CAD Design Considerations

When designing objects in CAD, there are various considerations that must be made depending on if you are turning a physical object into a digital one or vice versa. In this doc' I have outlined a number of considerations that should always be remembered when designing your parts:

Turning a physical part into a digital one:

- Don't just grab models from the internet. Most models on services such as "thingiverse" or "grabcad" have models which were made to an individual's preferences/specification. This does not mean they will match your actual component. Always measure and base your design off of the components you have. If you find a file from a manufacturer, always make a test part to see how things mesh and match up with its mounting.
- When taking measurements, always try and reference every measurement from the same face. If you take reference measurements from multiple places, then your model will get compounding errors.
- You don't have to have immaculate detail. Instead, make a part that fills the most important aspects of the thing of which you need. i.e. you don't need to model the teeth on a gear shaft if your design solely connects to the horn.

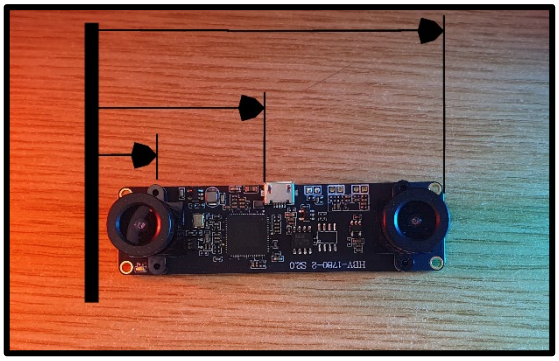

Figure 1 - Measuring from one side

- Always check your mounting holes dimensions and make a test piece that solely shows weather your dimensions are correct. I.e. don't waste time designing something if ultimately you haven't checked if it will fit.
- Don't forget about wires! You don't have to add the entire length, but if there are wires coming from a part, do include referencing to how large they are on the design. These are very commonly forgotten about.
- Need a really complex part for design reference? Take a photo from afar with a known distance marked on the face of the part or callipers at a set distance on the face of the part. If the camera is further away and the part is in the centre of the frame, you will get very little lens distortion. You can then import this photo into CAD and scale the image based upon the reference size you marked. This is a very quick way to get a close approximation of your part.

Figure 2 - An example of an image you can use for scale reference in CAD

Designing for 3D printing:

Figure 3 - Not enough clearance so the part gets stuck. This servo slightly tapers towards the base!

- Clearances are important. When you want parts to fit together, leave 0.4mm of clearance between the touching faces. When printed, these will then fit snugly together.
- Printing orientation matters. Just like wood, the 'grain' or the layers of the 3D print can rip and separate easier than the surface of a face.
- Try not to use sharp edges for connecting planes. Instead try and have a smoother transition between parts. This can be done easily by filleting a corner. 3D prints can have a weak interlaminar adhesion so the smaller this connecting area, the weaker the part.
- Never print spindles, shafts, pins etc. They are always very weak. Instead use existing materials such as metal rods, bolts, wooden dowel or anything similar for a circular pin. So many times, I have seen these in designs and they fail almost every time.
- A 5mm thick printed plastic part is very stiff and strong. Making parts huge adds a lot of weight and material to a design. Always consider how you can make your parts lightweight and save materials.
- 2D shapes can be laser cut, please don't print them.
- The printing process usually lays down lengths of material which are 0.2mm or 0.4mm in size. Try and keep to a multiple of this for best results when designing parts. E.g. Instead of a wall of 1.1mm, can it be 1.2mm thick?
- If you want multiple parts to lock together. Look at using dove tails or a bolt with a recessed nut to fix them in place. Yes, you can melt and 'weld' plastic parts together, but this can often damage either part and it is not reversible.

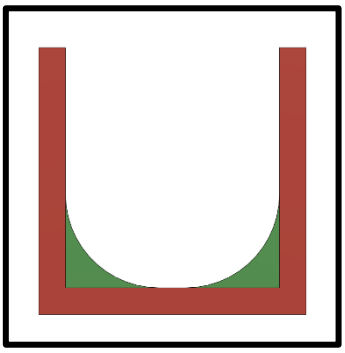

Figure 4 - In red, the desired part. In green, additional strengthening fillets to the sharp inner corners.

- If you have a large part, look at breaking the part up into smaller components which can be rotated and optimised for their appropriate printing rotation.
- Compliance can be incorporated into a design. You can design parts such that they flex and then clip into place. Simply adding a small nubbin and recess can allow for such locking parts.
- Try and ensure there is a flat face somewhere on the design. Often this will then be used as the side that sits flush on the bed of the printer.
- If your part has overhangs, then supports will be generated when it gets sliced for printing. Be aware of this as if you have long channels inside your part, they may get support material inside which will then be difficult to remove.

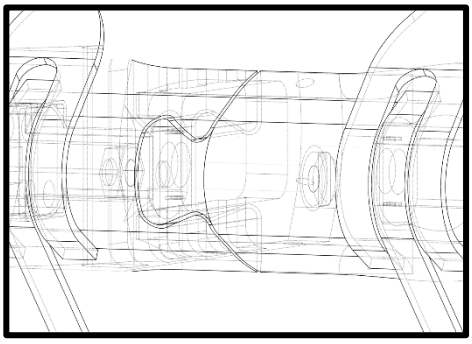

Figure 5 - A dovetail joint with a bolt to interlock the pieces

- Horizontally printed holes usually sag slightly when printed due to the layering. Try and either make them slightly larger to account for this or be prepared to drill them out to make sure they are circular.
- Threaded inserts are nice, but simply recessing a nut into your part can often be stronger.

If you ever have any questions, queries or concerns, feel free to ask. We will always be happy to help review designs and point out anything that may need improving.