Rapid Prototyping vs 3D Printing: Main Differences Revealed

Rapid prototyping and 3D printing are two terms thrown around in the manufacturing fields quite often. Both involve generating a physical, 3D object from a soft copy model on a computer. But to call them synonyms would be a misuse of both terms.

Rapid prototyping describes the process of producing a 3D object from a computer model using any method. 3D printing is one of those methods, but it can certainly be used for more goals than just rapid prototyping.

Keep reading for a better understanding of both rapid prototyping and 3D printing.

Methods of Rapid Prototyping

The concept of rapid prototyping itself has been around since the seventies. Projects and machinery cannot be built simply for an idea alone. That idea has to be physically designed so that people will know how to build it.

Every single design used to have to be drawn out by hand, with help from a ruler and a calculator. Human error was a huge cause of mistakes and, therefore, delays in product design.

In the late 20th century, we transitioned from a purely industrial society to a computer-assisted technological one. Fabulous computer models for new products were becoming available but translating them in a physical for was becoming extremely tedious and ripe with mistakes.

That was when the concept of rapid prototyping was born. While the most famous and convenient method of it has become 3D printing, it was not the first method. Still we would be remiss if we did not discuss it first.

3D Printing

3D printing's impact on rapid prototyping has been nothing short of monumental. As long as a designer produces their concept with the correct software, the printer can produce a model in less than a day.

Say for instance someone invented a new type of adjustable bowl. They could send the design to the printer, which could produce a scale model of it. While 3D printers cannot produce working gears and parts, they will at least give you a full size, plastic 3D model that you can use to test functionality and measure in real world applications. That is perfect for rapid prototyping.

But how does it work? Different companies build them in slightly different ways, but for the most part the process is called **additive manufacturing**. Here is a basic run through:

1. **These 3D printers contain 6 main parts**:
    a. A container of additive plastic
    b. A heating device
    c. Tube to transport the plastic
    d. Tool that shoots plastic into place

    e. A base to hold the object being built
    f. A protective case
2. **A design is sent to the printer's software.**
3. **When processed, the printer heats up the plastic "ink" to make it more malleable**
4. **The printer starts printing in a two-dimensional style for the first layer**
5. **Then consecutive layers are added.** That way all objects are printed from the bottom up
6. **The bottom layers start to dry as the top layers are being produced**

Once the object (in this case, a tangible prototype) is built, it takes a little time to solidify. Then you will be all set!

Just keep in mind that 3D printing, no matter its use, takes time. It is seamless and smooth, yes, but it simply cannot produce an object as fast as your Kodak at home can print out your bills. Good 3D printers take hours to make simple objects. Complex objects can sometimes take a whole day to make.

Source: Wikipedia- 3D Printing

Selective Laser Sintering

Selective Laser Sintering, or SLS, is another version of rapid prototyping and does not involve 3D printing. It also uses layering, but with a nylon powder rather than mailable plastic. SLS has been around longer than 3D printing and uses the same computer files for its designs.

The disadvantage? Price. SLS printers do a great job, but the powder used is not cheap and also hard to come by. The laser cutting hardware does not help your wallet either.

How does it work? The process starts the same as a 3D printer, with it accepting the digital file and "printing" the object layer by layer, from the bottom up.

Now the differences begin. Unlike a 3D printer, rapid prototypes produced by SLS are begun by spreading the powder across the powder bed. The laser than traces the section needed. Then the material is heated causing it to be fused together.

Next, the powder bed is lowered to make room for the next layer. Unused powder is recycled back into the system. The same exact process is repeated layer by layer until the object is done being built.

One problem with this version of rapid prototyping though is that is generally more "unclean" than 3D printing. When the object is done, you still need to pull off any excess powder clumps that may have accumulated. Over time, an SLS machine that is not well maintained will cause this issue to be more prominent.

Although this technology is older, it still has a done of applications for rapid prototyping. Thanks to the durability of its products, SLS is still used to make:

- **Tools and fixtures**

- **Fuel tanks**
- **Car parts and designs**
- **Furniture**
- **Plumbing pipes**

Source: Solid Concepts

Ballistic Particle Manufacturing

This type of rapid prototyping is more similar to your home 2D printer than anything else. It almost works the same way but using molten wax. Here the wax is fired in the form of micro droplets onto a surface using a moving nozzle.

The nozzle traces out the first layer, and then surface drops out so the next layer can be built. This is a relatively newer technology that is still mostly confined to the laboratory space. It makes sense, as the hot wax is a bit more dangerous to be around that plastic or nylon powder.

Source: Nist

Directed Light Fabrication

Direct Light Fabrication, also known as Electron Beam Free Form Fabrication or EBF3, is an exciting new form of rapid prototyping. It is honestly simplest one: all you need is light electrons heating up an electric wire. The wire is melted down to bond together.

You might already know where this process was derived from: welding! EBF3 takes the idea of welding and layers it on top of itself to produce a prototype single object. The disadvantage of this from 3D printing though: with such limited resources, designs are limited.

Directed Light Fabrication was actually first invented back in 2000 as a vital tool for astronauts aboard the International Space Station. Think about, these people are away on their own for months at a time. Simply sending anything to them is a daunting task, even with today's fairly reliable rockets.

If you give astronauts this tool instead, it is a game changer. Instead of needing to ship them another part, they can simply print their own while aboard the spacecraft. All Houston has to do is email them the file.

Sources: NASA Langley's Technology Gateway
ScienceDirect

Direct-Shell Production Casting

Direct-Shell Production Casting is not used as much due to its complex nature but is worth noting here. It produces by far the highest quality rapid prototypes. That is because it essentially part kiln.

The best way to think of this, in fact, is like pottery. If you were making a clay pot, you would first grab some clay. Then you would shape it into the design you want. Lastly, put it in a kiln. The kiln heats up the clay so much that it completely solidifies.

Similarly, here is how Direct-Shell Production Casting works:

1. **The machine is loaded with ceramic powder** (not clay, but it is derived from the same compounds)
2. **Like any other rapid prototyping, the design is sent to the system.**
3. **The machine gradually building up the object in layers using the powder and holding it in place with a liquid binder.**
4. **Once the mold is built, it is fired just like a kiln**.

Forget plastic: now you have a prototype that is as solid as your good china. If that is not good enough, some models allow the ceramic powder to be subbed out with certain metals.

Sources: NPD Solutions
C-MAC
NeoMetrix Technologies, Inc.

Practical Applications of 3D Printing

As you may have notices, rapid prototyping can be a bit technical, especially considering which method you are using. That is not always the case with 3D printing, which can be used for tons of practical as well as recreation applications, not just prototypes.

Because of the nature of their design and their primary purpose being for rapid prototyping from the get-go, the other aforementioned machines do not have all the capabilities of a 3D printer. Simply put, 3D printers can be fun! Let's learn about some of their exciting real-world applications.

Rapid Prototyping

This topic being what it is, we have to bring up rapid prototyping first. 3D printing has really changed the game on that. While the other machines work, they are undeniably more complex. Nowadays, if you have a design for a prototype, you can make it real with the help of a 3D printer. Here are a couple currently available for retail purchase:

- **Labists**- Very precise and does the job right the first time
- **Comgrow**- This one comes already partially assembled so you can start printing your prototype fast. Also a bit cheaper.
- **FlashForge**- This is a newer one and pricier than the rest. But it is Wi-Fi capable which will save you some time. You can also connect a flash drive with a design directly to it, eliminating the need for a computer entirely.

Medical Devices

One of the best uses for 3D printers outside of rapid prototyping is for medical devices. Here 3D printers can literally be a life saver. While most devices need to be produced safely in a lab, the

FDA is gradually allowing more and more things to be 3D printed. As long as approved digital models are used of course.

Think about it: say a patient desperately needs a stent. Unfortunately, the hospital is all out. By the time a new one is due to arrive, it will be too late. If the hospital has a 3D printer, they can simply make one themselves in just a couple of hours!

Some exciting developments in medical 3D printing include:

- **Human organs and tissue**: Granted, this is still a long way off. But scientists are trying to use some tissue to reproduce whole organs, thanks to 3D printing.
- **Surgical instruments**: The design of them needs to be so extremely precise, and they are quite expensive. Having a 3D printer in the long is cheaper for a hospital. Now they can mass produce them for the cost of the sanitized plastic.
- **Prosthetics:** After an unfortunate accident, patients are all too often hit with a huge medical bill for prosthetics. 3D printing has the ability to give you at least a descent arm or leg for thousands of dollars cheaper.
- **Orthopedic implants**- When you break your leg, metal is often used to help your bone along or flat out replace it. Now, using x-rays, doctors can create an exact replica of the missing bone peace and implant that for you for a perfect fit.

Speaking of medical implants, you might already have a 3D printed object and not even realize it. Where did you receive it? The dentist! Many dentists are already using resin-based 3D printers to create:

- **Dentures**
- **Aligners**
- **Crowns**
- **Implants**

Rather than shipping out a mold, they can make equally strong implants quickly in the office. X rays and molds are used to craft the design, and then it is printed out and implanted.

Cutting down on the chain of communication helps you receive an implant that is far less likely to give you any discomfort. Odds are, it is a perfect fit.

Sources: FDA
NS Medical Devices

Fashion

Wearing plastic does not sound super comfortable, but the ability to 3D print with softer materials is just over the horizon. That will mean the rapid reduction in the need for textiles derived from natural resources.

Another advantage here is the ability to make clothes that are both bulletproof and fireproof much easier. Police departments soon could be able to print out their own bulletproof vests that

are custom fit to each officer. Similarly, fire departments can cheaply produce as many life saving jackets as they need.

3D rapid prototyping already occurring in the fashion world is for sneakers. Let's face it, some of us have no problem dropping serious money for a pair of Air Jordans. Well, what if you could customize them? Add designs on the side. Or, finally fit your favorite pair with the custom inserts you need.

Soon you will not even need a Dr. Scholl's machine to give you an insert that might work to avoid a $600 custom pair. Just print what you need at home for a fraction of the price.

Source: Formlabs

Toys

3D printing also sees a lot of potential in making toys. Designs for a ton of different options are widely available online. Just buy a 3D printer and start printing! Although this may seem expensive, all you need to do is buy the one printer and any materials and you have endless toys. Much better than buying everything individually.

This of course would not be recommended for toddlers, as printed objects are definitely inedible. But feel free to make things like:

- **Action figures/ figurines**
- **Balls**
- **Lego pieces**
- **Other toy blocks**
- **Silly hats**

The ideas are endless. If you can think it and find a design, you can build it.

As A Hobby

Plenty of people are surely reading this and feeling like an inventor. The possibilities with 3D printing being what they are, it sure is tempting to create some rapid prototypes of your own. Nothing is stopping you but your imagination.

But in order to create a design, you need to do it in within the proper software so your printer will recognize it. No one wants to spend hours creating something, only to find out that their printer cannot read. So, before you begin check out one of these beginner designing programs and **confirm they are compatible with your printer**:

- **Cura**
- **PrusaSlicer**
- **MatterControl 2.0**
- **3DPrinterOS**- Ideal for MacOS

Source: All3DP

Weapons

3D printing really opens up a wealth of possibilities. Anything is possible. Unfortunately, like any technology, 3D printing is not always used with the purest of intentions. And the dark web, designs have circulated in the past for weapons, including knives and guns.

While some parts of weapons are generally allowed to be produce via 3D printing, whole weapons are not, even for self-defense purposes. Always check on the legality of this option in your jurisdiction beforehand.

Source: Wikipedia- 3D Printed Firearms

Recap

Rapid prototyping has been around for decades, keeping industry running smoothly by seamlessly helping along the creation of new ideas. Plenty of methods exist, like these we did not even mention:

- **Fused deposition modeling**
- **Laminated object manufacturing**
- **Solid ground curing**
- **Stereo Lithography**

But 3D printing is the all-around best choice. However, 3D printing is not limited to just prototyping. Its pure convenience and efficiency have the power to change lives, both in hospitals and on the playground.