LIGHTWEIGHTING 3D PRINTED INJECTION MOLD TOOLS TO REDUCE COST AND MANUFACTURING TIME

FORTIFY
+
nTopology

The Challenge

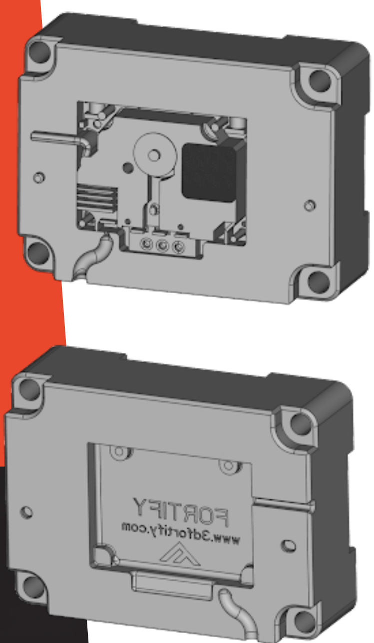
Validate that a lightweighted, lattice-infilled mold tool will perform the same as or better than a non-lattice-filled mold tool. This will save in material cost, print time, and time to molded part leading to accelerated new product development and a competitive advantage over traditionally printed or machined tooling. In addition, this work paves the way for new conformal cooling geometries which could be used to further drive down cycle time.

Background

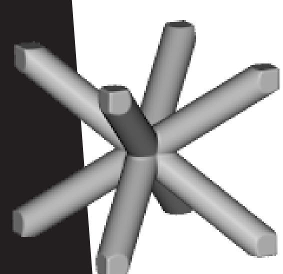
We chose an electrical housing mold because it has been designed to be a torture test to improve our molding outcomes. At Fortify, we use this mold to benchmark things such as printer process changes, new molding materials, and new molding processes. This made it an obvious choice to implement a lattice structure for lightweighting as we already have a large amount of data on molding outcomes.

What makes this mold a torture test are the sheer number of challenging features packed into the core. There are high aspect ratio core pins, tightly packed ribs, tiny ribs (<1mm width), blind pockets, features down to 0.5 degrees of draft, a fine knurling pattern, and a tough shutoff feature.
We brought nTopology into this case study because of its generative design platform and ability to quickly, easily and efficiently apply a lattice structure to any geometry, no matter how complex.

The goal was to save print time and material cost by implementing a lattice structure to the core of the mold while maintaining or exceeding performance requirements.



Original CAD file of the electrical housing mold



Body-Centered Cubic unit cell.
Image source: nTopology

The Process

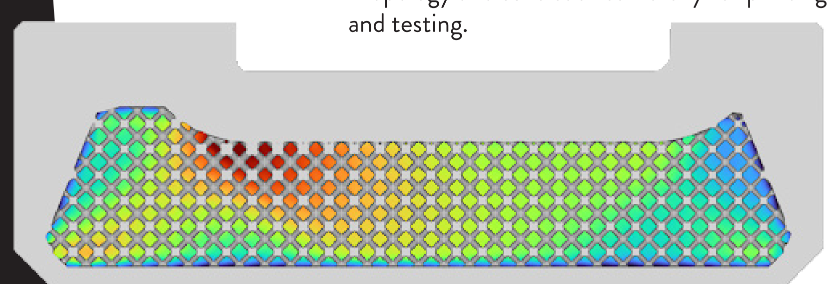
The original CAD model was sent to nTopology. After importing the model, faces were selected that were important for the boundary conditions, and an initial static analysis was performed. This informed the engineer of the original stress and displacement values.

Next, a uniform shelling operation was performed followed by the addition of a lattice structure to the core. With nTopology, there are over 30 predefined unit cells along with the ability to design your own. In this case, we went with the Body-Centered Cubic unit cell (BCC) because it is fully self-supporting when oriented in the build direction.

The BCC unit cell also provides a relatively low percent infill while still being able to support the principal overhangs. Additionally, it is able to be printed at the smallest thickness that our Fortify FLUX Core machine can print.

After the lattice structure was added, another static analysis was performed. The Von-Mises Stress results were used as fields for nTopology's field-driven design capabilities which essentially drives the design based on physical and simulation data. Using field-driven design, a variable shell operation and variable lattice thickening operation were performed which variably changed the thicknesses across the core: thicker where they needed to be and thinner where allowed based on the simulated stress values.

The minimum and maximum lattice thickness values were changed and another static analysis was performed until all the goals and parameters were met. The final model was exported out of nTopology and sent back to Fortify for printing and testing.



BCC unit cell and field overlaid which drives the thickness of the lattice beams.
Image source: nTopology

Results

The mold with the lattice performed identically to the mold without the lattice. Both tools were tested with identical molding parameters including:

Max deflection of .01in
5 tons of clamp tonnage
2000psi injection pressure
10m/s injection speed
1200psi pack pressure
Total injection time of 20s
Cooling time of 80s
Air cooling for 30s
Automated ejection system

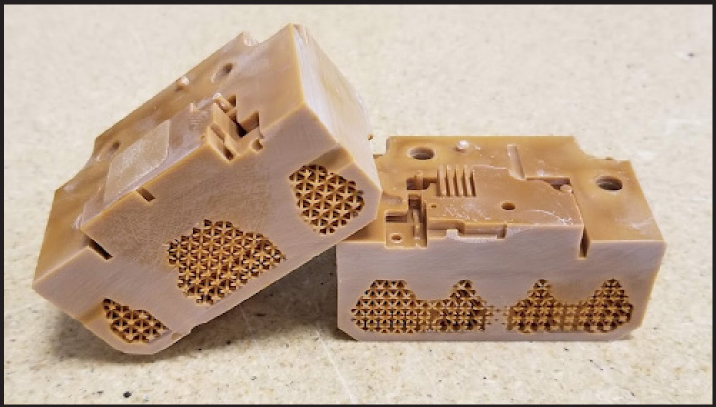
When the initial simulation was performed the solid mold showed .002in of deflection. The max allowable was defined as .01in. The final design showed .0096in of deflection meeting the defined goal. The nTopology designed mold tool printed in 6.6 hours allowing us to print, clean, and start our post-cure on day one and mold on day two. The original was printed in 8.5 hours allowing us to print only on day one, clean and post-cure day two, and mold on day three. Along with this 22.35% saving in print time we saw a 29.04% material reduction amounting to 119.86 mL material saved equivalent to $59.93 of material.

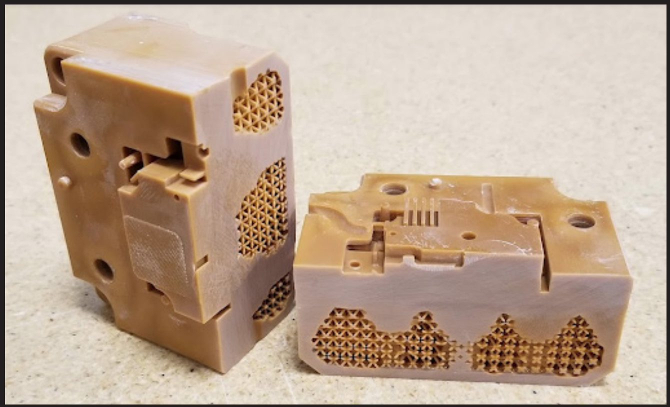
	ORIGINAL MOLD TOOL	NTOPOLOGY LATTICED MOLD TOOL
# of shots	50	50
Print time	8.5 hours	6.6 hours
Time to molded part	3 days	2 days
Print Material	Digital Tooling Resin	Digital Tooling Resin
Material amt.	399.518mL	279.658mL
Material reduction	N/A	29.04%
Material cost	$199.76	$139.83 ($59.93 savings)

This case study validated that by using next-generation software like nTopology and our FLUX Series 3D Printers our customers can speed up their new product development without sacrificing quality or performance while saving time, cost and material.

To learn more about this case study or how Fortify can help you, please visit us at

www.3dfortify.com/mold-tooling or sign up for our tooling pilot program https://get.3dfortify.com/molding-partner-network/





The final printed part was cut in half to show the lattice