Simulation Assumptions

The CAD can be converted to the appropriate file format for a vertical CNC mill to remove material from 1733x774x300mm blocks.

Stress and strain simulations were carried out to observe regions of stress concentration and any deformations due to the clamping force which was taken as 50kN (5 tonnes) total distributed over the outer surface. The temperature distribution simulation looked at the results of conduction as heat was dissipated. The assumptions made were uniform 150℃ on the inside due to the PP part (melting point 120℃) and an ambient air temperature of 25℃ (giving a heat flux of 57 kW/m^2). Note, the effects of water cooling were too complex for the time available. The mesh used was a mixed-type medium resolution mesh, no local refinement was made.

Heat Flux: $$\frac{Q}{A} = q = \lambda \frac{dT}{dx} = 137 \times \frac{150 - 25}{300 \times 10^{-3}} = 57\ kW/m^2$$

Cost

Volume: $$V = (1733 \times 774 \times 600) \times 10^{-9} = 0.8048052\ m^3$$

Mass: $$M = \rho V = 2.8 \times 10^3 \times 0.8048052 = 2254\ Kg$$

Material Cost: $$C = C_m \times M = 3.32 \times 2254 = £7{,}484$$

Total: $$T = C + W + P \approx £18{,}000$$

Cost per part: $$X = \frac{18000}{50000} = £0.36$$

Where M is mass, ρ is density, V is volume, C_m is the price per Kg of material, C is the material cost, W is the machining cost, P is the operator cost (assuming one), X is the cost per part (assuming a conservative 50,000 made)