Design challenge for AM Redesign

Mehta, P., **Berdanier, C.G.P,** Malviya, M., Miller, C., and Manogharan, G. (2019). An empirical study linking additive manufacturing designers' behaviors to success in manufacturability. 2019 Solid Freeform Fabrication Symposium.

Objective

The objective of this challenge is to redesign the ALCOA bearing bracket in such a way that its topology and shape are optimized for minimizing weight while fitting in the target envelope and meeting the technical requirements. The bracket is intended to be additively manufactured (using laser powder bed fusion technique) and the design shall also minimize and/or eliminate the need for support structures. The efficacy of the design submission will be evaluated via FEA, strength-to-weight ratio and manufacturability.

a) You are provided with a CAD design of the existing model
b) Based on intuition and results from FEA analysis, you can come up with a design with minimum weight/volume to meet the given loading conditions.
c) It is advised to concentrate on bulk removal of material and not use lattice structures for light weighting the part design.
d) Please indicate the intended print orientation/direction in your submission along with one-two sentences of justification for your choice.
e) The maximum time duration for this activity is 90 minutes

Design requirements

Design material: 15-5PH per AMS5862:
Elastic Modulus (E) = 29,000 KSI = 200,000 MPa = 200 GPa
Poisson Ratio (ν) = 0.27
Yield Stress (σ_y) = 145 KSI = 1000 MPA
Density (ρ) = 0.283 lb/in^3 = 7833 kg/m^3
Material is assumed to be linear elastic
Minimum geometric feature: 0.025 in.
Minimum wall thickness: 0.045 in.

Parts shall be optimized for minimum weight with the following boundary and loading conditions:
- Base support: The part is bolted against a mating plate of high stiffness
- Bolts interface: The parts is fastened with four #10-32 high strength tension rated bolts as indicated in the specifications
- Bearing interface: The part is loaded through a high stiffness spherical bearing with three load cases:
1. A load of 1,250 lbf applied horizontally
2. A load of 1,875 lbf applied 45 degrees from the horizontal
3. A load of 2,500 lbf applied vertically