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Weight Reduction of an U.A.V.'s Wing through Topology Optimization

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This paper discusses the topology optimization as a method for weight reduction of an U.A.V's wing made EPS (Expanded Polystyrene). The advantages of the polystyrene in comparison with other materials commonly used in aviation, such as wood or PVC (Polyvinyl Chloride) foam, relays on EPS's low cost, good recyclability and ease of manufacturing. Along with these advantages, the usage of polystyrene instead of profiled wings becomes a feasible alternative when the EPS structures are lighter than other options. Considering cargo aircrafts, weight savings on structure allows a corresponding increase in payload. Furthermore, for a given load, lighter structures lead to less consumption, increasing the aircraft autonomy.

The lift surface analyzed in this paper composes the aircraft "Iron Man", designed and built by students of Federal University of Bahia for SAE Brazil Aero Design®. Based on an EPS structure, the wing was topologically optimized to define geometrical features of the holes. The procedures performed in the optimization considered as domain the volume throughout the internal region of the wing. A finite tridimensional element mesh was generated in HyperMesh® and the optimization process was performed in Optistruct®, both ALTAIR® commercial package. The objective was to minimize the flexibility of the assembly by restricting the volumetric fraction of the wing by 30% up to 50%, according to the previous

analysis, until an optimized material allocation is reached. The polystyrene structures were flight validated with full design load and predicted load factor verified by telemetry.

A comparative evaluation was performed between the optimized structure and other options available. For this purpose, wood wings and foam PVC profiles were modeled in a CAD environment. It was noticed that the proposed EPS structure was 14.7% lighter than the PVC foam structure and 30.0% lighter than the wood structure.

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