

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)Author: Mr. Jakub Michalka
Poland, kuba.michalka@gmail.comPROPOSITION OF APPLICATION OF GENERATIVE DESIGN ALGORITHMS IN THERMAL
APPARATUS DESIGN AND CALCULATIONS**Abstract**

Generative Design is a method of constructions' design process, utilizing evolutionary algorithms and topology optimization, to create an optimal result on the basis of given boundary conditions. This approach is used mainly in mass optimization and strength maximization - in the literature, optimization algorithms of architectural, utility and industrial structures are available, confirming the validity of the application of this technique in the design development. Thanks to development of proper algorithms it can also be applied to the process of designing radiators and heatsinks. Use of this method, together with additive manufacturing technologies, allows to deliver a construction much more efficient in both capturing the heat from the equipment and dissipating it. However, the complexity of heat transfer phenomena requires further research, development and optimization of algorithms.

In this paper a new approach to design of cooling systems is presented, based on the Generative Design. Traditionally, such systems are designed on the basis of human experience, which excludes the possibility to create the most efficient and optimal, organic-like shape of the structure. Use of additive manufacturing techniques and multi-axial milling allow to maintain low complexity of part structure (by replacing entire assemblies with one part) and simultaneously – achieve very high intricacy of the part shape, maximizing its capabilities.

In context of space engineering applications, the optimization process of cooling devices is very important, as it allows to minimize the mass of the construction, and lower its overall dimensions, while maintaining (or even enlarging) its required thermal and/or mechanical properties. Use of 3D printed elements in space applications is growing over the point of being only the experimental payload, to being core structure components. Implementation of methods used to design structure elements to the field of thermal applications is a natural way of development, due to existence of potential for improvement and thanks to great capabilities of topology optimization and Generative Design approach to such devices.

In the paper, the ideological algorithm is proposed, with analysis of its possible implementation, on the basis of existing software solutions in the field of Generative Design. Comparison analysis of traditionally and with use of Generative Design methodology designed cooling elements was performed, in FEM simulation environment. Initial conclusions were drawn, together with analysis of further development of said method and feasible implementation examples in constructions in space- and ground segments in aerospace engineering.