore trade-off methodologies to select feasible parts, test and verification plans as well as manufacturing strategies for space parts are to be developed.

Participating partners

There are four companies participating in this external project. The project is funded by the ESA and led by the DMRC, it started in November 2013. The project partner "Invent GmbH" works on structural parts for satellites made from composites or metals and brings in a lot of experience in designing and certification of these parts. Knowledge on satellite systems, potential components for the optimization and the needed requirements are provided by the system manufacturer "OHB Systems AG". The manufacturing of the sample parts will be made by "citim GmbH", an experienced manufacturer for prototypes and small series. For production of space flight-relevant metal parts machines of the "SLM Solutions GmbH" are used. SLM is the fourth partner in the project, bringing in the experience in Additive Manufacturing, as known from the work in the DRMC and with citim.

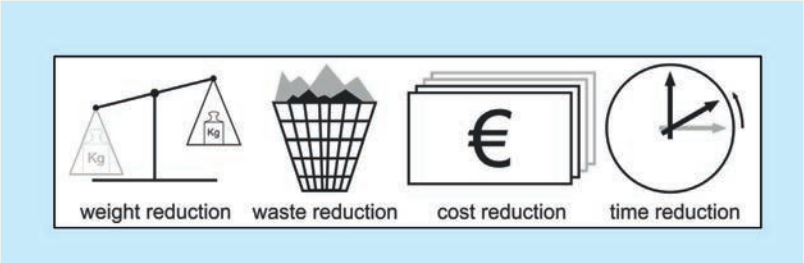

Figure 1: New Structure objectives in a nutshell

Project Goals

In a first step, a trade-off methodology was developed and used for selecting sample parts of already developed satellites. Based on this procedure, actual structure elements were identified and assigned:

- Case A parts: identical elements applicable to each platform
- Case B parts: more complex parts featuring a high buy-to-fly ratio

Typical relevant parts are those with a high buy-to-fly ratio and time-consuming or complex fabrication steps. For each case one part was examined in detail. These parts were built in the Selective Laser Melting (SLM) process. The resulting improvements gained by changing the manufacturing process regarding costs and weight were figured out.

Additive Manufacturing and testing of space parts

For manufacturing of space parts there are special requirements like an extremely high reliability and lightweight design demanded. Additive Manufacturing enables these lightweight designs but also requires a special quality assurance. Therefore, a space dedicated test and verification plan as well as a special manufacturing strategy for both parts was developed. This will help to ensure a certification for space use. The testing includes material tests for example regarding stress corrosion

susceptibility, crack growth and tensile strength but as well part related process control like density and accuracy tests.

How are cost reductions possible?

It will be analyzed which cost reductions can be achieved by Additive Manufacturing due to three different reductions.

- Reduction of weight used in the satellite
- Reduction of waste in production do to fabrication processes
- Reduction of manufacturing time

Selected and redesigned parts

For the examination of cost reduction for near series production of identical parts applicable to each platform (case A) the “edge inserts” were selected. They are glued into CFRP-panels and are used to provide screw holes for mounting of further parts. Many of them fit into one build job and thereby a reduction of manufacturing time is expected.

Figure 2: Additive manufactured case A parts: “Edge Insert”

For the evaluation of weight, waste, time and cost reduction for complex parts with a high buy-to-fly ratio due to redesign of elements the “Reaction Wheel Bracket” is used. Four of these brackets are used per satellite to mount a reaction wheel for adjusting the orientation of the satellite without using propellant. The part was redesigned with a topology optimization to gain a huge weight reduction.

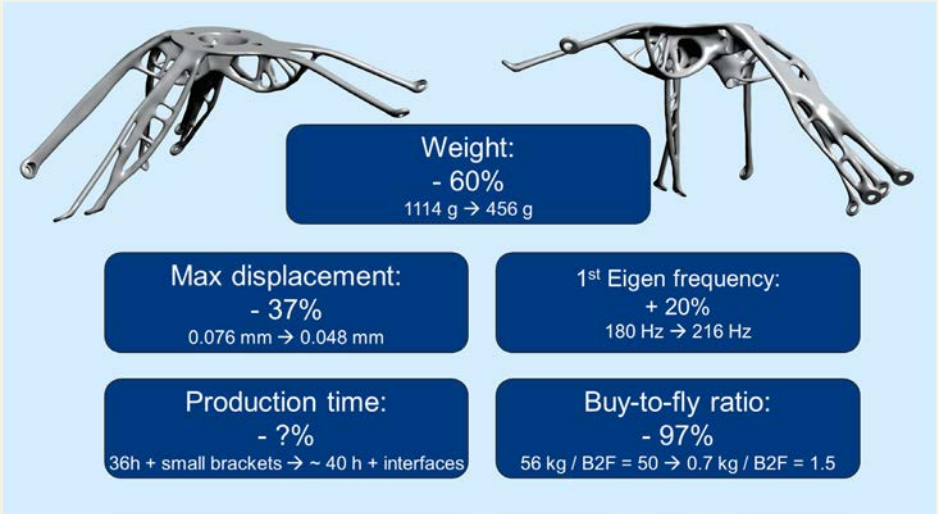

Figure 3: Optimized satellite part and achievements for “Reaction Wheel Bracket”