

# CASSWORKS

Introduction guide to Rapid Prototyping at the CASS

January 2014

Our Technician is Anatol Just works at the CASS on Monday, Tuesday and Wednesday and he schedule for consultations is between 11:00 and 12:00. Anatol is based in the Commercial Road Building room CR5-15.

1. Process.....materials, size, layering, how the machine works
2. Files and preparation
3. FAQ's
4. Costs

## 1. Process.....materials, size, layering, how the machine works

### SLS Eos P385

Build Envelope: 280mm x 280mm x 600mm

Layer thickness: 0.15mm

Minimum wall thickness: 1mm

Material: Nylon PA2200 (PA 2200 is a Nylon 12-based material that has been specially formulated to meet FDA requirements. This specialty material can be used in contact with food and human tissue.)

Postfinish: None

Colour: white

Accuracy: +/- 0.3% (min +/- 0.3mm)

Vertical Build speed: approx 10mm/hour

CASS Students material cost: £3.03/mm height Minimum Charge:£25 (MATERIAL COSTS ONLY)

### Cost example:

1.Part with a dimension of 280 x 280 x 40mm size

(we will always need to add 6mm of base material to the build)

+£3.03/mm: 40mm height + 6mm base = 46mm x £3.03 = **£139.38**

2.Part with a dimension of 280 x 140 x 40mm size

+£3.03/mm: 40mm height + 6mm base = 46mm x £3.03 = £139.38/2 = **£69.69**

(The second example uses half the build envelope, therefore the cost is halved)

Please note that once we receive your files we will be able to confirm the cost of production and payment can be made through the e-shop following this link:

[http://eshop.londonmet.ac.uk/browse/extra\\_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40](http://eshop.londonmet.ac.uk/browse/extra_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40)

Part stacking: Yes



**ZCorp 510**

Build Envelope: 254mm x 355mm x 203mm

Layer Thickness: 0.1mm

Minimum wall thickness: 2mm

Material: Starch (plaster like)

Postfinish: hardened with Epsom salt solution

Colour: white to light grey (RGB colour printing possible, but not active)

Accuracy:  $\pm 0.2\%$

Vertical Build speed: approx 10mm/hour

CASS Students material cost: £ 1.20/cm<sup>3</sup> Minimum Charge:£25 (MATERIAL COSTS ONLY)

Please note that once we receive your files we will be able to confirm the cost of production and payment can be made through the e-shop following this link:

[http://eshop.londonmet.ac.uk/browse/extra\\_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40](http://eshop.londonmet.ac.uk/browse/extra_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40)

Part stacking: Yes

**ZCorp 310**

Build Envelope: 203mm x 254mm x 203mm

Layer Thickness: 0.1mm

Minimum wall thickness: 2mm

Material: Starch (plaster like)

Postfinish: hardened with Epsom salt solution

Colour: white to light grey

Accuracy:  $\pm 0.2\%$

Vertical Build speed: approx 10mm/hour

CASS Students material cost: £ 1.20/cm<sup>3</sup> Minimum Charge:£25 (MATERIAL COSTS ONLY)

Please note that once we receive your files we will be able to confirm the cost of production and payment can be made through the e-shop following this link:

[http://eshop.londonmet.ac.uk/browse/extra\\_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40](http://eshop.londonmet.ac.uk/browse/extra_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40)

Part stacking: Yes

### **Envisiontec Perfactory**

Build Envelope: 25 micron: 45mm x 36mm x 200mm

50 micron: 85mm x 64mm x 200mm

Layer thickness: 0.025mm and 0.05mm

Minimum wall thickness: 0.3mm (well supported)

Materials: Acrylic resins, Pic100 (for casting) and RCP30

Postfinish: UV curing

Colour: Yellow (Pic100) and Salmon pink (RCP30)

These parts need a support structure, which the end user will have to remove

Vertical Build speed: 5-15mm/hour

CASS Students material cost: £20/hour Minimum Charge:£25 (MATERIAL COSTS ONLY)

Please note that once we receive your files we will be able to confirm the cost of production and payment can be made through the e-shop following this link:

[http://eshop.londonmet.ac.uk/browse/extra\\_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40](http://eshop.londonmet.ac.uk/browse/extra_info.asp?modid=1&prodid=208&deptid=19&compid=1&prodvarid=0&catid=40)

Part stacking: No



### **How the Selective Laser Sintering (SLS) Works:**

SLS process produces parts directly from 3D CAD model; layer by layer similar to SLA but rather than liquid resin powder is used. The CO2 Laser provides a concentrated heating beam which is traced over the tightly compacted layer of fine heat-fusible powder.

The temperature in the entire chamber is maintained little below the melting point of the powder. The laser slightly raises the temperature to cause sintering, means welding without melting. For next level, piston moves down along with the formed object and powder is spread with a roller for next layer. Process repeats until full object is formed.

Functional products with snap fits, living hinges, thermally and mechanically loaded parts. SLS has wide variety of materials available. SLS polyamide (Nylon) material allows the production of fully functional prototypes with high strength and suitable for snap fits, living hinges features.

Build duration lasts from 10-60 hours for the sintering process alone, followed by a cooling period, which is usually the same amount of time, as the build process)

Once the parts are removed (broken out) from the build chamber they are cleaned with a glass filled blast compound.(sand blasting).

The parts can be spray painted and dyed using fabric stain (Dylon) Metal Plating is also possible. If a very smooth finish is required, we recommends to using a filling in primer (additive procedure) to fill any stepping which naturally occurs in any 3D printing process. This step usually needs to be repeated a few times for best results.

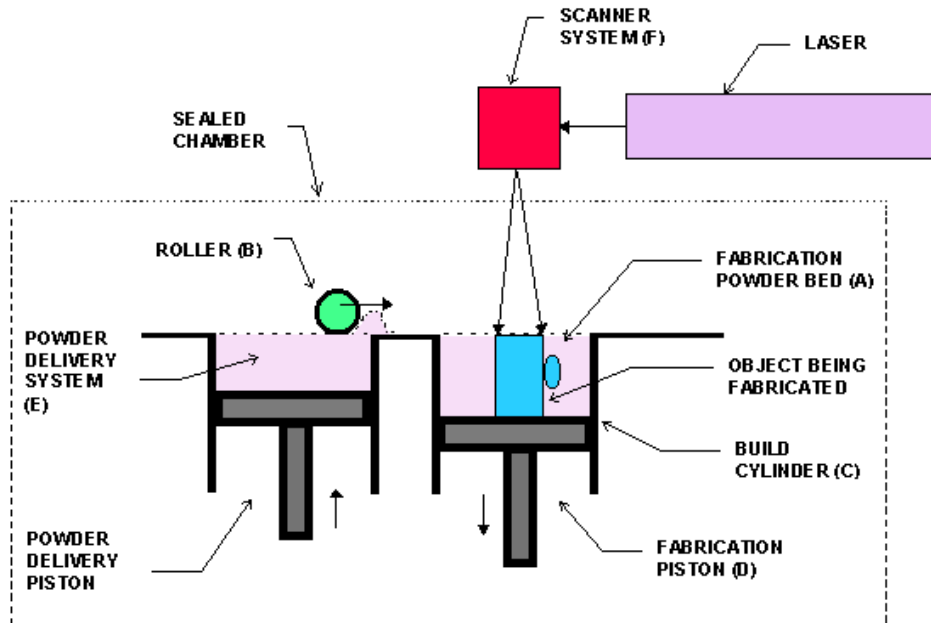


Fig. 2. Selective laser sintering.

#### How the Z Corp works?

The basics, as with all Z Corp 3D printing machines, are as follows. The Z Corp 3D printers rely on the layer-based printing of binder onto powdered material. As each layer of between 0.089 and 0.102 mm is put down the layer form is solidified, and the next layer built on top of that.

As the model is encased in a block of powder, this means that the system can be utilised to the full by 'stacking-out' the build chamber (as can be done with most powder-based systems) and much of the 'unused' powder can be recycled for subsequent builds. The system uses standard inkjet print heads from Hewlett-Packard and this also gives the Z Corp machines their huge advantage: colour. By using separate colour binders, the system can print colour directly into each layer at its periphery where required, allowing full-colour, high-resolution models.(not applicable at Cassworks).

#### Build times vary from 2-24 hours.

The removal process is similar to an architectural excavation, by gradually removing any loose excess powder to locate and remove the parts. Parts are then hardened using a Epsom salt water mixture and allowed to dry. If a stronger finish is required, we recommend to using 2 component epoxy resin or Cyanacrylate (Superglue).

All parts can be sanded, drilled and cut. Spray finishes would need the parts to be hardened with either Epoxy resin or Cyanacrylate.

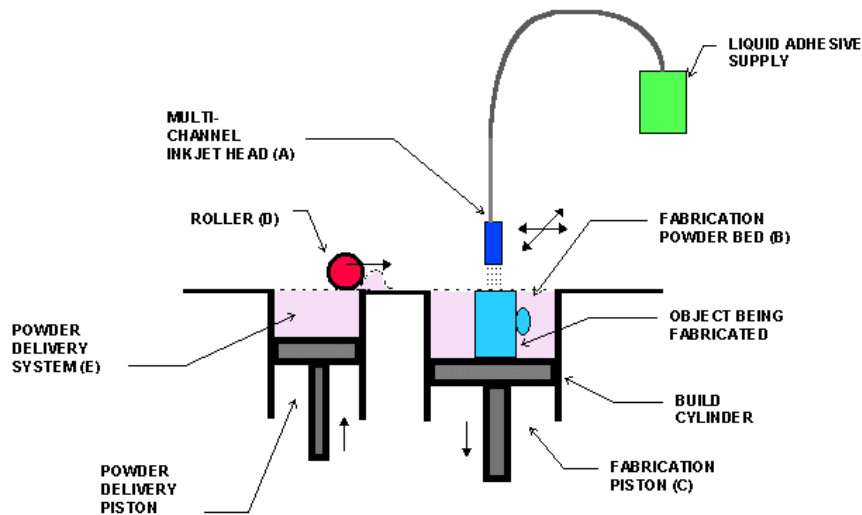


Fig. 7. Three dimensional printing.

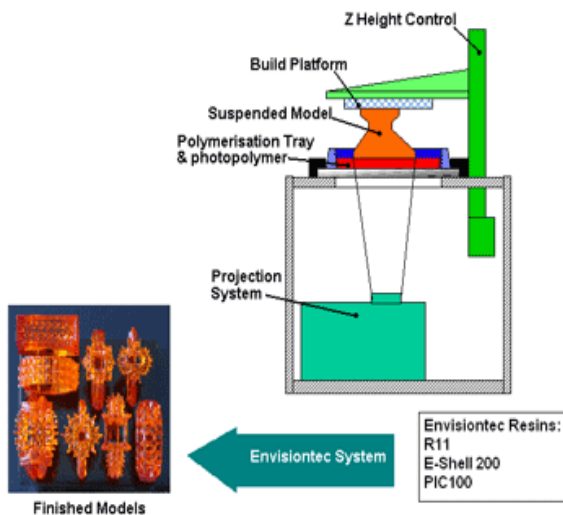
### How the Envisiontec works?

This technology involves a curable liquid resin, and ultraviolet rays which expose the resin via a projector from below to create models in an additive manufacturing process. This process requires a support structure to hold the part and any overhangs. (Parts are built upside down). Build times vary from 5-30 hours.

The support structure is usually removed after any post-curing, if applicable. The layer thickness can be set between 25 and 50 micron.

Parts produced on the Envisiontec are commonly used for small intricate objects, such as jewellery and model making and sculpture.

Parts can be spray painted and metal plated.



## 2. File Preparation:

File Formats Accepted:

.stl, .obj, .3dm

### Polygons Only

Our 3d printer only understands explicit geometry. All files that we receive ultimately end up as .stl files before being sent to be printed. This format is quite old and contains very little information: vertices, edges, normals and scale. There is no implicit geometry like patches, nurbs or subdivision surfaces. So make sure your implicit geometry is converted to explicit polygons before giving it to us.

### Turn off smooth shading while modelling

Smooth shading is controlled by your software and hardware and changes the look of the geometry. Use a faceted shading method that allows you to see each polygon explicitly. This is how your model will look when printed.

### No Bitmaps

We cannot accept bump, normal, displacement or texture maps, due to the need for explicit geometry.

### Closed Geometry

All the objects that make up your model must be closed or “watertight”. Overlapping geometry should be booleaned into 1 solid object.

### Appropriate amount of geometry

Make sure you have enough geometry on your curved surfaces to prevent faceting. This will of course depend on the size of the model you are printing.

### Feature size

In general, long thin features are difficult to print. A rule of thumb is for every 1mm of length a feature should be .5mm thick. So, a 5mm long robot’s antenna would need to be about 2.5mm in diameter to survive once printed.

### Scale

Be aware of the final size of the object you will be printing. Think about how large the final print will be. Don’t put too much geometry in a spot that will only be a few millimetres across.

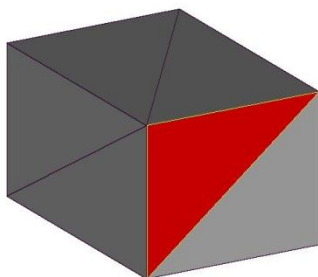
### Structural integrity

Will your model be able to support itself? Beware of chicken-like proportions: a large body supported by thin legs. The legs could easily break during shipping or from the weight of the heavy body.

## Common Problems

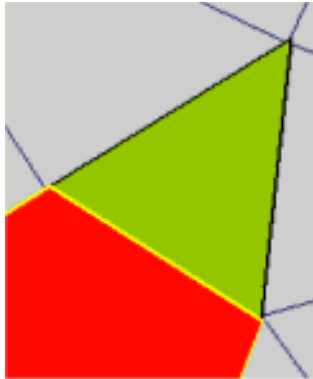
### Inverted triangles

In the STL-format, a normal indicates the outside of a triangle. When the normal is pointing in the wrong direction (the inside) we call the triangle a flipped triangle.



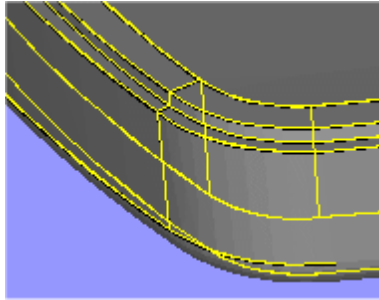
### Bad Edges

To have a correct STL-file, all edges of each triangle should be connected properly to a neighbour. If an edge is not connected properly, the edge is called a bad edge. The green triangle has 1 bad edge, the 2 other edges have correct neighbours. A group of connected bad edges will make one bad contour.



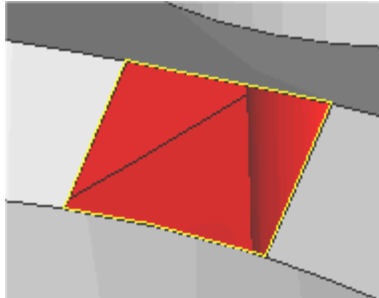
### Near Bad Edges

Near bad edges are bad edges that are near other bad edges. These are mainly caused by 2 surfaces that are not well connected. You can solve this problem very easy with stitching.



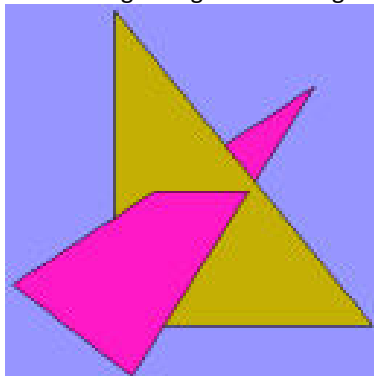
### Holes

When triangles are missing and therefore rendering a 3D model into an open surface.



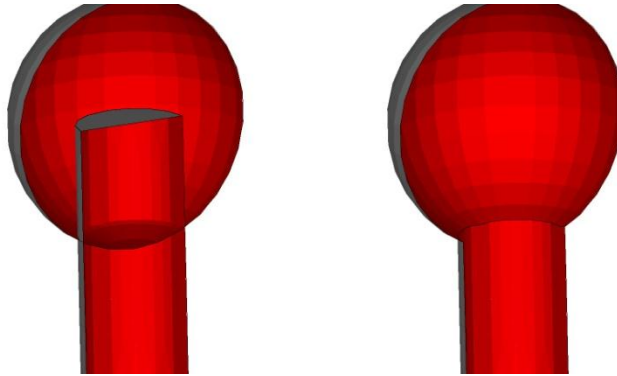
### Intersections Triangles

Intersecting triangles are triangles cutting each other.



### Multiple Shells

When solid objects are overlapping without removing internal overlaps through a Boolean operation. (Image shows sliced view (Object on the right is correct))



### Overlapping triangles

There are numerous reasons for overlapping triangles.

- Incomplete or no Boolean operation
- Exporting overlapping geometry and hidden geometry
- Bad alignment of geometry

### Object Dimensions

Always ensure that you resize the model to be produced to the correct dimension before exporting. This should ensure that the exported triangulation resolution is correct. (0.01mm)

Large objects such as houses and else, which stems from a technical drawing may need to be exaggerated, as feature size would be incorrect, leading to a file, which is not structurally sound for production.

Example a house, which has been downscaled to 1:500 would have a wall thickness of only 0.2mm.

3.FAQ:

### Lead Time

Usually between 3-5 working days. However we do have peak periods especially close to general hand in dates at the end of term. We always recommend to submitting your file 2 weeks before you actually need it, as the service may be interrupted due to faults, service or other reasons beyond our control.

### How can I make more of the process?

3D printing is a great tool, when applied in a correct context. A lot of times models could be handmade much quicker and cheaper. Also, we encourage to mixing your model-making using other materials. Post finishing, such as spray painting and metal plating help achieve a great looking model for presentations or prototyping.

### How can I get the parts cheaper?

Since the cost of 3D printing is based on build height and build time, it usually reduces the cost to make best use of the build envelope of the selected machine. Always allow 10mm(x,y,z) of space in between parts, if your model consists of multiple objects.

### Is there any software to check files myself?

There are 2 good options to check your files for 3D printing.

1. Minimagics from Materialise, lets you check for errors and dimensions and allows you to save the file as a .mgx file, which compresses your file down to 20% the original size.
2. Netfabb basic, lets you check and fix .stl files and resave them.



### How do I get my 3D/CAD drawing to you?

We have consultations every Monday and Wednesday between 11am-12pm in Room CR-515. Please make sure that you bring your .stl file on a memory stick. If any work is needed, we will discuss the requirements and can arrange to have another meeting later in the day, depending on availability. Once a good file has been received your model gets scheduled on a first come basis.

### Do I need to hollow my model and when and how?

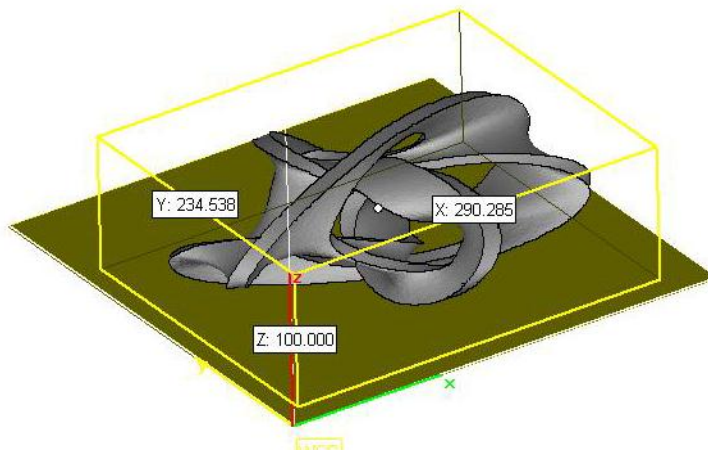
If your model is very blocky and has very thick walls, we recommend to hollowing your model. The advantage is that the cost for the model will be lower and the model tends to have less distortion, if built on the SLS.

Please make sure to add a drain hole to be able to remove any excess powder stuck inside your model. You can also design a plug, which can be fitted to fill the drain hole.

Recommended wall thickness: SLS: 1-2mm, Z Corp: 5mm

### 4. Cost examples:

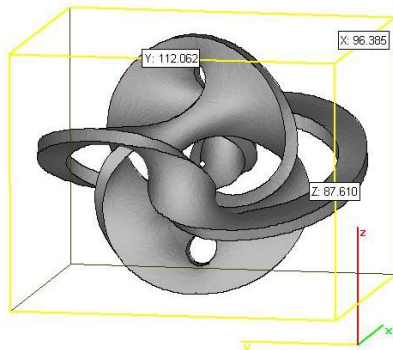
**SLS:** £3.03/mm height on 280mm x 280mm envelope



A model with a height of 100mm (100mm + 6mm base = 106mm x £3.03) would cost £321.18 in material due to the volume it uses on the machine. Any unused space in the machine would still use up material and degrade it, even though some can be re-used. Therefore the cost is volume based. You could however add another part to the same envelope for the same cost.

Z Corp: £1.20/cm<sup>3</sup>

Model has dimensions of 96mm x 112mm x 87mm and has a volume of 50cm<sup>3</sup> = £60



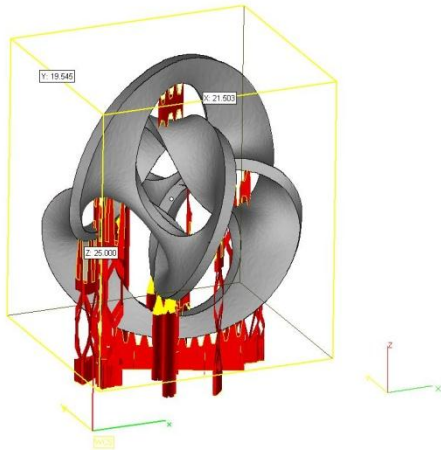
Any material used as support material during a build on the Z Corp can be recycled. The cost is therefore lower than on the SLS.

Envisiontec: £20/hour

Since the material on the Envisiontec usage is quite small, the cost can be gauged on build time. An average sized jewellery object takes between 2-5 hours build time.

Also depending on the surface area of the model and the resulting need for support structure, the cost may be higher. The model below takes around 3.5 hours to produce at a cost of £70.

(Image shows support structure)



Since there are many factors to consider when costing any 3D print, we will always need to see your final model (.stl) first. Once the model has been put through our price calculator and we know the exact cost for the material usage, you can then proceed to pay for the material usage via the online payment system.

We will only schedule a 3D print, when payment has been received.

Contact:

Anatol Just Room CR5-15

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Tel: 020 7320 1853