3D print on fabric

Take clothing design to a new level with 3D art

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Jen is a technology and DIY enthusiast with a passion for making. She is excited about the use of 3D printing, because it propels so many new ideas in art, science, renewable energy, and medicine.

Right
Decorate your clothes in a new way by 3D printing directly onto fabric

YOU'LL NEED

- **Fabric for testing**
- **Item of clothing to decorate**
- **8 bulldog clips** (available in office supply shops)
- **3D Printer or access to one**
- **3D printing filament** (we recommend you start with PLA)

3D printing is becoming ubiquitous – it's being used for everything from building houses to chocolate creations to the next generation of space rockets.

But in fashion especially, 3D printing has given unprecedented freedom to create and experiment with new shapes, materials, and ideas. The creativity spurt from fashion designers has inspired us to try applying 3D printing to our own clothing. Directly onto clothing that is.

Printing directly onto fabric is perhaps the fastest way to get your 3D design onto clothing, but it requires some best practices to avoid damaging your fabric.

Here, we show you our safe method to print directly onto a garment of your choice using a standard desktop 3D printer – so get your fabrics ready, and let's get started!

PART 1
DESIGN

The first step, as with all 3D printing, is obtaining a digital model of your 3D design. For this tutorial, we used Fusion 360 modelling software to write the text 'Make it Yourself', and extruded it to a height of 2 mm. We also used open source models from Thingiverse of a heart (**hsmag.cc/hTxzNp**), and spikes (**hsmag.cc/ZDNHSp**).

Whether you decide to make your own design or use an existing model, you will end up with an STL file that is now ready for slicing.

PART 2
SLICE

Slicing your STL is the step where you tell the 3D printer exactly how you want to print the model. You will do this with slicing software such as Simplify3D,

FASHION DESIGNERS 3D PRINT EVERYTHING, SO CAN YOU!

- Order a custom 3D-printed jacket by Danit Peleg. Globally known for her graduate work on fully 3D-printed outfits, Danit now has a customiser where you can create and order your own jacket. Find it here: **hsmag.cc/ApDxBG**
- Designers like XYZBag 3D print unique bags, as designed by you: **xyzbag.com**
- Adidas launched their custom shoe Futurecraft 4D, with a 3D-printed sole made of liquid resin material, which they plan to mass customise and mass produce.

which we used to slice the models prior to printing on our Witbox 2 printer.

Tuning the slicer settings for your specific printer model can be a fine art. We used these settings for printing PLA onto fabric: nozzle temperature of 200, layer height of 200 microns, 50 mm/sec print speed, 2 mm retraction (extruder specific).

Most slicing software will require you to enter these settings, but you may have to fine-tune them slightly if you are using a different 3D printer. This can involve some trial and error. Once you have set the settings, export the sliced file as gcode, which will be read by your 3D printer.

PART 3
PREPARE THE PRINTER (IMPORTANT!)

The trick to 3D printing directly onto fabric is preparing your 3D printer for the task. Everything depends on the nozzle of the printer being just the right height above the fabric. Too close, and it will scratch the fabric; too far, and it won't lay down the first layer (and all following layers!) properly, resulting in a tangled mess and residue on your fabric.

Fabrics have some thickness, which will change based on the type of fabric, and throw off your printer's calibration. So, here is our general method for getting your model to print safely onto any fabric.

Step 1: Safety offset!

Before you do anything with the fabric, first and foremost, adjust the offset on your printer. Think of it like this: typically, your printer is 'zeroed' at the point where the tip of the nozzle just about touches the print bed. If your thick fabric were on the print bed at this point, the nozzle would come down and press into it, likely damaging the fabric with a hole. So firstly, we will lower the offset ('the zero point') →

Left
We attached the fabric securely with clips on all sides. It must be as taut as possible

TOOLS

- **One sheet of regular A4 copy paper**
- **3D Slicing software** (such as Simplify3D)
- **3D modelling software** (such as Fusion 360, to make your own designs)

Above
These edgy spikes could easily be used for cosplay. The printer had no trouble printing high 3D shapes directly onto fabric

Above
Testing out the satin, moments before the clip snapped!

RESULTS WITH DIFFERENT FABRICS

For this tutorial, we experimented with cotton, satin, denim, and linen. They had slightly different properties, but all produced wearable prints. We even threw them in the wash, inside out, and surprisingly, the smaller parts stayed on (although the large spike didn't).

Fabric	Warping	Attachment	Tidiness of 1st layer
Cotton	Med	Good	Yes
Satin	Low	Very Good	No
Denim	Med	Poor	Yes
Linen	Low	Good	Yes

by around three times the thickness of your fabric. This increases the distance between the print bed and the nozzle. We chose to lower the offset to -3 mm for all our prints, which we like to call 'the safety offset'.

Most modern firmware will allow you to change the offset on your 3D printer. If you have old firmware on your machine with no offset capability, we wouldn't recommend printing directly on fabric. Make sure you update your firmware first!

> **Most modern firmware** will allow you to change the offset on **your 3D printer**

Step 2: Position fabric

Now that you've set your safety offset, place your fabric on the print bed.

Always test on some scrap fabric before you attempt to print on your favourite clothing. We placed the fabric evenly on the print bed, and attached it around the perimeter with several bulldog clips. Pull the fabric as taut as possible on all sides, to prevent it from sliding around on the print bed. Make sure the clips won't be in the way of your extruder as it travels to the start point.

Position the fabric so that the excess hangs to the most unused part of your printer — away from the extruder and any moving rods.

With a Witbox, the nozzle moves in relation to the print bed, whereas with other printers, the print bed will move in relation to the nozzle. This latter mechanism wouldn't be ideal for printing on fabric because the excess fabric would get dragged around and likely get caught in the printer's mechanism.

Step 3: Tune the offset

Now, with your fabric securely on the print bed, we need to fine-tune the offset again to make sure the

Below
You can usually find the 'Adjust offset' feature in your 3D printer's settings

OTHER WAYS TO ATTACH 3D PRINTS TO FABRIC

- In the 3D slicer settings, add a 'skirt' to your design, which is basically an outline around your model, several shells thick, that will adhere to the fabric (as in the photo with the spikes). You can then sew through this skirt with a needle and thread, which will permanently attach the print.
- Print the text letters or design you need directly onto the print bed as you would normally (not onto fabric), and then attach them to the fabric with thread, as you would attach an embellishment.

nozzle is perfectly positioned above the fabric for the best 3D printing.

Because you have done a safety offset in Step 1, the distance between the tip of the nozzle and your fabric should be quite large. Now, we are going to gradually reduce this distance by upping the offset. This should bring the tip of the nozzle and print bed closer together. How far up you go will all depend on the thickness of your fabric, (eg denim vs satin).

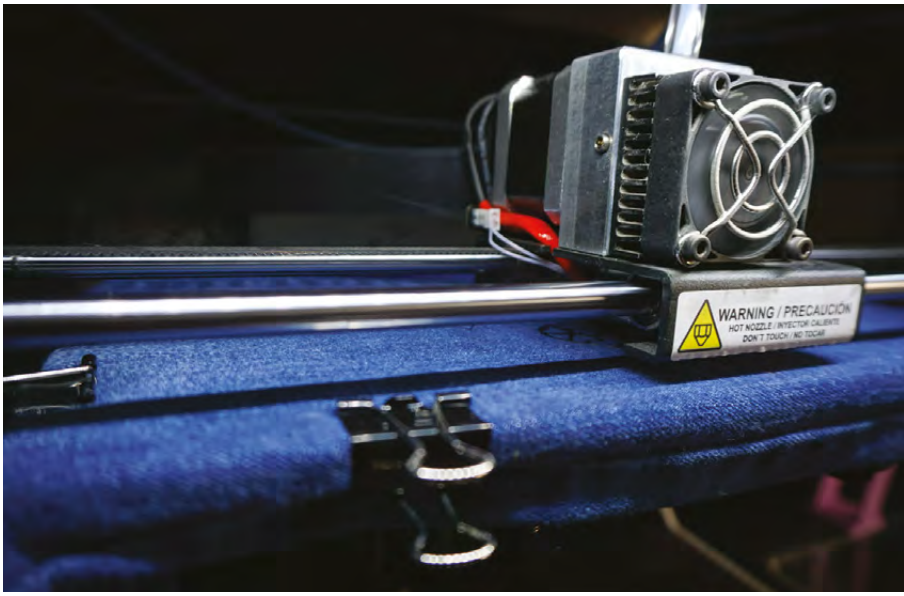
How do you tell when the distance is perfect? Wedge a regular A4 sheet of copy paper between the nozzle and the fabric as you keep upping the offset. Move the paper back and forth until you start to feel some serious resistance, but you can still move the paper back and forth. This step is more of an art than a science, but some experimentation will give you a good feel for it.

Once you have adjusted the offset to perfection, you will also need to level the print bed. This ensures that the distance between the tip of the nozzle and the print bed is the same on all parts of the bed, which results in an evenly stuck-on print.

The printer we used had auto-levelling by means of an inductive sensor, so it performed the bed-levelling automatically after we set the offset. If your printer comes with auto-levelling, definitely use it at this point.

If it doesn't auto-level, you can manually level the print bed now using the same copy paper method, but moving the nozzle to different parts of the print bed (ideally, 4–5 points).

Below
Early prep for Valentine's day. The filament lays down neatly once the settings are right



PART 4
PRINT!

Wow, so many settings, but we promise it's worth it. Now it's time for the fun part. Print!

With your gcode ready, you can now pass it on to the printer and start seeing your 3D design emerge on the fabric, as if by science.

You can print with any standard PLA filament. We printed our designs with 1.75mm PLA filament in white and black, but you can go mad.

The prints do come off the fabric (cleanly!) if you pull them hard enough, so we see this as a one-time decoration method that you can peel off and change for a different one after a few wears.

This is just the beginning of our experiments, and we are constantly learning. Do you have tips or tricks to share? Get in touch!

This tutorial is the result of our collaboration with Josef Dunne at Champion 3D, who consulted us on best practices for 3D printing and helped make these 3D prints possible on fabric (**champion3d.com**). □

Above
Sprucing up an old pair of jeans!

TAKE IT FURTHER

- Want more flexible prints? It's possible. You can print with flexible 3D filaments, like Ninjaflex or Semiflex, in pretty much the same way as you would print with PLA. Check out this project by Becky Stern to design your own custom cap with flexible filament and sewing: **hsmag.cc/CxgCGg**
- Several makers have designed their own 3D-printable fabrics, made from tiny interlocking pieces you can print in one go on the print bed. Often, they open-source their designs. Check out designs by Devin Montes here: **hsmag.cc/LCjsKp**
- 3D print some custom buttons! You can design and 3D print buttons in rigid or hard plastics and attach them to your clothing (We recently printed some banana-themed buttons for a quirky custom shirt).