Rapid Prototyping – a basic guide.

In this guide we cover the basics of rapid prototyping in manufacturing – what it is, why we use it and the types of processes used in rapid prototyping.

As ever, we try to make these guides simple and easy to read so that you can get a basic idea of what is currently available (the world of rapid prototyping is moving so fast that new materials and processes are appearing daily). If you would like to find out more or have any questions, then please contact us.

info@redsouldesign.co.uk or call us on:0333 5773660 Mobile:07728 795233.

Rapid Prototyping – What is it?

Essentially rapid prototyping is about quickly creating a physical item or series of items that replicate the sketches or models of an idea.
Rapid prototyping is **generally** associated with what we call "additive manufacture" – a process where a part is built up in layers of material rather than being cut from a lump of material (also known as subtractive manufacturing).
However rapid prototyping can be either **additive** or **subtractive** (more on this in a bit)

Just a word of caution – many people, for some inexplicable reason, associate rapid prototyping with the word cheap. This is wrong. Rapid prototyping is rapid – and can be very expensive. What is more applicable is the term "cost effective".
The extra effort time and cost spent at the beginning of a project is more than repaid in the benefits given at the end of a project.
It's all about what process you use and how detailed you need the parts to be – more on this later.

Rapid Prototyping – Why use it?

There a few reasons to use rapid prototyping:

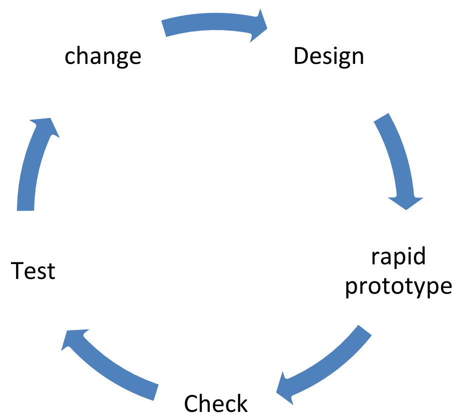
- Being able to see the part
- Being able to feel the physical part
- Being able to test the part
- Presenting an idea to a client or boss (this is a proven sales technique)
- Being able to quickly iterate a design.
- Its fast.

The latter two reason are probably the most significant of the reasons from an engineering point of view.

Now, traditionally prototype parts were slow to be made, often having to wait days, if not weeks for a part. They were either machined or cast or built in some way that took quite a while.
Nowadays, you can be waiting just hours.

What you require from a rapid prototype varies from design to design. Some may need a representative idea about a part, others may want a very detailed part with the correct colour – but both will want it quickly.

What this gives is the ability to change the part based on a real item. You can quickly change the design of the 3d model based on what you see in the prototype. The changes can be done very quickly ready for another round of prototyping…effectively creating a loop. This loop cycles until you are happy with the design.



Once you are happy with the design, you can move forward onto the next stage – whether that is production or otherwise.
Either way, effective design changes can be made in a matter of hours as opposed to a matter of months.

T: 03335 773660 M:07728 795233 E: info@redsouldesign.co.uk W: www.redsouldesign.co.uk

Rapid Prototyping – Manufacturing processes.

As mentioned earlier, there are two main process for making a part:
Additive and subtractive.

Additive is the relatively newer way of rapid prototyping and is what is associated by most people to rapid prototyping *(note – 3d printing isn't really new. It was first thought of in the very early 80's, but due to patents, was expensive and only really industrially used. Now the patents have run out, there has been a surge to the market from many companies, making the tech more accessible and cheaper)*

Additive is the process of adding material to itself in order to form a part – think of it like building a house. You are creating layers of brick to make a wall. The same is true for additive where you use layers of material to build a shape.

Subtractive is a more traditional form of manufacturing where material is removed from a large piece of material to form a shape – like a sculptor using a large piece of stone and carving out the required shape.

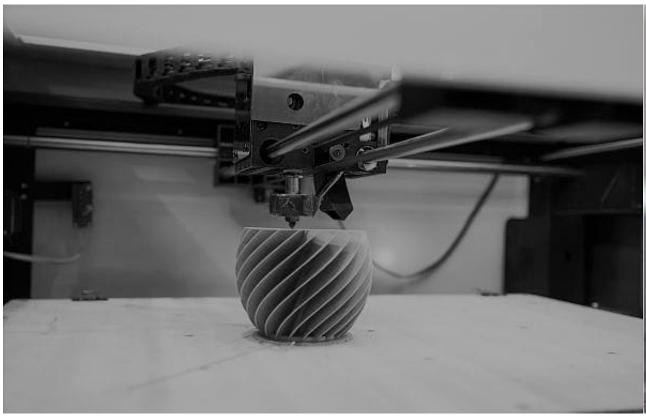
The main difference between the two is that additive allows for almost any shape you could think off. You can have internal passages and shapes that are impossible to make using a traditional technique.

ADDITIVE PROCESSES

In the additive world there are three main processes for plastic type parts: FDM, SLA and SLS and two for metal: DMLS and SLM.

FDM – Fused deposition modelling

This is a 3d printing process that melts thermoplastic filament material and places it onto a build platform in a pattern (called a layer). This process is then repeated until enough of the layers have built up to form the required 3d shape…. like the pictures below.

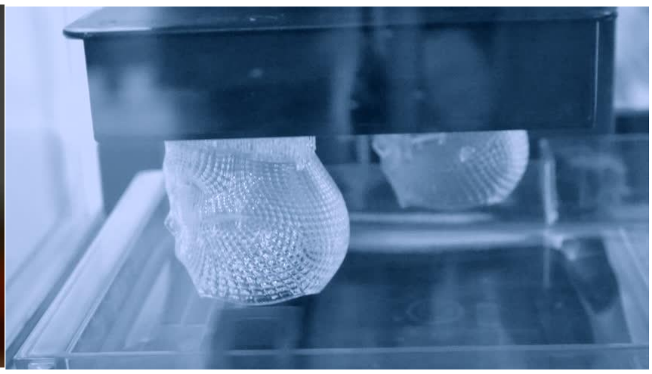


FDM parts are great for a looking at the shape and form of an objects and can also be produced to represent the durability and strength of an object, although this does depend on the material used. You can even print food (chocolate is a favourite)

FDM is relatively low cost, quick and is very good for initial design evaluation. The parts made are very stable, rigid and have good strength.
If the material required is for the final part is available in the form of filament, then functional testing can be performed by the FDM part.
One of the downsides of FDM is detail and lower tolerances on dimensions. Whilst this is getting better, smaller details and accuracy are often not as good on FDM parts as they are on other processes.

SLA – Stereolithography

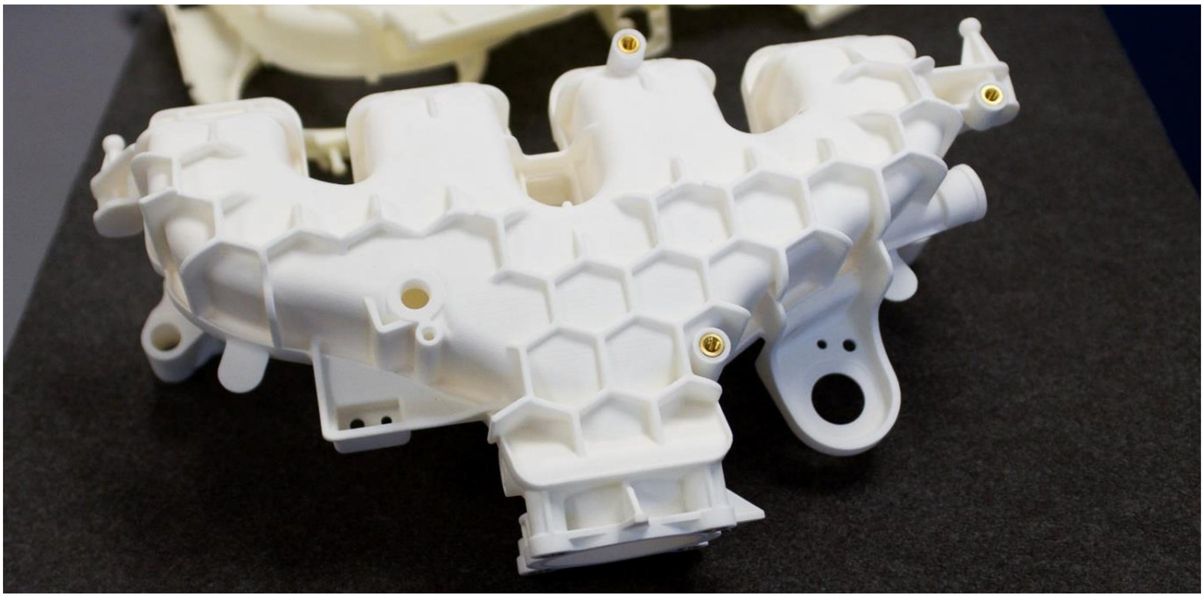
Stereolithography (SLA) is possibly the most popular and common form of additive manufacture. SLA work by using a build platform that is submerged in a tank of photosensitive resin. A laser “draws “a shape through the resin, the resin that is touched by the laser is hardened and forms the first layer. The platform moves slightly and then the process is repeated until the required number of layers has been achieved. Often the parts will need some form of support structure. The below pictures show some examples of this.



The benefits of SLA include high part precision, very fine detail, smooth surfaces and high dimensional tolerances. Some of the downsides are that SLA does tend to take longer to print than FDM, the parts are generally fragile (depending on material used) and costs are generally higher as the machines are much more complex than the relatively simple FDM printers.

SLS – selective Laser Sintering

SLS is a very similar process to SLA except that instead of a resin, the printers use a powder material.
The material is heated to just below melting point, at which point a laser draws a shape along a thin layer of material. This causes the material to melt and fuse together. Once the shape is drawn, the fused material moves down a distance, the new layer is covered with powder and the process begins again.
An example of an SLS part is below:

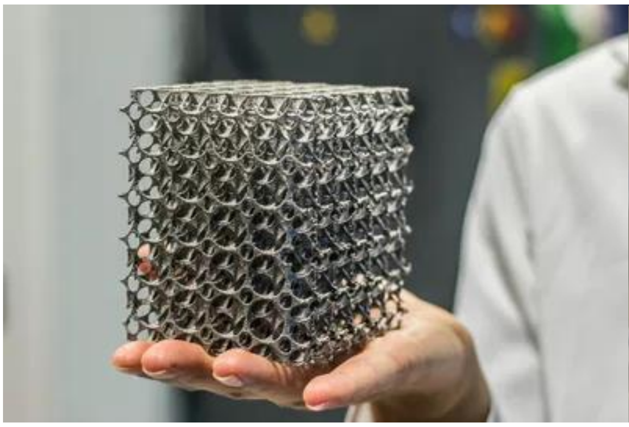


Benefits of SLS parts are that they need no support structure (so are cheaper to clean up), its fast, has good layer bonding and produces very complex and detailed parts.
Downsides are that parts are generally brittle, absorb water (standard SLS material is nylon), prone to warping and shrinkage (so high tolerance parts are no good for SLS), expensive and it’s a wasteful process.

DMLS – Direct Metal laser sintering and SLM – selective Laser Melting

DMLS and SLM are essentially the same process. The only key difference between the two is that DMLS uses a laser to fuse / weld the material together (like SLS). SLM uses the laser to melt the material together. This is a big distinction.

The process used is essentially the same as SLS, where a laser draws a shape into a thin amount metal powder, heating it, and causing it to fuse/ melt into layer. The fused material is then moved down slightly, covered with more fresh material and the process restarts.
Some examples of DMSL and SLM are below:




Benefits of DMSL and SLM parts are that they allow working parts to be produced with very complex external and internal designs, that simply wouldn't be possible with traditional methods of manufacture. The parts produced can be of production quality – indeed a lot of aerospace companies use 3d printed metal parts to reduce cost, increase efficiency and reduce weight. Waste material is recyclable. SLM parts are stronger as a rule and both types of parts can be finished by machining or other metal processing techniques
The downsides to DMSL and SLM is cost. Part cost tends to be very high and the prices of 3d printers are very high. DMLS parts are porous compared to an SLM part (this is the difference between fusing and melting). Parts tend to be smaller.

Although the costs are high, it's a question of relative cost. If a 3d printed cost if half as expensive as a traditional part, but reduces labour by half and increases overall efficiency, then is it more expensive? These factors must be weighed up when considering the application.

REDSOUL DESIGN

Subtractive Processes

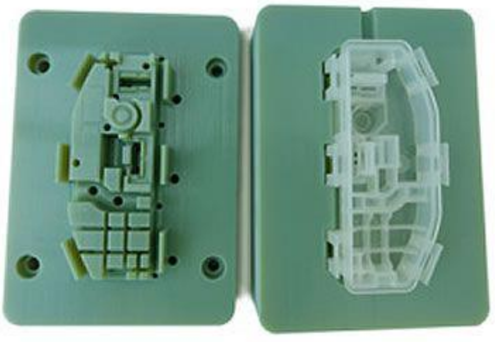
Subtractive processes are considered a more traditional way of manufacturing. Sheetmetal, milling, injection moulding etc.
However, that doesn't mean to say that they can't be used in rapid prototyping. Many of Redsoul Design's Partners have changed their business model and are now geared up to do fast turnaround parts and indeed rapid prototyping.

Rapid Machining

Parts are available in as little as 5 working days (and quicker- depending on the part). This is ideally for testing out simple parts or low volume complex shapes that do not have a requirement for any internal geometry that could only be achieved by 3d printing

Injection mouldings

Parts are now available in just 15 days. Injection moulding companies can now use mould tools that have been 3D printed, thus reducing the cost and time to get a mould made. The moulds will not last as long as a steel tool but will give representative parts and allow for functional testing without the very high tooling cost of traditional injection moulding.



Vacuum Casting

Parts can be vacuum cast – a process that is low volume injection moulding. A 3D printed representation of the final part is used to make a silicone mould. The silicone mould is then filled with a casting resin (under vacuum to reduce air bubbles), the resin is allowed to harden and then removed from the mould. The resin part is then cleaned and finished to the client standard. The resins used can replicate various plastics and properties.

We hope you have enjoyed this guide and found it useful. For any inquires or more information, please feel free to contact us.