Morris and Watson

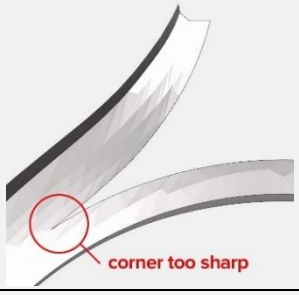
# CAD Design Guidelines

## Investment wash

Investment is the plaster-like material that is used to encase wax or resin patterns, creating an impression ready to receive the molten metal.

Fragments of investment can break up during metal injection and relocate to other parts of the casting creating holes, porosity and poor surface quality. This is referred to “investment wash”.

Investment wash is one of the most common sources of casting defects and can be caused by several design aspects or errors. The most common design issues that cause casting defects are explained below.

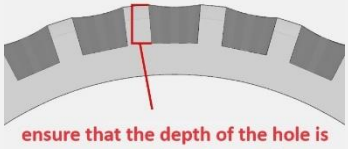



### Sharp Edges

A common cause of investment wash is the CAD model containing sharp edges, points or corners. Edges, points and corners should all be **curved with a radius of at least 0.125mm** (also known as rounding, filleting or edge softening).

Popular design software such as Matrix has plugins and functions to perform this task.

The most common sources of sharp edges are components with edges that meet to a point and straight, sharp angles (such as split shanks or lettering).

ensure that the depth of the hole is not greater than the opening (e.g. if the opening is 1 mm wide, the depth should be less than 1 mm wide)

### Holes, Gaps and Voids

Another cause of investment wash is when models contain aspects such as lettering, stone holes, fine gaps or spaces that have a depth that is greater than the width of the opening. **The depth of the void should not exceed the width of the opening of the void.**

***The maximum depth of a hole should not exceed 0.30 mm***

If the design requires holes, then a small pilot divot is better, allowing for the entire hole to be drilled out later.

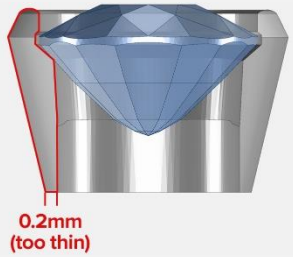
Adequate spacing between parts or components that are not meant to be touching is important. Small gaps or voids can be sources of investment wash or poor formation.

**Always maintain a gap of at least 0.20 mm** between components such as claws, setting posts and walls.

**If this is not possible, fill the gaps and drill them out later.**

Ensure that any holes are ***greater than 0.20 mm in diameter*** and ***do not have a depth larger than the diameter or opening of the hole.***

If the design requires a pilot hole, then a small pilot divot is better, allowing for the entire hole to be drilled out later.




### Material Thickness

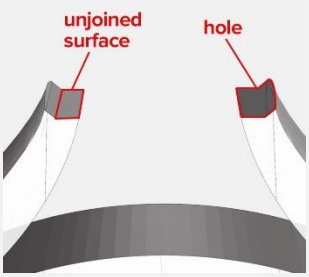
The wall and component thickness should be considered when creating designs.

Cast material that is too thin may cause shrinkage, porosity, distortion, or breakages.

Factors such as the surface area and complexity of the design may require greater design thicknesses.

***The minimum design thickness should be at least 0.40 mm*** and ***broad or flat areas should be at least 0.50 mm thick.***

If the final piece is required to be moulded for multiple copies, then should be at least 0.90 mm thick.



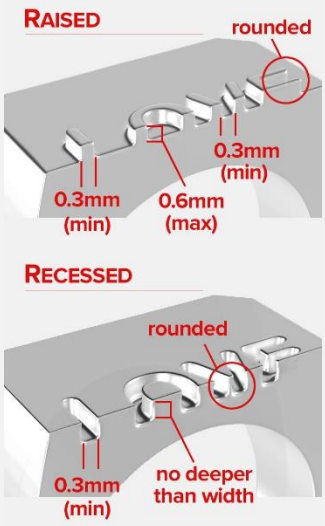

### Naked Edges and Non-Watertight Models

Naked edges are open edges which are not connected to any neighbouring edges, producing a model that is not “watertight”. Errors may not be visible to the naked eye.

**Non-watertight models can cause print issues** and may be detected as corrupt or invalid by print software, preventing the file being printed and adding possible delays.

Ensure to utilise the analysis and check functions in your CAD design program to determine if your model is "watertight" and free of any naked edges.

Curved surfaces are a typical source of naked edges, particularly with text designs on 3D files. Most text fonts are designed with graphic design in mind, not 3D printing.



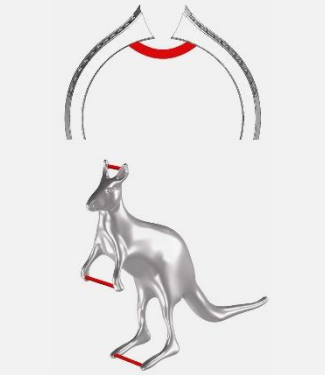

## Text and Lettering Design

CAD designs often include text, hallmarks, logos and stamps and are usually recessed into a section of the design. While these designs look great and can be useful (particularly for showing a maker's mark or caratage) stylised fonts and impressions are not always conducive to successful investment and casting. If the design includes these aspects, **consider using square angles or simple fonts such as Sans Serif**. Avoid curved designs that taper to a fine point.

***Raised text: designs must have a minimum width and spacing between letters of at least of 0.30 mm. Raised text should only have a maximum height of 0.50 mm.***

***Recessed text: designs must have a minimum width and spacing between letters of at least of 0.30 mm. Recessed designs should be recessed to a maximum of 0.30 mm deep and no deeper than the width of the opening.***

If possible, **draft or taper by 5-10 degrees so that the bottom of the impression is narrower than the opening** and avoid sharp corners ensuring that ***edges and corners are rounded to at least 0.125 mm.*** If a complex or highly stylised design is required, laser engraving may more suitable.



## Unsupported Components and Protrusions

Designs that contain aspects that protrude or are poorly supported can break off during the casting process, particularly at the wax handling (cleaning, treeing, etc) and investment stage or they can twist and warp at the casting stage.

Please ensure that protruding and thin parts are thick enough to support themselves or contain additional supporting sprues or strips to minimise the risk of breakage. The thickness required is specific to the design. **Alternatively, a supporting or bridging sprue of at least 0.80 mm in diameter can be inserted on the drawing to add support.**

This also applies to components that may have large gaps and openings or unsupported protrusions (i.e. shanks that have an open gap to place the setting in, or claw settings that may require a supporting halo sprue).


## Multiple Parts and Components

Designs with multiple parts or components (i.e. setting and shank) need to be exported as separate STL files, especially for multiple components that are cast in different alloys.

Designs with multiple parts or components that are to be cast in the same alloy need to be connected via a sprue so they can be cast as one continuous piece.

Some designs can be printed and cast as one piece, but quality and feasibility are not guaranteed. Best practice is to export multiple components into separate STL files.

**Multiple files may also allow for faster and tidier cleanup of difficult to reach areas.**


## Finishing and Shrinkage

Castings are typically supplied in a semi-raw form with further finishing required.

**Finishing can remove up to 0.10 - 0.20 mm of the surface material**, so this needs to be factored into the design.

Shrinkage may also occur over the various stages of printing and casting.

**Allow for at least 1% shrinkage in gold and silver alloys and 2% for platinum alloys.**

This is especially true for components where accurate dimensions are required (e.g. stone setting spaces and finger holes in shanks).

## Designs That Restrict Metal Flow

Models that have design aspects with varying thicknesses and angles can restrict metal flow during the metal injection process. Main sprues are generally attached to the thickest part of the model to allow optimal metal flow.

Design aspects that are thinner or encourage a longer or more complex metal flow path may require additional feeder sprues to reduce the metal flow path length.

This can reduce the likelihood of components not forming properly or metal solidifying before it can successfully fill all the required spaces.

**Unsure? Ask us.** Feel free to send your CAD model, STL file or design to our CAD/CAM or Casting team. With decades of CAD, casting and manufacturing experience, our team can point you in the right direction. Contact your local office or trusted Morris and Watson Customer Service person, who are always willing to help.

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