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Resin 3D Printers

The Best Choice for a Home-Based 3D Printing Business

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Introduction

Starting a home-based 3D printing business in 2021

The COVID-19 pandemic has upended peoples' lives and careers, but it has also presented new business possibilities for creative people. Workers are looking to grow their incomes to replace jobs they lost or to supplement wages suppressed by reduced work hours and decreased opportunities for promotions. People are also spending more time at home and looking to fill that newfound free time with hobbies. These trends combine to make starting a home-based business related to hobbies an attractive and lucrative prospect.

Many types of hobby businesses can capitalize on these trends. One that is growing in popularity and becoming more affordable as technology improves is to design and sell items produced with 3D printing. 3D printing is suitable for a wide array of hobbies but is particularly popular for miniature figures, gaming pieces, model railroading, dollhouses, jewelry, cosplay, and home décor. Starting a business in one of these areas can be profitable and enjoyable.

Types of 3D printers

Two categories of 3D printers are suitable for running this type of home-based business – Fused Deposition Modeling (FDM) printers and Stereolithography Apparatus (SLA) printers. An FDM printer passes a heated filament of thermoplastic through its printhead's nozzle to build up solid objects layer-by-layer. An SLA printer uses focused UV light to cure liquid resin layer-by-layer as it builds up solid objects. In layman's terms FDM printers are called filament printers, and SLA printers are called resin printers.[1]

Many affordable models of filament and resin printers are available. *Figure 1* shows a typical filament printer, and *Figure 2* shows a typical resin printer. For the hobbyist planning to start a home-based 3D printing business, a resin printer is a better choice than a filament printer.

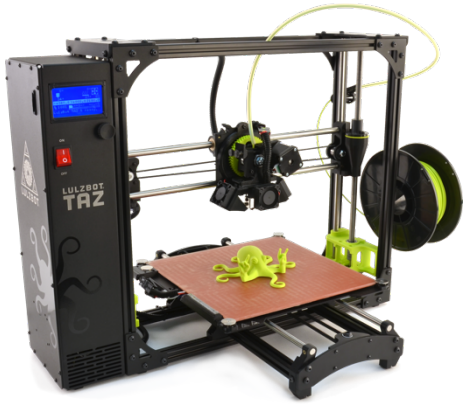

Figure 1 - filament printer

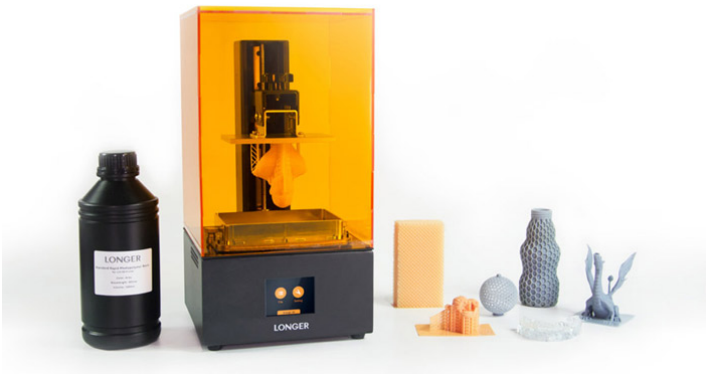

Figure 2 - resin printer

[1] Grames, Emmett, "SLA vs FDM / Resin vs Filament 3D Printer: The Differences," *All3DP* online, accessed March 12, 2021, https://all3dp.com/1/sla-vs-fdm-resin-vs-filament-3d-printer-the-differences/.

Advantages of resin printers

Print quality

Customers who purchase 3D printed objects primarily care about the product's aesthetic appeal. Most do not know or care about the equipment and processes used to create the object. They may not even realize it was produced by a 3D printer, but they will be able to differentiate between high and low quality. Resin printers produce higher quality objects than filament printers. The difference in quality results from their different printing processes and resolution.[2]

Filament-printed objects have visible layer lines and feel rough to the touch. Consumer-grade filament printers have layer thicknesses of 0.05 to 0.4 mm at best. Their resolution in the XY plane matches the filament thickness which is usually 0.4 mm. Due to the circular nature of the filament, each filament line has rounded edges even after the layers settle vertically. Thick layers and rounded edges reduce filament printers' ability to print crisp edges and fine detail.

Resin printers have layers that are as much as five times thinner than the thinnest filament printers. Consumer-grade resin printers can produce layers ranging from 0.01 mm to 0.2 mm. In the XY plane, the resolution of the printer's LCD screen determines how fine a part can be printed. This resolution is typically 0.05 mm. These layers have sharper edges resulting in parts that are visually appealing and smooth to the touch.

Figure 3 shows the same fan blade design printed by a filament printer and a resin printer. The filament-printed fan blade has ragged edges, contour lines, and ridges on finished surfaces. The resin-printed fan blade has smooth edges and surfaces as well as crisp edges around each blade. Refer to *Table A-1* in the Appendix for a comparison of the resolution of popular consumer-grade filament and resin printers.

Figure 3 – a fan blade printed by two types of 3D printers. Left: filament (FDM) printer, Right: resin (SLA) printer

[2] "Guide to Stereolithography (SLA) 3D Printing," *formlabs* online, accessed March 14, 2021, https://formlabs.com/blog/ultimate-guide-to-stereolithography-sla-3d-printing/.

Production speed

Consumer-grade 3D printers print slowly, often taking many hours to complete each object. The more products a business creates, the more it can sell. Resin printers are faster than filament printers because of the method they use to print objects.

Filament printers build objects in a combination of lines and layers. The printhead builds each layer through laying a heated filament down in a series of lines. When it finishes each layer, it moves up and repeats the process for the next layer. The print speed for each layer depends on its cross-sectional area and the rate at which the printer lays down the filament. A small, thin object will print faster, while more complex and dense objects will take longer. The print time for each layer of filament will often be measured in minutes compared to seconds for resin. Objects can be printed faster by reducing the print quality but doing so is only recommended for prototyping and not for consumer products.

Resin printers print each layer as a whole regardless of the object's cross-sectional area. The time to complete each layer depends on the UV exposure time required for the resin. Resin printers pass the UV light through LED screens similar to cell phones and tablets. This light cures the resin by lighting the pixels that match the shape of the layer's cross section. A resin printer with a monochrome screen will print three times faster than one with an RGB screen because the UV light can pass through all of the pixels instead of just the blue ones. Regardless of the screen type, resin printers create layers for most objects faster than filament printers. The first several layers of resin require cure times of up to a minute to ensure proper adhesion to the build plate, but subsequent layers can usually be printed in 10 to 15 seconds. Although the finer resolution of resin printers means the same object requires more layers than a filament printer would, their ability to print each layer in seconds rather than minutes translates to a measurably faster total print time. Refer to *Table A-1* in the Appendix for a comparison of the print speeds of popular consumer-grade filament and resin printers.

Clear and translucent parts

Although both filament and resin are available in a variety of colors, resin printers work best for creating clear and translucent parts. The quality difference results from the different print processes.

Each line laid down by a filament printer ends up having small gaps to the lines around them due to the filament's round cross section. Thick, curved, and complex shapes will end up with a lot of gaps, each of which causes refraction to the light passing through it. This process results in an object that usually looks opaque.

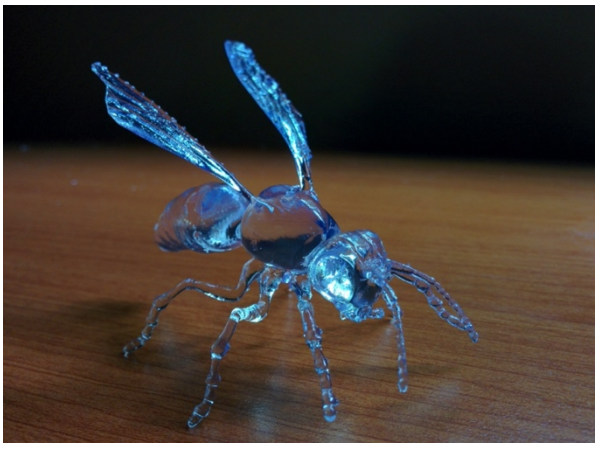

Figure 4 – a resin-printed translucent bug

Resin printers create clearer transparency because they print each layer as a solid mass. The resulting object has no gaps that refract light between the layers either. Less light refraction allows resin printers to create finely detailed clear and translucent parts.[3] *Figure 4*

[3] Plewa, Kat, "Transparent 3D Printing: what are your options? (2021 Update)," *sculpteo* online, accessed March 14, 2021, https://www.sculpteo.com/blog/2019/11/27/transparent-3d-printing-what-are-your-options/.

shows a translucent blue bug printed with a resin printer. Notice how light passes through it without revealing layer lines.

Disadvantages of resin printers

While resin printers produce higher quality parts in a shorter time than filament printers, be aware of some drawbacks.

Build volume

Because resin printers use the same LCD screen sizes as cell phones, their XY plane print areas are limited by their screen sizes. These sizes are typically smaller than comparably priced filament printers. Be sure to account for your finished product sizes when purchasing a 3D printer. Refer to *Table A-1* in the Appendix for a comparison of the build volumes of popular consumer-grade filament and resin printers.

Post-processing

Although resin printers typically print objects faster than filament printers, they require additional work after printing to create usable products. The printer cures the resin enough to hold its shape in the printer, but the object remains sticky and does not cure enough to be safely handled.

Several steps are necessary to post-process a resin-printed object:

1. After removing the object from the build plate, wash it to dissolve any uncured resin remaining on the object's surface. Use a solvent such as isopropyl alcohol with a concentration of at least 90% or a cleaning product like Simple Green.
2. Cut off temporary supports that were added as part of the printing process.
3. Fully cure the resin by exposing it to UV light for approximately 15 minutes. Curing can be done in sunlight, but a better option is to purchase a UV curing station to rotate the part to ensure even exposure. *Figure 5* shows a combined wash and curing station sold by a 3D printer manufacturer.

Figure 5 - a wash and UV curing station for resin objects

These steps add extra expense, time, and effort to resin prints that are not required with filament printers, but the higher print quality and print speed of resin printers justify the time and expense.

Hazardous materials

While fully-cured resin parts are safe to handle, precautions must be taken when working with liquid resin.[4] Uncured resin can irritate skin and resin vapors can irritate lungs. Work in a well-ventilated area

[4] Swift, Katherine, "Resin safety – Safety tips for working with resin," *Resin Obsession* online, accessed March 13, 2021, https://www.resinobsession.com/resin-resin-resin/resin-safety/.

and wear protective equipment to mitigate these hazards. Responsibly dispose of cleaning solutions that become contaminated with uncured resin.

Most of these hazards can be eliminated by using the newer water washable resins, and by using a printer with a built in air filter. Water-washable resin costs slightly more than standard resin, but the safety advantages for home use make it worth the expense. Not all resin printers have the capability to use water-washable resin though.[5]

Printer maintenance

Filament printers are lower maintenance than resin printers. They typically require little more than regular cleaning of the build plate, nozzle, and extruder, lubrication of the moving parts, and tensioning of the timing belts. Occasionally the printhead's nozzle will need to be replaced.[6]

Resin printers require costlier maintenance than filament printers. In addition to lubricating the moving parts and cleaning the build plate and resin vat, several parts will need to be replaced regularly. The FEP film on the bottom of the resin vat must be replaced frequently, often after printing just 1 to 2 liters of resin. Each layer of resin temporarily sticks to this thin plastic screen as it cures. When the built plate pulls the object away every cycle, the FEP film suffers a bit of wear.

Because the LCD screens in resin printers are subjected to UV light, they eventually degrade and wear out. Print quality will start to suffer as the screen nears the end of its life. The screens cannot be repaired and must be replaced when they wear out. Screens last for approximately 1000 hours of printing.[7]

Some resin printers include an air filter which must also be replaced regularly to cut down on fumes from the liquid resin.

Conclusion

Although resin 3D printers require post-processing, extra safety precautions, and costly maintenance, their print quality, production speed, and ability to print clear and translucent parts make them more suitable for a home-based business than filament printers. Customers will not see or care about this behind-the-scenes work; they will primarily care about the quality, design, and availability of products. Most sales are conducted online on sites that encourage customers to leave ratings and reviews. Customer feedback can make or break a business, so producing the best possible product is a sound business strategy. An affordable, consumer-grade resin 3D printer is the best way for a home-based business to create quality products that customers will love.

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[5] Bird, Michael, "Elegoo Water Washable Resin – Is It A Washout?," *INOV3D* online, November 20, 2019, https://www.inov3d.net/elegoo-water-washable-resin/.

[6] Carolo, Lucas, "3D Printer Maintenance: Tips to Maintain your FDM Printer," *All3DP* online, accessed March 13, 2021, https://all3dp.com/2/3d-printer-maintenance-fdm-3d-printer/.

[7] "So You Want A Resin 3D Printer?," *3D Printer Universe* online, June 26, 2019, https://3dprinteruniverse.com/blogs/world-of-3d-printing/so-you-want-a-resin-3d-printer.

Appendix

Below is a comparison of popular, consumer-grade 3D printers that are suitable for home-based business use.

Manufacturer	Model	Price	Type	Build Volume (L x W x H)	Print Speed (maximum)	XY Resolution	Layer Thickness
Creality3D	Ender-3 Pro[8]	$224	Filament	220 mm x 220 mm x 250 mm	180 mm/s (XY plane)	0.4 mm	0.1 – 0.4 mm
Prusa	MINI+[9]	$399	Filament	180 mm x 180 mm x 180 mm	200 mm/s (XY plane)	0.4 mm	0.05 – 0.25 mm
Anycubic	Mega X[10]	$399	Filament	300 mm x 300 mm x 305 mm	200 mm/s (XY plane)	0.4 mm	0.05 – 0.3 mm
Anycubic	Photon Mono[11]	$269	Resin	130 mm x 80 mm x 165 mm	50 mm/h (Z axis)	0.051 mm	0.01 – 0.15 mm
Elegoo	Mars 2 Pro[12]	$330	Resin	129 mm x 80 mm x 160 mm	30 - 50 mm/h (Z axis)	0.05 mm	0.01 – 0.2 mm
Elegoo	Saturn[13]	$500	Resin	192 mm x 120 mm x 200 mm	30 - 40 mm/h (Z axis)	0.05 mm	0.01 – 0.15 mm

Table A-1 - Specifications of popular consumer-grade 3D printers

[8] "Creality3D Ender-3 pro High Precision 3D Printer," *Creality* online, accessed March 13, 2021, https://creality3d.shop/products/creality3d-ender-3-pro-high-precision-3d-printer?gclid=CjwKCAiA4rGCBhAQEiwAelVti3GULXpbEDOTlYhC4NvpsJ9t3Yt7rn7ZfuwMyO5GGgOqaruPVDkJrxoCZ6QQAvD_BwE.

[9] "Original Prusa MINI+," *Prusa Research* online, accessed March 13, 2021, https://shop.prusa3d.com/en/3d-printers/994-original-prusa-mini.html.

[10] "Mega X," *Anycubic* online, accessed March 13, 2021, https://www.anycubic.com/collections/anycubic-mega-3d-printers/products/mega-x.

[11] "Photon Mono," *Anycubic* online, accessed March 13, 2021, https://www.anycubic.com/collections/anycubic-photon-3d-printers/products/photon-mono-resin-3d-printer.

[12] "Elegoo Mars 2 Pro Mono LCD MSLA Resin 3D Printer with Air Purifier," *Elegoo* online, accessed March 13, 2021, https://www.elegoo.com/collections/mars-series/products/elegoo-mars-2-pro-mono-lcd-3d-printer.

[13] "Elegoo Saturn MSLA 4k 8.9" Monochrome LCD Resin 3D Printer," *Elegoo* online, accessed March 13, 2021, https://www.elegoo.com/collections/saturn-series.