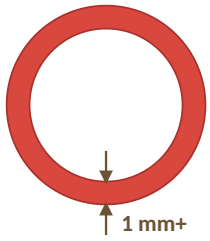
DESIGN FOR CASTING GUIDE

Design it to cast, not just to print.

A printer will happily print a wall, claw or gap that the flask cannot turn into good metal. These are the design rules that decide whether a pattern casts. The figures are common starting points published by casting services and suppliers. Check them with your caster, then prove them in your own alloy.

1 Walls



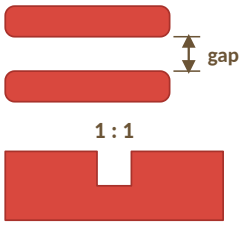
1 mm band, 0.8 mm walls

2 Prongs & seats



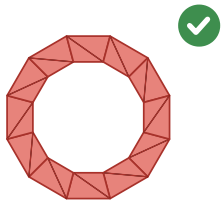
Sized to the stone

3 Gaps & detail



Room for the investment

4 File prep



Closed mesh, in mm

THE NUMBERS AT A GLANCE

0.8 mm most walls in gold, silver from 0.6 mm	**1 mm min** ring band wall	**0.5 mm** claws and small bezels, 0.8 mm for long wires	**0.3 mm** min gap between parts, wider is safer	**1 : 1 max** engraving depth to width	**1.5 mm+** drain holes in hollow pieces, two or more

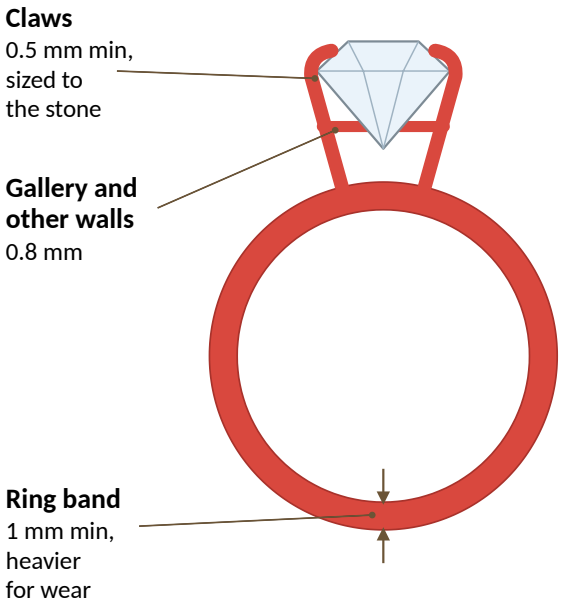
Common starting points from the Materialise, Shapeways, Stuller, Cooksongold and Formlabs design guidelines, mostly for gold. Your caster's numbers come first.

Before you start

- **Ask your caster for their limits.** The alloy, the investment and the casting machine all change them, and your caster's numbers overrule any chart, including this one.
- **Design for the metal.** These limits are for finished castings. They are set by whether the investment survives, the metal fills and the piece stands up to wear, not by what the printer can print.
- **Know your metal.** Materialise accepts 0.6 mm walls in gloss finished silver but asks for 0.8 mm in gold. Stuller's production standards want 0.8 mm between shank rails in platinum and palladium, against 0.6 mm for other metals.
- **Allow for finishing, then test.** Polishing removes about 0.1 to 0.2 mm, so every feature must still meet the minimum after it is polished. Prove your numbers with a test plate (step 6).

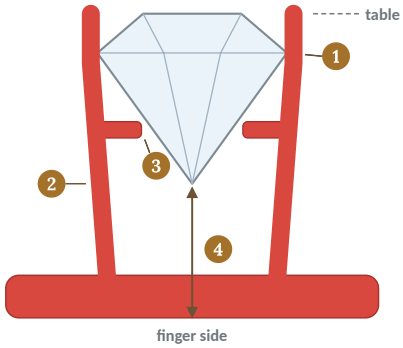
1 Walls, wires and prongs

- **0.8 mm for most walls.** Stuller and Cooksongold use 0.8 mm for structural and external walls, and Materialise for most gold pieces. Materialise accepts 0.6 mm in silver with a gloss finish.
- **Ring bands 1 mm or more.** Materialise asks for at least 1 mm, as a thin band can break in wear. Stuller's production standards start shank profiles at 1.5 mm wide and 1.7 mm thick.
- **Inner walls 0.6 mm.** For walls and floors that run between structural walls (Stuller).
- **0.5 mm for small parts.** Claws and small bezels need at least 0.5 mm (Cooksongold). Stuller's minimum for metal to cast at all is 0.5 mm thick by 0.6 mm deep.
- **Long wires and prongs 0.8 mm.** For rods and prongs in open, mesh-like designs (Materialise). Short details on a solid surface can go down to about 0.35 mm across and 0.4 mm high.
- **Go heavier where it matters.** Anything that takes wear, holds a stone or gets polished hard needs more than the minimum.



2 Stone seats and settings

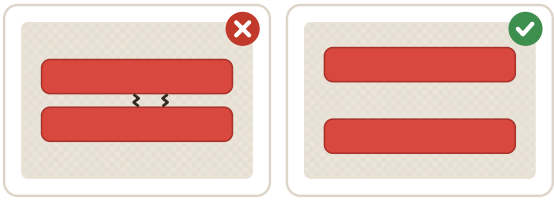
- **Keep the stones in the file.** Seat each one around the actual stone, or the calibrated size you will buy. Stuller only accepts customer stones within 0.1 mm of the stones in the CAD file.
- **Size prongs to the stone.** A Formlabs castable resin test ring used 0.7 mm prongs on 2.5 mm side stones and 1 mm prongs on its 8 mm centre stone. Stuller sizes prongs in proportion to the stone, never under 0.45 mm.
- **Leave the setter metal to move.** Stuller's standards overlap each prong 0.15 mm into the girdle, with the base of the domed tip level with the table. That leaves metal above the girdle to bend over the crown when the stone is set. Bezel walls at least 0.45 mm.
- **Clearance under the stone.** About 0.2 to 0.3 mm between a diamond's pavilion and the gallery, and 0.3 to 0.5 mm for coloured stones, which often have bulging pavilions (Charlie Herner, Ganoksin). Keep the culet at least 0.5 mm clear of the finger (Stuller).
- **Stones 0.15 mm apart,** girdle to girdle, when prong set (Stuller).
- **Design heavy where you polish.** Finishing takes off about 0.1 to 0.15 mm (Materialise, gold) and up to 0.2 mm (Stuller). Add it to prongs, bezels and edges.



1. Overlaps the girdle 0.15 mm, tip at table
2. Prong in proportion to the stone, 0.45 mm min
3. Gallery 0.2 to 0.3 mm clear (0.3 to 0.5 mm for coloured stones)
4. Culet 0.5 mm or more clear of the finger

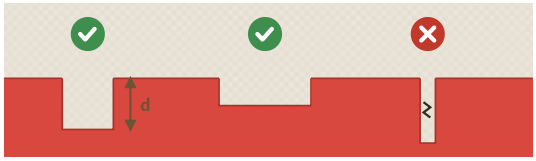
3 Gaps, holes and engraving

- **Every gap becomes investment.** It has to fill, then survive molten metal rushing past. Too thin, and it breaks or the parts fuse.
- **0.3 mm is the minimum gap** (Materialise, Shapeways). Stuller's standards ask for 0.6 mm between shank rails, and 0.8 mm in platinum and palladium. Wider is safer.
- **Draft prongs near a wall.** Formlabs suggests a 5° draft, which leaves more room for investment between prong and wall.
- **Holes 0.5 mm or bigger** (Formlabs, Cooksongold, Stuller), and that small only in thin material.
- **Engrave no deeper than wide.** 1:1 depth to width at most (Materialise, Shapeways). A deep, narrow line leaves a thin fin of investment.
- **Lines 0.3 to 0.35 mm wide or more.** Stuller's standards: letters 0.35 mm wide, 0.3 mm apart, no more than 0.6 mm deep, with 0.6 mm of metal under recessed text. Cooksongold keeps recessed text to 0.5 mm deep.
- **Plain fonts.** Shapeways prefers sans-serif. In Formlabs' tests, the smallest letters of an ornate script failed to cast.



Too tight: the thin investment breaks

Room to fill and survive 0.3 mm min, wider is safer

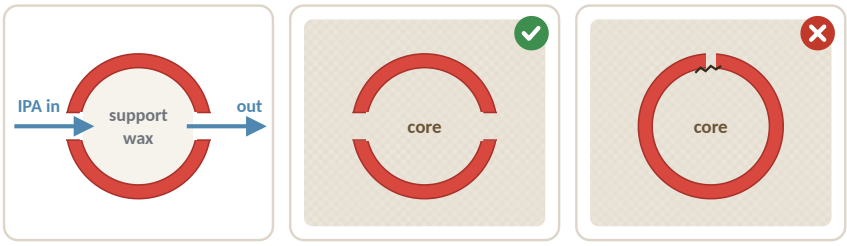


1 : 1 max **wider than deep** **deep and narrow**

Red: the pattern, which becomes metal. Speckled: investment.

4 Hollow pieces

- **Why hollow.** Less metal in a large piece means lower cost and weight. In a CAD example by Eddie Bell (Santa Fe Symposium 2012), cutting the minimum wall of a 13 mm hollow bead from 0.75 to 0.5 mm took its gold weight from 5.91 g to 4.75 g, nearly 20% less.
- **Start the shell at 0.7 to 0.8 mm.** Formlabs recommends 0.7 mm for hollow shells in its Castable Wax Resin, and 0.8 mm is the gold wall minimum at Materialise. Go thinner only after a test cast.
- **Two or more holes over 1.5 mm,** spread out (Materialise). Shapeways says two at opposite ends work best. Make them part of the design, as decorative or stone setting holes (Bell, Formlabs).
- **Printed wax: let the support out.** On a WaxJet a closed hollow prints full of white support wax. The holes let warm IPA in and dissolved support out. Check nothing is trapped, and let the IPA evaporate fully before investing.
- **Anchor the core.** Through large enough holes, investment fills inside and out at once and the core stays tied to the mould (Bell). One 3.5 mm hole in a bangle leaves a large core on a plug too small to hold it when the metal arrives (Formlabs). Casters can laser weld the holes shut afterwards (Bell).



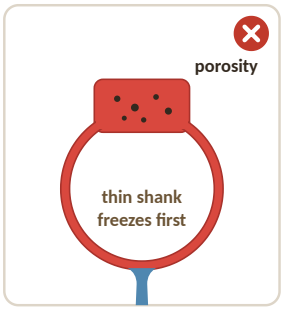
Printed: support fills it, warm IPA flows through

Invested: the core is tied to the mould

One small hole: the core hangs on a thin plug

5 Help the metal feed

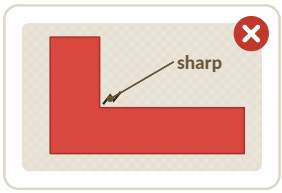
- **Metal shrinks as it freezes.** Most gold and silver alloys lose 5 to 6% of their volume from liquid to solid (Eddie Bell, for the World Gold Council). Every section needs liquid metal feeding it while it freezes.
- **Thin sections freeze first.** A thin section between the sprue and a heavy one freezes and cuts off the feed. Bell calls thick, thin, thick "always a recipe for shrinkage porosity".
- **Keep sections even.** Uniform cross sections are one of the best things a designer can do for fill and density (a caster in MJSA Journal). Where they must differ, sprue the heaviest part.
- **Take the mass out, not the strength.** For a heavy top on a thin shank, Bell suggests hollowing the top from the finger side and thickening the shank.
- **Fillet inside corners.** A sharp inside corner leaves a point of investment that can break off into the metal (Formlabs). Cooksongold suggests a 0.3 mm radius.
- **Add a sprue point to the model.** A small post or pad on the thickest section, away from seats and detail, as in the Casting Tree guide.



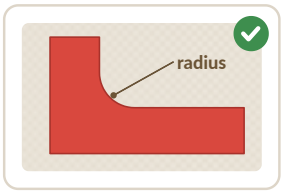
Heavy top, thin shank, sprue on the thin part



Top hollowed, shank thicker, sprue on the heavy part



Sharp inside corner

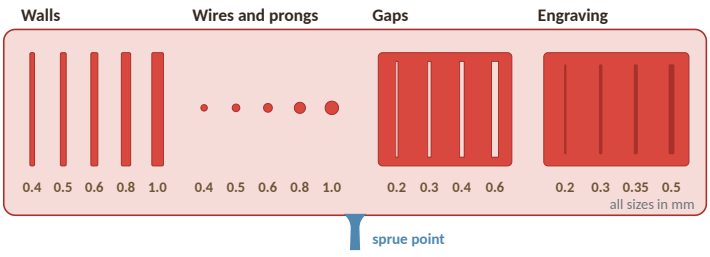


Filleted, 0.3 mm or more

6 Prove it with a test plate

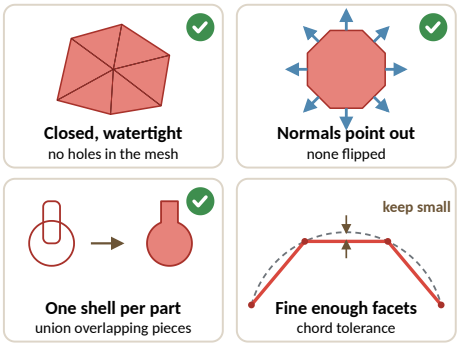
- **Make one small plate** with steps of wall, pin, gap and engraving sizes around the numbers in this guide. Cast it in your own alloy with your caster's process and see what fills. Repeat for a new alloy or caster.
- **Measure shrinkage, do not guess it.** Metal contracts as it cools, the investment expands and offsets much of that (Richard Austin, Ganoksin), and the pattern has its own tolerance (Flashforge quotes ±0.04 mm per 20 mm for the WaxJet). Stuller: the shrinkage you get depends on your process.
- **Published figures vary.** In Austin's test, acrylic bars cast 0.71% and 0.86% smaller than their models. With finishing, Weston Beamor quotes about 1 to 3%, and Shapeways about 2.5% plus 0.25 mm for gold. A rubber mould adds more.

> Your shrinkage, in %
>
> **(pattern minus cast) ÷ pattern × 100**
>
> Measure the same feature on the clean pattern and the finished casting, then scale the model. For rings, see the Ring Sizing guide.



7 Prepare the file

- **Model in millimetres.** Set the units before you start. A millimetre file read as inches prints 25.4 times too big.
- **Closed and watertight.** Every part is a closed volume, with no holes or gaps in the mesh.
- **One shell per part.** Union overlapping pieces, such as prongs, head and shank, into one solid before export.
- **Normals out, no self-intersections.** Run a mesh check and fix flipped normals, holes and intersecting triangles.
- **Fine enough facets.** You cannot print a model smoother than its STL. For Rhino, Stratasys suggests a tolerance under half the printer's resolution (0.01 mm for a 0.03 mm printer).
- **Export STL.** The WaxJet software takes STL and SLC files (Flashforge).



COMMON DESIGN MISTAKES

MISTAKE	WHAT GOES WRONG	DO THIS INSTEAD
Walls or claws under the minimum	Short fill, or parts that bend or break in wear	0.8 mm walls, 1 mm bands, 0.5 mm claws
Designed to the minimum, then polished	Prongs, bezels and edges end up too thin	Add about 0.1 to 0.2 mm where you polish
Gaps under 0.3 mm	Investment breaks, parts fuse or fins form	0.3 mm min, wider where you can
Engraving deeper than it is wide	Thin investment fins break, lines fill poorly	1:1 max, lines 0.3 to 0.35 mm wide or more
Heavy section fed through a thin one	Shrinkage porosity in the heavy section	Even sections, sprue the heaviest part
Sharp inside corners	Investment points break off into the metal	Fillet, about 0.3 mm radius or more
Hollow piece with one small hole	Trapped support, a shifting or broken core	Two or more holes over 1.5 mm, spread out
Guessing shrinkage	Wrong size, most noticeable on rings	Measure it with a test cast, then scale

BEFORE YOU EXPORT: CHECKLIST

- [ ] Units in mm, piece at final size
- [ ] Gaps 0.3 mm or more, wider if you can
- [ ] Even sections, sprue point added
- [ ] Walls and claws allow for polishing
- [ ] Engraving no deeper than wide
- [ ] Hollow: two or more holes over 1.5 mm
- [ ] Prongs sized to stones, stones in file
- [ ] Inside corners filleted
- [ ] One closed shell, normals out

3D WERK

Local Flashforge WaxJet support in Sydney

Questions about your wax patterns?

support@3dwerk.com.au

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