Photocentric

Printing Ventilator Valves
A test case for mass manufacture by 3D printing using screens

Purpose

To explore the viability of 3D printing respirator valves in volume using Liquid Crystal printers.

Designs

We used an open source design https://grabcad.com/library/respirator-free-reanimation-venturi-s-valve-1/details?folder_id=8017467. Designs will need the approval from the respirator manufacturer.

Medical approval

All of our hard polymers will pass cytotoxicity and skin sensitisation tests if processed correctly. Our polymers are chemically similar to those used in dental amalgams which are used internally in the body for life. If these have been reacted fully by the free radical process, they will pass Class 1. Medical approval would be part of our declared manufacturing procedure. Covance have agreed to fast track approval to Class 1 for our suggested grade for making respirator valves, RG35 (amber, translucent). We have added an antimicrobial agent to the formulation to make the product safer. Because of the circumstances Covance will complete the tests in 4 days.

The need for the valve

The UK is currently searching for domestic manufacturers of ventilators and other related parts. https://www.ucl.ac.uk/healthcare-engineering/news/2020/mar/global-search-low-cost-ventilator-technologies

These will have to manufactured quickly, ideally from domestic manufacturers to avoid export restrictions on components. New respirator valves will need to be manufactured and tooling is often held or machined in other countries, is at capacity or is not available.

Due to potential contamination from previous patients, it may be that they need to be replaced, and some hospitals have run out.

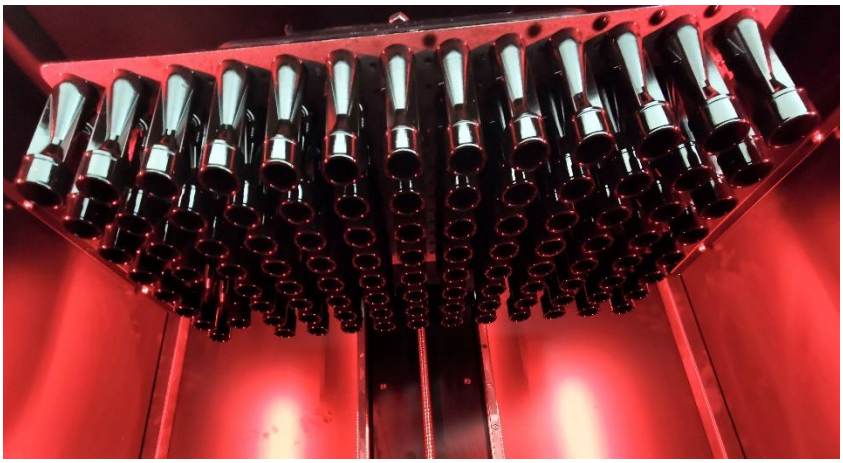
Alternative methods of 3D printing

The majority of SLA prototype resins in the world are made from oxetane based cationic resins (3DS, DSM etc) and will not pass those tests because they are highly hydroscopic, whereas our chemistry will. They also would take an impractically long time to manufacture by laser beam.

FDM does not provide high enough resolution (the internal air channel hole has a 1.0 mm internal diameter, making it difficult to manufacture), it cannot be autoclaved (as it is thermoplastic), it leaves a surface that is rough and corrugated and will harbour bacterial growth.

Our trial manufacturing of valves
We printed the valve vertically as tightly as possible on the bed (no supports) on the following printers:

Liquid Crystal Magna
Quantity per bed: 104 (platform area 510 x 280mm)
Time to print: 8 hours (@100 micron)
Quantity per hour: 13
Scanned resolution: +/-100 µm (>90% of the bed)
Quantity made per Magna per week = **1560** (running 24 hours a day, 5 days a week)



Liquid Crystal Titan
Quantity per bed: 171 (platform area 700 x 392mm)
Time to print: 11 ½ hours (@100 micron)
Quantity per hour: 14.9
Scanned resolution: +/-75 µm (>90% of the bed)
Quantity made per Titan per week = **1710** (running 24 hours a day, 5 days a week)

Liquid Crystal Maximus

Quantity per bed: 220 (platform area 920 x 510mm)
Time to print: 9 hours (@100 micron)
Quantity per hour: 24
Scanned resolution: +/-150 µm (>90% of the bed)
Quantity made per Maximus per week = **2933** (running 24 hours a day, 5 days a week)

Validating the valves we manufactured

We printed over 600 of them overnight on three machines.
All have the internal 1mm hole open and after post processing were dry, shiny and hard.

Supplying valves

Photocentric could produce >40,000 of these valves every week using the existing Liquid Crystal printers in our building, working 5 days a week, printing 24 hours a day.