Rapid Fluidics
Shaping the Future of Microfluidics

DESIGN FOR ADDITIVE MANUFACTURING

Below highlights some of the key design points that should be considered when designing parts for 3D printing, also considerations when specifically designing microfluidic devices. These points are guidelines however due the nature of 3D printing these may need to be adjusted to suit your application.

GENERAL RULES:

1) Avoid Sharp Edges/Corners

- Sharp corners and edges are areas of high stress concentrations, which increase the risk of cracking or premature failure.
- Use fillets or chamfers on all internal and external sharp edges and corners where possible, to reduce stress concentrations during printing.
- Chamfers of >0.4mm are acceptable for corners.
- Internal/external fillets of >0.5mm are generally acceptable. Larger fillets help to improve strength and aesthetics. Smaller fillets <0.5mm are still acceptable however at <0.2mm these fillets may not be accurately represented on the resultant printed part.

2) Ensure Sufficient Wall Thicknesses

- Where channels, holes or voids are located close to one another or the edge of the part, increasing the wall thickness at this point will provide greater strength, reducing the risk of delamination in these areas.
- The ideal wall thickness would be ≥1mm for holes and channels, for specific applications speak to one of the RF Engineers.

3) Design Within Realistic Print Tolerances

- Depending on the required printer, settings and material, typical resolution limits are approximately 25-50μm in XY and 10-50μm in Z.

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4) Remove Excess Material

- Optimise the part geometry to remove excess material where possible.
- Unlike some machining processes, removal of additional material does not cost more; in fact, it reduces the material usage and enables higher part density per build, reducing unit cost.
- The decreased weight also reduces the risk of errors during printing such as detachment from the platform.

5) Minimise Unsupported Overhangs

- Features that don't have sufficient layer-to-layer support will require support scaffolds. This will increase post-processing time, surface damage risk and consequently cost.
- Overhangs of roughly <45° are generally acceptable without additional supporting scaffolds (also dependent upon print orientation).

6) Avoid Fully Enclosed Volumes

- All channels and chambers must include an inlet and outlet, this allows any uncured resin to drain and be cleaned effectively.
- The inlets/outlets are generally of the same diameter as the channels, however they can be larger/smaller to accommodate fittings e.g. threads or luers.

7) Consider Print Orientation Early in Design

- Parts designed to print flat generally have shorter print times for small batches (reducing cost).
- For larger batch production, designs that can be printed vertically (on an edge) improve throughput and reduce cost.
- The final part printing orientation will be chosen by an RF Engineer, however recommendations on orientation will be considered.

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8) Avoid Large, Thin, Flat Parts

- Having a large surface area and small thickness can lead to residual stresses and warping of the part. A part that has roughly a <10:1 (length:thickness) ratio will be less prone to warping.

- To minimise warping further, add relief holes, ribs, or local thickening to improve the stiffness.

9) Plan Critical Interfaces

- Valve seats, sealing surfaces and mating faces should be clearly defined, generously supported, and isolated from distortion-prone geometry.

- Assessing the print orientation for critical interfaces could help to optimise functionality.

10) Allow For Post-Processing Access

- Areas requiring additional post-processing should be accessible so that sanding or lacquering, for example, could take place.

- These processes may alter the mechanical properties of the material (such as biocompatibility) and so should be discussed with the RF team on the suitability for each application.

FOR MICROFLUIDICS:

11) Consider Minimum Channel Dimensions

- If channels are enclosed use minimum dimensions of 200μm x 200μm (width x depth).

- If channels are open use minimum dimensions of 100μm x >50μm (w x d).

- The minimum channel dimensions may vary depending on the resin selected, i.e. biocompatible resins are more viscous requiring larger channels, please see resin options guide here.

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12) Use Curved Channels

- SLA & DLP printing enables continuous channel geometry.
- This allows you to remove sharp turns and optimise the fluid paths for ideal flow characteristics.

13) Circular (or Oval) Channel Cross-Sections Preferred

- 3D printing allows for square, circular and any bespoke shaped channel cross-sections.
- Circular channels print more consistently and provide a more uniform flow than square/rectangular channel geometries, when printed enclosed.

14) Minimise Channel Lengths

- For channels under ∅ 400µm aim to keep the length:diameter ratio under 150:1.
- Long, convoluted (~2 or more bends/turns) channels with a small cross-sectional area are more prone to blockages, particularly below ∅ 400µm.
- To reduce this risk of blockage, keep channels as short and direct as possible for the design.

15) Maintain Channel Aspect Ratios

- Enclosed Microfluidic channels should ideally be ~1:1 (width;depth).
- Enclosed channels/chambers, above 10:1 (w:d) may collapse or deform when printed.
- If a large chamber is essential permanent support pillars may be required in the design to avoid collapse.

The design points covered in this document are general guidelines, please get in touch and talk to one of our engineers if you have any questions regarding your design!

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