Exploitation and enhancement of design flow dedicated to additive manufacturing for an industrial demonstrator

S. Gohy*, C. Grappasonni*, M. Bruyneel*, B.Bernay[†], C.Chary[†] and M. Francois[†]

[*] GDTech engineering
Avenue de l'expansion, 7, 4432 Alleur, Belgium
e-mail: sebastien.gohy@gdtech.eu, web page: http://www.gdtech.eu

[†] Sonaca
Route Nationale, 5, 6041 Gosselies, Belgium
e-mail: marc.francois@sonaca.com, web page: http://www.sonaca.com

ABSTRACT

The coupling of topology optimization with additive manufacturing is a major breakthrough in the industrial design in the last years. The baseline process starts from an ad-hoc selection of the parts suitable to be produced by additive manufacturing based on size, material and scope. Then, the topology optimization problem is set up to find the structure that ideally satisfies all the operating constraints. Design for Additive Manufacturing (DfAM) comes after, and it develops parts accounting for the geometrical and thermal limitations related to the fabrication. As a result, additive manufacturing process simulations of such designs can be carried out to predict deformations and residual stresses and, as a consequence, to prevent potential failures. The support structure can also be optimized at this stage together with the printing strategy, by replacing tests with simulations. Eventually, the part can be fabricated first-time-right.

This work deals with the design, simulation, manufacturing and testing of a wing anti-icing system demonstrator. The existing component is a straight T-duct obtained by several sequential laborious manufacturing techniques, which can be avoided thanks to additive manufacturing. Taking advantage of the re-design process, the improvement of fluid-dynamic performance has also been considered. Therefore, the T-shaped duct with its mounting plate has been optimized to minimize the airflow total pressure loss and to minimize the mechanical compliance subject to a 20% mass reduction. The DfAM has been carried out after selection of the printing direction. An a-posteriori simulation of the manufacturing by SLM predicted the deformations encountered during an unsuccessful preliminary attempt of fabrication. Eventually, variations in the printing strategy and design allowed the manufacturing of functional parts to be experimentally tested.

The talk will highlight limitations of the design procedure and the challenges arising when industrial applications are considered. The coupling of topology optimization with additive manufacturing still needs additional developments to be fully exploited. Further simulations are presented to explain how the structure support can be designed by defining a thermal topology optimization problem.

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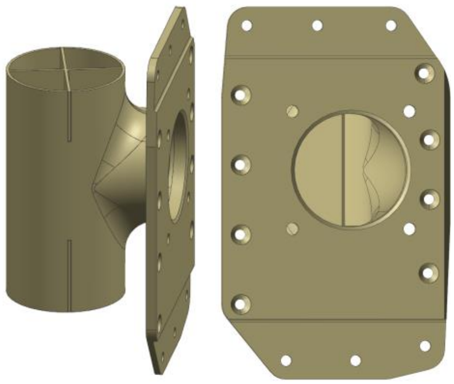
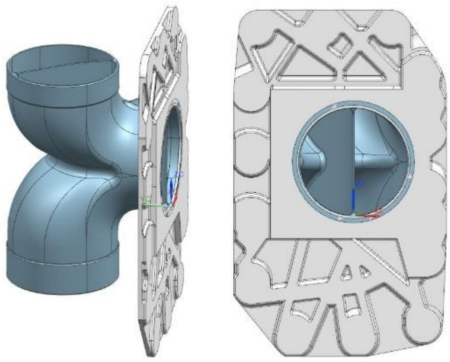
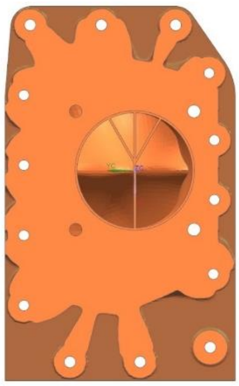


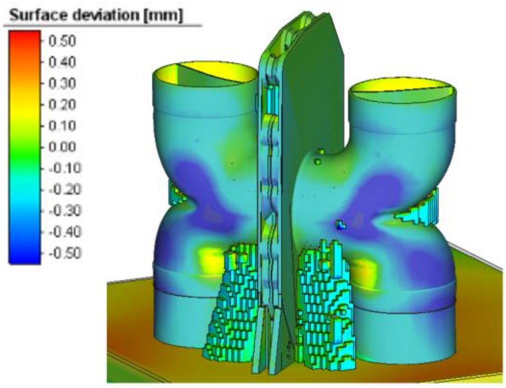
Current design



Design for additive manufacturing after fluid and mechanical topology optimization



Topology optimization result of the mounting plate



Simulation of the manufacturing in the succesful configuration

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