M2.01 – 3D Printed Thermal Hard Masking

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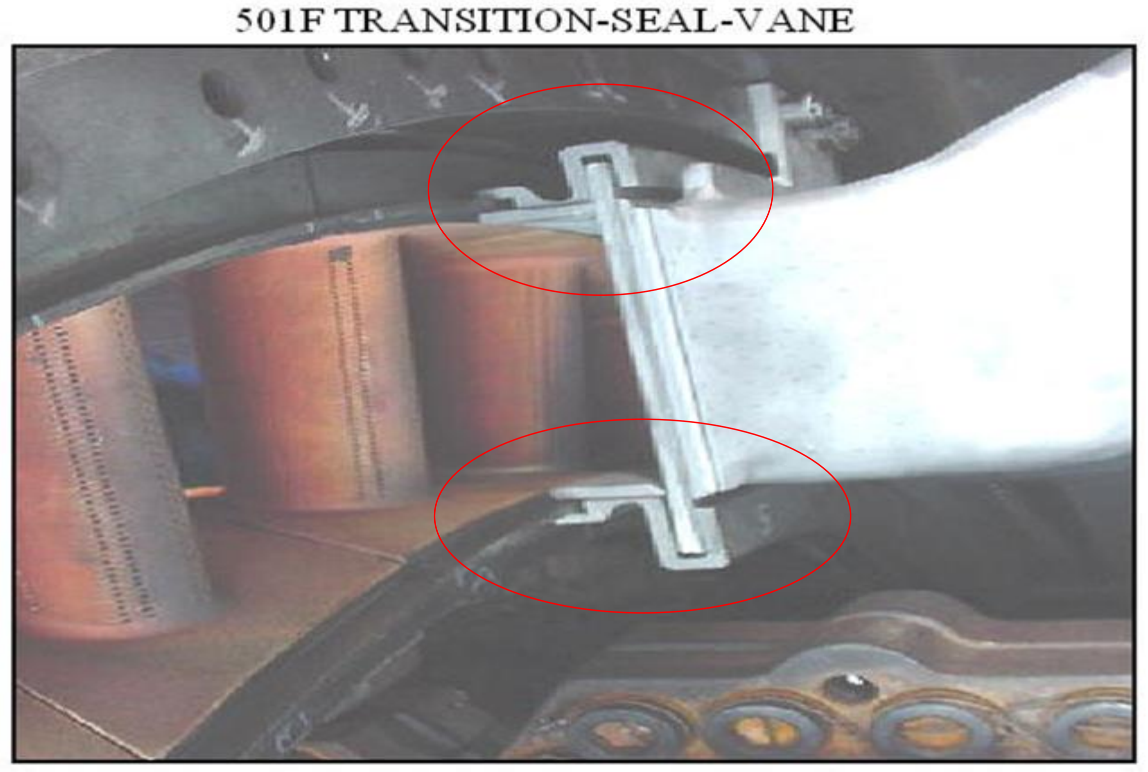
Introduction

- Curtiss-Wright manufactures products for a variety of industries; from aerospace to power and energy.
- Post processing for these parts requires a lot of preparation and materials, which means a high production cost.
- Processes include aluminum oxide grit-blasting, and high temperature thermal sprays. (High Velocity Oxy-Fuel, Plasma Arc, and Laser Cladding)

Initial Problem

501F TRANSITION-SEAL-VANE



- One part produced is a floating seal for an aerospace exhaust.
- For processing, the seal is currently hand masked with fiberglass tape.
- Our goal was to find an alternative to masking by hand that would be cost effective and of high tolerance.
- 3D printing offered the most versatility to survive both the grit blasting environment and the thermal spraying, while being reusable.

Mask Design

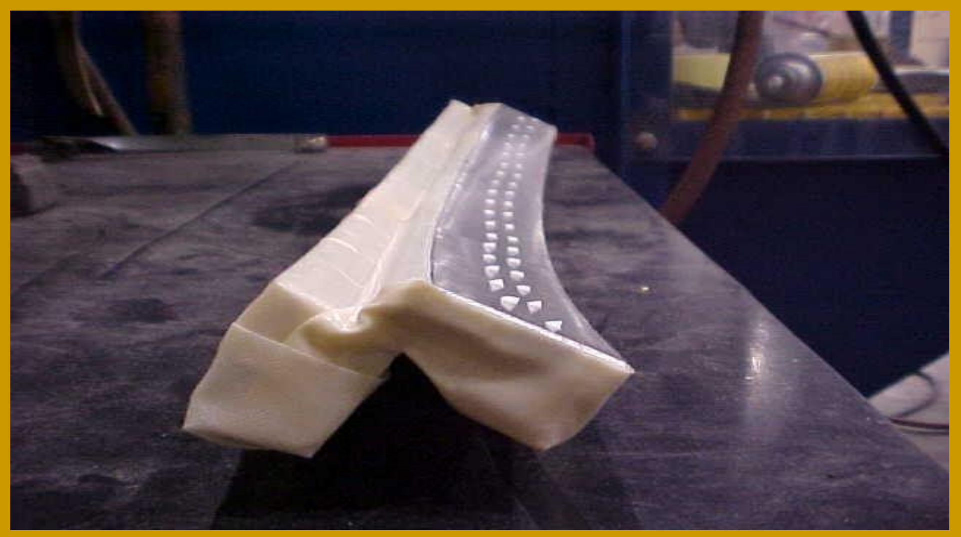


Figure 1 – Tape Masking

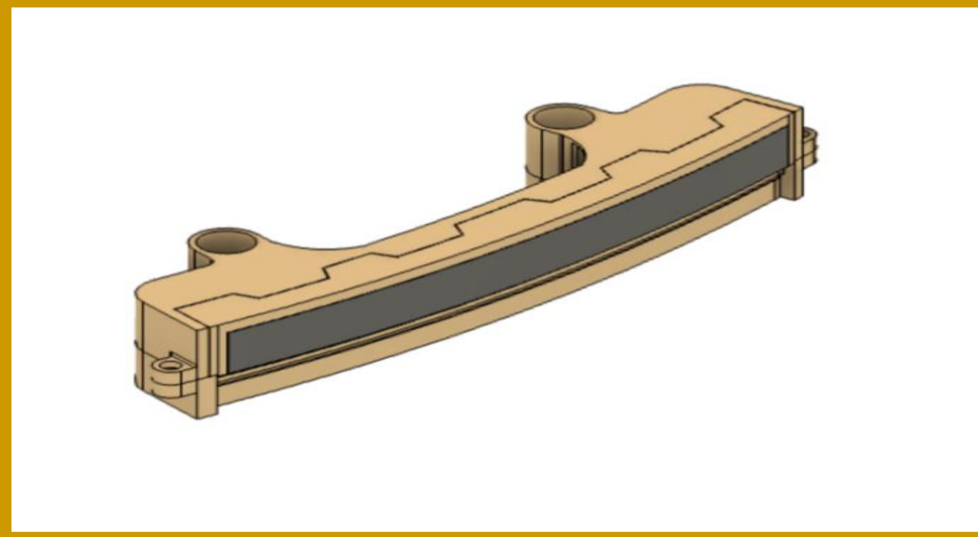


Figure 2 – Final Mask Design

- Figure 1 shows the company's initial tape masking process vs Figure 2 shows the CAD model of the new 3D printed hard mask
- Designed mask will be printed from ULTEM-1010 (High-Temperature resistance thermoplastics) with an industrial printer.
- Initially, the team did HVOF test at Curtiss-Wright for samples of ULTEM-1010 to make sure mask can resist the harsh environment.
- The designed mask should allow for zero overspray beyond the grey portion as shown in Figure 2.
- First mask design, shown in the Figure 3, featured 8 interlocking components, four disposable front component joined by dovetails and four large back supporting components.
- Topology optimization shown in Figure 4 was performed on the mask to reduce unnecessary filament use and to reduce processing cost.

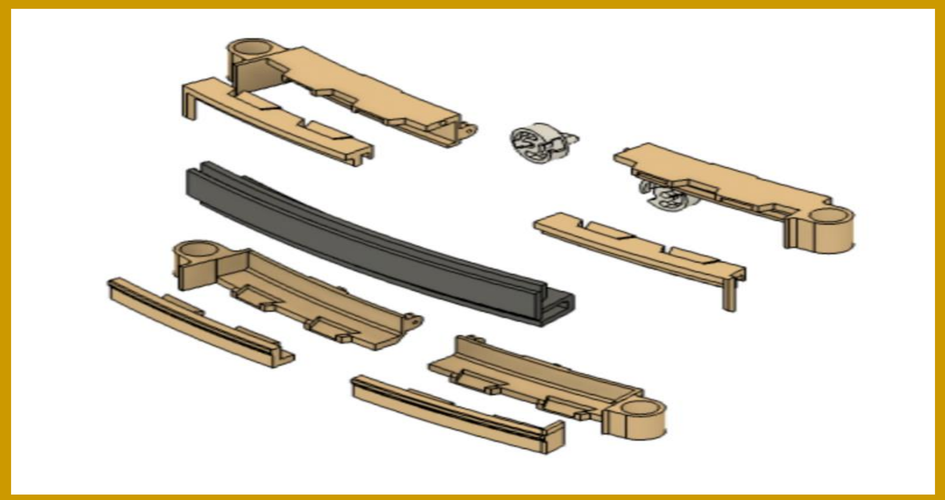


Figure 3 – Initial Design Exploded View

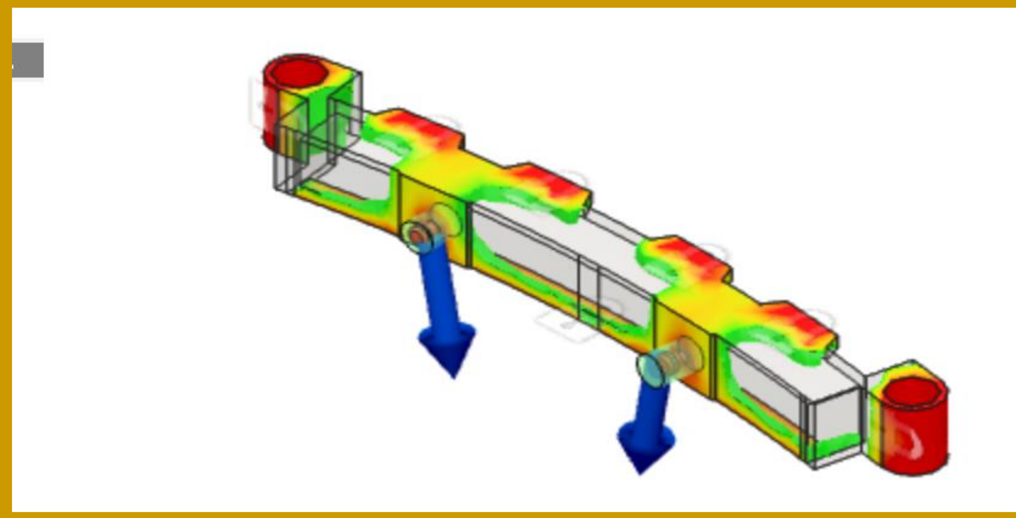


Figure 4 – Topology Optimization

Material Test Results and Discussion

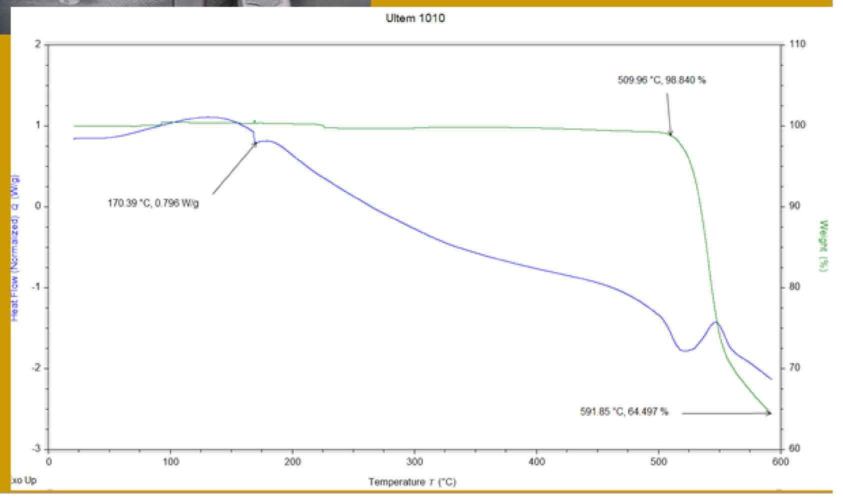
- Material testing showed that Ultem 1010 with the Dichtol sealant would survive the HVOF process
- Cost analysis results for six batches of eight parts

  Cost of six batches Taping = $ 4098.0

  Cost of Six batches Printing = $ 729.85

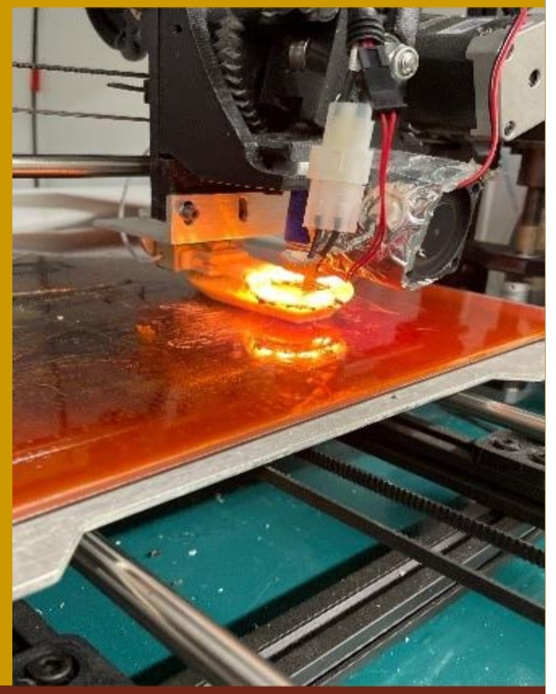
  Average Savings (six batches) = $ 3368.15

  Overall Savings per part = $70.17
- Topology Optimization Cut material usage by another 25%
- Thermogravimetric analysis shows that there is not material decomposition due to temperatures up to 500 degrees Celsius



Printer Design

- Aside from designing alternative masking, the teams stretch goal was attempted to modify a consumer level printer to adequately print Ultem parts of comparable strength.
- The reasoning is because industrial printers for quality Ultem use are expensive. If a cheaper printer can be altered for the same capabilities at an overall lower cost, the attempt should be made.
- The team was able to successfully modify a LulzBot Taz4 to successfully print ASTM "dog bone" coupons for flexural and tensile testing



Project Conclusion

- Due to the influence of our project, Curtiss-Wright had decided to go through with the investment of an industrial printer for alternative masking.
- Alternative Masking would lead to and overall reduction of $86 per part over six batches.
- Savings could increase depending on mask useful lifetime.

Material Choice	Total Cost	Saving Yield (10 batches)
Ultem 1010 + TPU	$ 2077.60	$ 2,422.00
UHTM Tape	$ 4500.00	$ 0.00
Ultem 9085 + TPU	$ 2234.40	$ 2265.60