FORTIFY

CASE STUDY

MEDICAL DEVICE PROTOTYPING IN END USE MATERIAL

BRIDGING DESIGN TO FULL VOLUME PRODUCTION

THE CHALLENGE

By providing design files, a list of materials, and assembly instructions, Maker Mask enabled individuals around the world to make NIH community approved masks with 3D printers.

In addition to the DIY masks, Maker Mask was looking to make masks more widely available through volume production - especially as communities continue to re-open and essential workers (outside of medical) like teachers, retailers, etc. need to protect themselves.

Going from 3D printed materials to full scale production with different end use materials has its challenges. Maker Mask was looking for a way to validate end use material for the mask design before putting into full scale production.

***Application** / Injection Molding*

***Material** / TPV 80A*
TPU 70A

***Customer** / Maker Mask*

SOLUTION

Fortify advised on modifying the design from a part that was DFAM (design for additive manufacturing) to something that was DFIM (design for injection molding). Fortify successfully printed the designed molds on an in-house FLUX ONE 3D printer. The Fortify team then molded various materials on the tool and provided the parts to the Maker Mask team. This enabled Maker Mask to make a decision on the final material as they ramp up to full scale production.

***Left** / 3D printed mold tool for mask design included a single cavity with three plates*

***Right** / Injection molded part run on Fortify's 3D printed tool*

BACKGROUND

In response to the COVID-19 crisis, Maker Mask's goal was to enable people to meet community needs for high quality, protective masks and other critical medical supplies. As the pandemic continued to loom over everyday life, the sustained need for community approved masks became apparent and Maker Mask started working to address the shortages of personal protective equipment with a plan to manufacture the masks at high-volume via injection molding.

With new manufacturing processes afoot to produce at scale, Maker Mask needed to test the materials before putting it into full production. Traditional tooling would have taken 6-8 weeks of lead time and at a high cost.

MITRE Corporation (A Maker Masks collaboration partner) suggested the team leverage Fortify's 3D printed tooling solution as a method to rapidly prototype and test materials.

Image courtesy of Maker Mask

Maker Mask 3D printed mask design

THE PROCESS

STEP 1: DESIGN THE MOLD

Fortify's applications engineering team designed the mold tool to be a single cavity with three plates, and one "floating" core.

> "This was a super unique mold design, that allowed Fortify to flex a lot of muscles. Not only did we print the largest printed mold I've ever seen, we were able to create a very natural geometry that would have taken a significant amount of time to machine."
>
> - Ben MacDonald, Molding Applications Engineer, Fortify

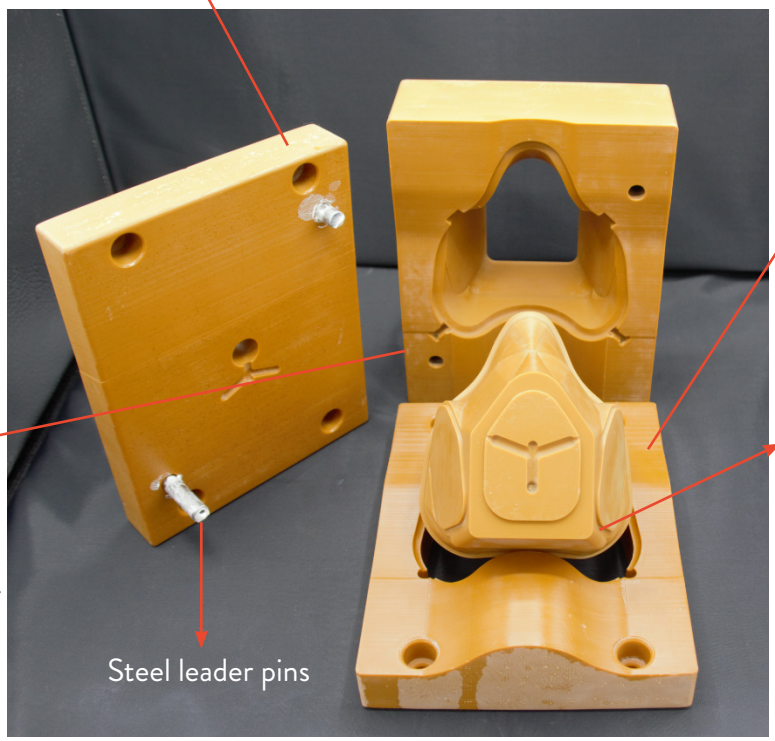
The CAVITY consists of the first plate and second plate. The CORE consists of the third plate and floating core.

A HALF - CAVITY

FIRST PLATE

Houses sprue bushing and creates the flat front face of the mask

- Runner plate connects sprue bushing to runner system
- Fixed plate directly mounted to the top clamping plate
- Houses steel guide pins that position and support the second plate of the mold stack



SECOND PLATE

Cavity plate for the mold stack that creates the rest of the outside geometry of the mask

- "Floating plate" not fixed, but supported by two 3/8" diameter steel pins for easier ejection due to significant ejection forces from a large part
- Includes two large shut-offs on either side, creating holes for filter attachment
- Incorporates two inserts which create loops that allow straps to be attached to the mask.

B HALF - CORE

THIRD PLATE

Core plate that is fixed and mounts to the bottom clamping plate and forms mask area that seals to the face

- Incorporates four inserts that create four loops for connection points for the mask straps
- All inserts are easily added and removed by hand to the two fixed sections

FLOATING CORE

- Fifth insert on B half is a floating core which creates full inner geometry of the molded part
- Floating core is supported by a cutout on the fixed core plate

ADDITIONAL DESIGN CONSIDERATION

- Large mold stack - a big win for 3D printing: 121.75mm x 160mm x 203.2mm (4.8” x 6.3” x 8”)
- Parting line is a curved face with a natural flow and is designed to mimic the centerline of the base sealing section of the mask in order to avoid an undercut on either side of the mold
- Mold designed to be unsupported on all four sides of the mold stack. To ensure successful molding, a 15mm wall thickness was incorporated to accommodate for the injection forces.
- Direct sprue gate in the plastic mold displays ability of Fortify’s tools to withstand injection molding pressure
- Geometry of this mold would typically be very pricey and have long lead times if machined.
- Designed to mold directly in press without mold base

STEP 2: PRINT THE MOLD

Fortify printed the mold cavity on an in-house FLUX ONE 3D printer with Digital Tooling Resin, powered by LOCTITE 3D IND147 HDT230 Tough Natural. The LOCTITE resin offers a high heat deflection while providing a smooth surface finish for mold production.

The FLUX ONE printer enables a step change in performance from other 3D printed tools with two proprietary technologies:

- CKM - Continuous Kinetic Mixing
  - A mixing, heating, and recirculation module that allows ceramic fibers to be incorporated into the base resin without settling out. This results in a fiber homogeneously dispersed throughout the printing process leading to better strength, stiffness and heat deflection temperature
- Fluxprint - Magnetic Alignment
  - A magnetic field is applied throughout the printing process to orient the fibers in the optimal orientation for better material performance.

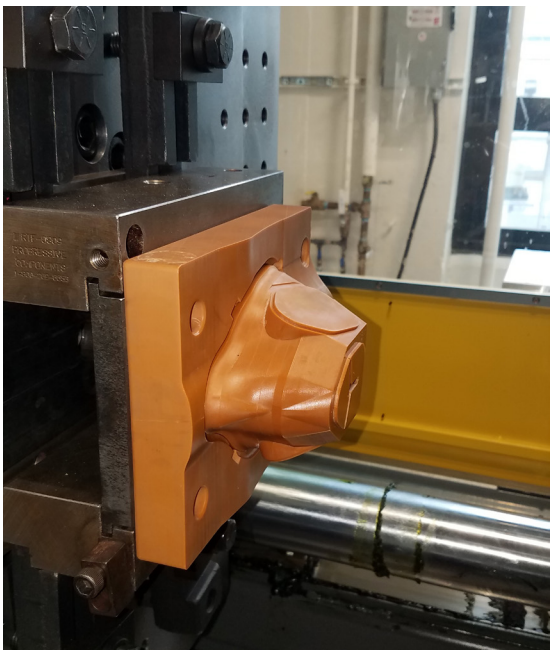
With fiber-reinforcement aligned in the tools, Fortify’s mold tools can outperform other 3D printed tools- which means more shots in more materials for more complex geometries.

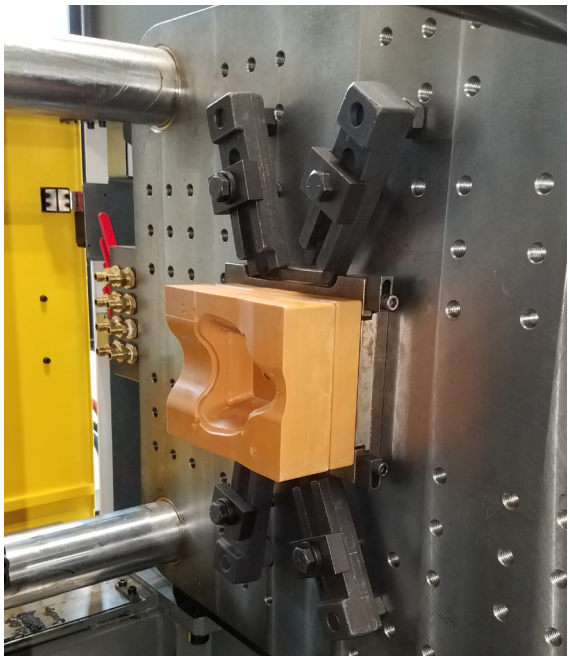
FORTIFY DIGITAL TOOLING RESIN
POWERED BY

LOCTITE®

STEP 3: SHOOT THE MOLD

Two different materials were run on Fortify's 3D printed mold tool:





STEP 4: TEST THE MATERIAL

Maker Mask was looking for a material that could create a good seal, was comfortable to sit on a person's face, and had enough structural integrity to mount and secure the air filter in place. Being able to physically touch and test the material in the intended design enabled Maker Mask to make that decision ensuring confidence in ramping up volume production.

TPV 80A

TPU 70A