

## Design Guidelines for FDM technology



This guideline is supposed to be used by people who already have knowledge in 3D design, CAD/CAM, etc. and it's goal is to show the key points when designing a model for FDM 3D printing, thus cutting the time and margins of error.

It is recommended to follow the guidelines when designing a part to be built using FDM technology, but it is not mandatory and already existing 3D models may be ready for printing, thus consider this document as a list with good practices.

FDM is accomplished by extruding thin layers of molten plastic layer by layer, producing strong, rigid models with nearly-visible lines where the layers are bond. As a general rule FDM is used for bigger

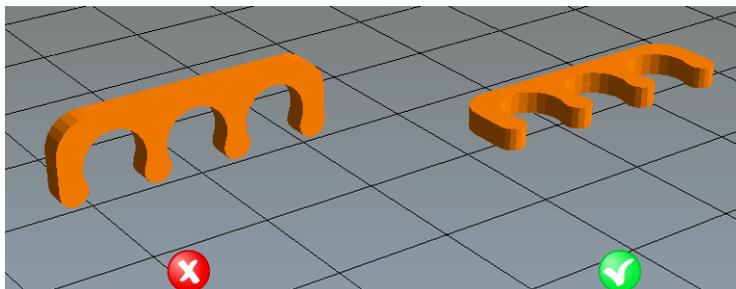
(functional) prototypes, where the surface finish is not that important, and other technologies (like SLA) are used for smaller, very detailed parts where the surface finish is smooth and shiny. Of course there are ways to improve the surface finish of FDM parts and Solidfill offers these services.

### Shrinkage and warping

Since a wide range of materials (ABS, PLA, PET, HIPS, Nylon, FPE – rubber like) may be used with the FDM technology, our team will automatically adjust the 3D model to the shrink rates of the specific material, so you don't have to take care of it when doing the modeling.

Our machines have enclosed build chambers to maintain constant temperatures, while printing which reduces and almost eliminates warping. However if your parts are prone to warping (long thin parts with no ribs) we will advise you how to modify them.

### Orientation



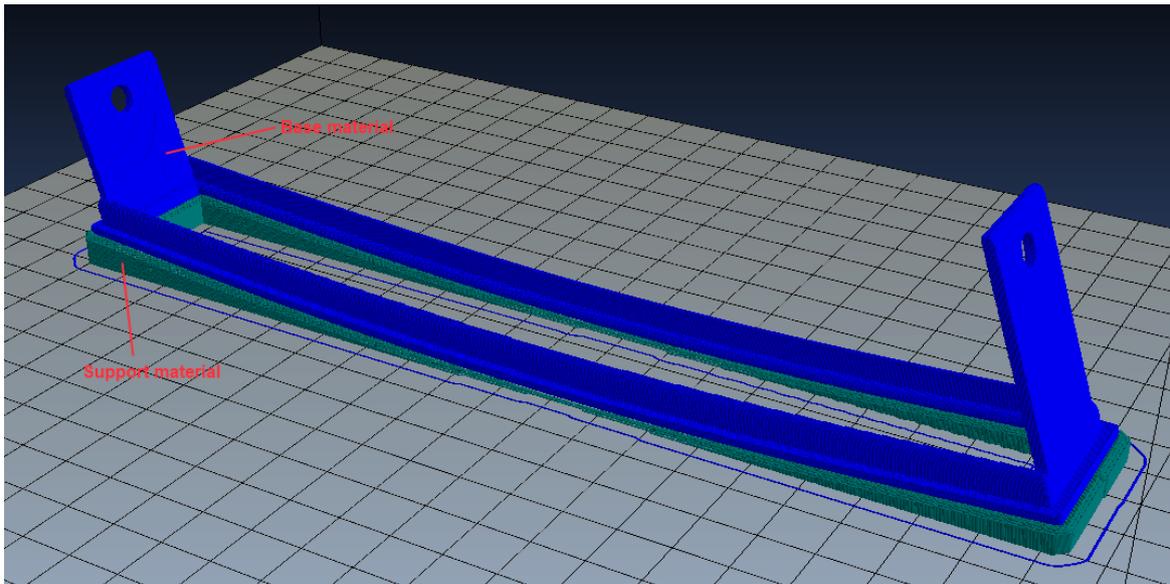
Since objects are printed on a large flat surface (heated glass bed) it is crucial that the parts stick to it, eliminating any movement or warping of the plastic during the printing process. This is why it is important that the parts have a flat surface, which will be used as the first layer deposited on the heated bed. Of

course we will use the best orientation for your part, or generate support material if it doesn't have a flat surface.

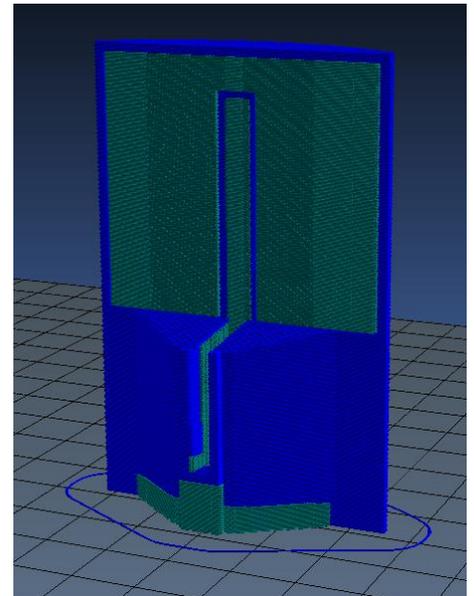
## Support material

Some parts, which have steep overhangs, bridges or no flat surface, are not possible to be build without the help of support material, because plastic cannot be deposited 'in the air'. In such a case a different material than the base one is used to support the part and it is removed (dissolved with special chemicals) later. We will try to position the part in such a way that the less possible support material is used, however sometimes we cannot escape it, so it is important that you design your models in ways that restrict the usage of support material - thus saving time and material.

Support material is not needed for the holes, angles bigger than 60 degrees (45 degrees is also possible, but not recommended) and bridges up to 2cm long.



It is possible support material to be deposited between two faces of the part, but it should be avoided, because it may leave marks on the base model. We will try to find the best orientation for you

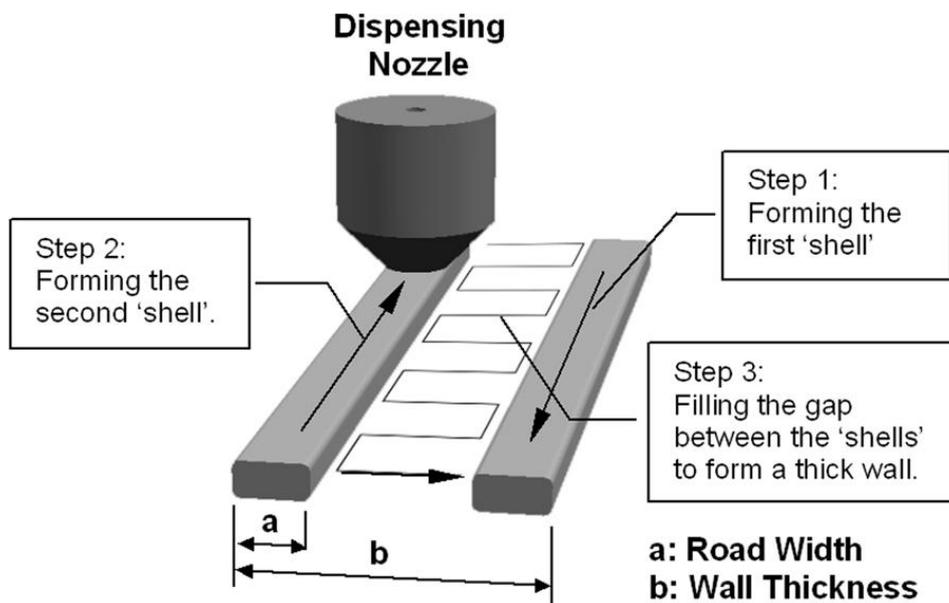


## Holes

Holes on FDM machines are generally undersized as result of many factors. This is considered as common for FDM machines, because it is easier to drill a smaller hole, than the opposite. When tight tolerances are required, either the holes in the model may be oversized or they may be drilled later. For example to get a 5mm hole it has to be designed with 5.2mm diameter. For holes up to 10mm in diameter you can add 2% to 4% correction and smaller for bigger diameters. Since the value by which you have to oversize the holes is different for different diameters, please consult with us to get the most accurate results. In general we will always review the design and either ask you to make the hole bigger or do it by ourselves, so it is not a big issue.

## Wall thickness

As a general rule, the bigger the wall thickness - the stronger the part, but of course it depends on the size and geometrics of the specific model - small parts may be strong enough with 0.2mm walls, while bigger parts will be brittle and will need thicker walls. Try not to make walls thinner than 1mm, just to make sure your parts will be strong enough. Wall thickness lower than 0.2mm will not be printed at all.



A good practice is to design the minimum wall thickness according to the layer thickness, so here is an example table how to do it.

Slice thickness	Wall thickness
0.1mm	0.3mm
0.2mm	0.6mm
0.25mm	0.75mm

## Fillets

Fillets are not necessary with FDM printing, but they may help reduce the stress during printing and strengthen the part. Also if they are printed horizontally on the first case we will have to add support material, while on the second case we might not need it.

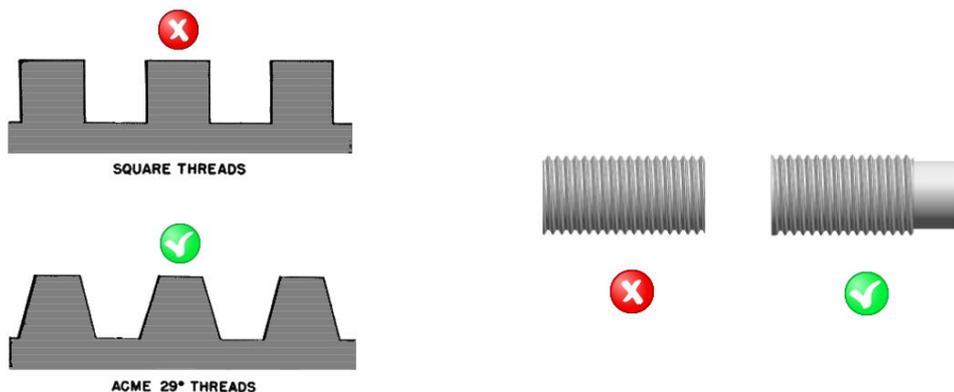


## Minimum column and pin size

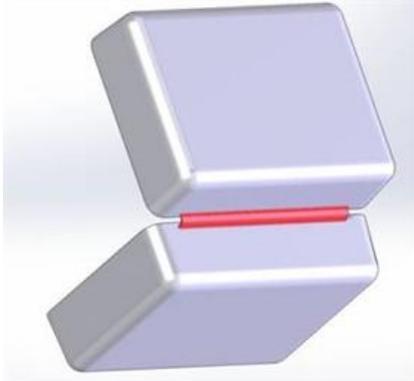
You should take care of the pins and columns width size (as well as other small features) of your parts, otherwise they may come out brittle or not printable at all. Small pins should not be less than 2mm in diameter if you want an usable part. Smaller sizes may print, but you should consider using more suitable technology we provide - SLA.

## Threads

When designing threads avoid sharp edges and 90 degrees angles as they can be stress concentrators in plastic parts. ACME threads (as shown on the pictures) are found to work well with FDM, so this is the recommended type. Recommended minimum size of the thread is 0.8mm. Small threads produced with FDM are not possible with holes smaller than 3mm, also there are easier alternatives.



## Living hinges



We can print living hinges (with some restrictions) with our FDM machines by printing the base part with one material (PLA or ABS for ex.) and the hinge itself with another, special rubber material, which can be easily bent, twisted and stretched. To do this, however we have to create 2 separate STL files, which have to match perfectly - one for the base part and one for the hinge and process them with our software. To save you the hustle just send us your files and we will do this for you.

## Finishing

Since the FDM technology works the same thermoplastics used in our everyday life, parts can be drilled, tapped, sawed, milled, etc. just as any other plastic part. Also we at Solidfill provide services for surface finishing like sanding, brushing and treating part's surface with special chemicals, so the visible layers are removed and it is smooth and polished.

