WHITE PAPER

Why Large-Format Printing Matters

Businesses can expand their use of additive manufacturing by turning to large-format 3D printing. To produce larger parts, many currently turn to outsourcing. However, outsourcing 3D printing can be time-consuming and costly. In this report, we look at how in-house large-format 3D printing with the Form 3L stacks up against other methods of production, chiefly outsourcing and using FDM printers.

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Introduction

As demand for additive manufacturing continues to grow, users often run into the problem of having to create prints which exceed the build volume of a desktop 3D printer. When a project requires a larger print than the build volume of a small-format fused deposition modeling (FDM) or stereolithography (SLA) printer, traditionally, there were only a few established options available:

1. Outsource parts to a service bureau.
2. Use small format in-house printers and assemble multiple parts.
3. Upgrade to a large-format FDM machine to print the entire part.

The arrival of the Form 3L fundamentally changed the status quo in 3D printing by offering a complete large-format solution at the fraction of the cost of traditional, industrial 3D printers. The Form 3L provides businesses the flexibility to print a wider range of part sizes and achieve higher throughput while maintaining the part quality and ease of use that professionals and businesses demand.. This report will compare investment in the Form 3L to the three popular options mentioned above.

So, when it comes to 3D printers, how large is “large-format”? Large-format 3D printers today generally offer 25-30 cm (9.8-11.8 in) cuboid build space, compared to the 15-20 cm (5.9-7.9 in) dimensions common in desktop 3D printers. In practical terms and as we’re thinking in three dimensions, this means the build volume is often three to five times larger than a standard desktop printer. To visualize this size, a large-format printer can print a full-sized bicycle helmet in one piece.

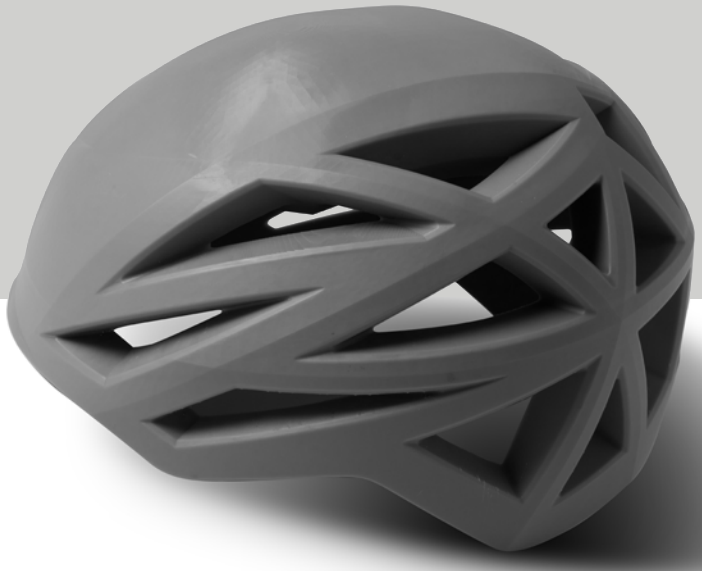
These benchtop large-format 3D printers can create full-scale prototypes and models for a wide variety of applications and industries.

Examples of what large-format printers can create:

- **Engineering:** Full-size looks-like and functional prototypes so teams can test and validate a more realistic model.
- **Healthcare:** Full-size anatomical models in one print so medical professionals can better prepare for surgeries and procedures.
- **Manufacturing:** Full-size molds for rapid tooling and large jigs and fixtures that don’t require assembly.

There are 3D printers on the market that go well beyond the sizes mentioned above, but these are limited to industrial 3D printers, where prices skyrocket, complexity increases, and facility requirements become stringent.

As mentioned earlier, there are industrial 3D printers on the market with similar performance metrics to the Form 3L, but with these printers, prices skyrocket, as does the complexity of operating the machines. In this white paper, we compare in-house large-format printing on the Form 3L to other methods of producing similar parts.



1. In-House 3D Printing Compared to Outsourcing

The main reason businesses choose to outsource is that purchasing a variety of machinery to produce the multitude of parts in a product often requires substantial investment, a dedicated location, and expertise to operate the machines. This can be avoided by outsourcing these large parts and having them shipped to your business. That said, in-house printing comes with multiple significant benefits over outsourcing with a service bureau.

In this section, we will cover three of the main benefits of in-house large-format 3D printing:

- Reducing costs in the long term.
- Increasing innovation through truly rapid iteration.
- Being able to address and shield your business from supply chain shocks.

REDUCING COSTS

Outsourcing can be appealing because it requires no upfront investment cost. Businesses simply send their 3D file to a service bureau, and it appears in the mail a week or two later. For businesses doing only a few 3D prints, irregularly, outsourcing can often meet their needs.

However, as 3D printing applications expand, the continuous use of outsourcing can lead to ballooning budgets. An upfront investment in in-house 3D printers will result in significantly lower costs per print and overall cost savings. This is especially true with large-format printing, as costs run as much as 4x the cost associated with in-house printing.

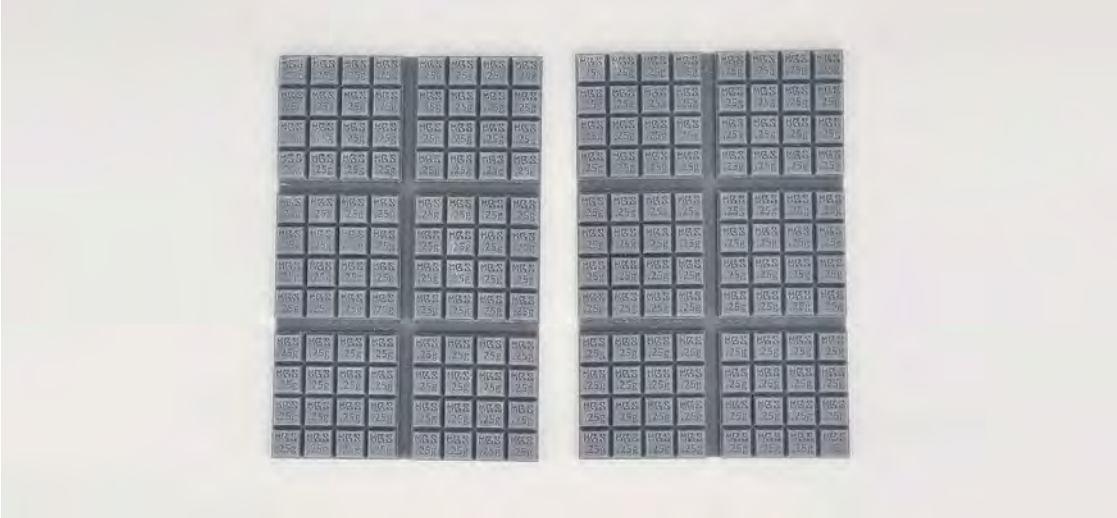
Comparing Costs: Form 3L and Outsourcing

PART	FORM 3L PRICE PER PRINT	OUTSOURCING PRICE	FORM 3L PRINT TIME	FORM 3L MATERIAL	OUTSOURCING LEAD TIME
Femur	$25	$350	23 hours	Grey Resin	One to Two Weeks
Three Part Jig Assembly	$71	$500	33 hours	Tough 2000 Resin	One to Two Weeks
Helmet	$114	$750	42 hours	Tough 2000 Resin	One to Two Weeks
Helmet	$97	$750	8 hours	Draft Resin	One to Two Weeks
Vacuum Nozzles	$10	$160	16 hours	Grey Resin	One to Two Weeks
Spoon	$33	$160	12 hours	Grey Resin	One to Two Weeks

* Form 3L print times with Draft Resin are up to 4x faster than the Standard and Engineering Resins above.

* This table only shows material cost, and does not factor in equipment costs and labor costs which will vary on each business.

This pricing dynamic can be illustrated by Capture It In 3D, a NYC based scanning company which was outsourcing large-format prints for its clients before eventually investing in a Form 3L. Owner and CEO David Lynshue believes that Capture It In 3D will be able to quickly make its money back on the machine: “I can recover the entire cost of the Form 3L in a few months. We’re not a super small single person company, but we’re not Microsoft either. This machine was exactly what we were looking for.”



Capture It In 3D prints full-sized chocolate molds that do not need assembly on this Form 3L.

According to Lynshue, “we’re personally less interested in smaller format prints right now; the larger format space is growing quickly and that’s where we want to be. We are seeing strong demand for large project orders.”

Cost savings is often something many Form 3L users notice once they start printing with the machine. R+D technician at Black Diamond, Matt Tetzl, said “We have reduced our costs on full-size prototypes from $425 a print to $70 a print. With that savings, Form 3L would pay for itself in only three months.”

To measure your own cost savings, use our free ROI tool below to get a better understanding of the price difference between Form 3L and other printing techniques.

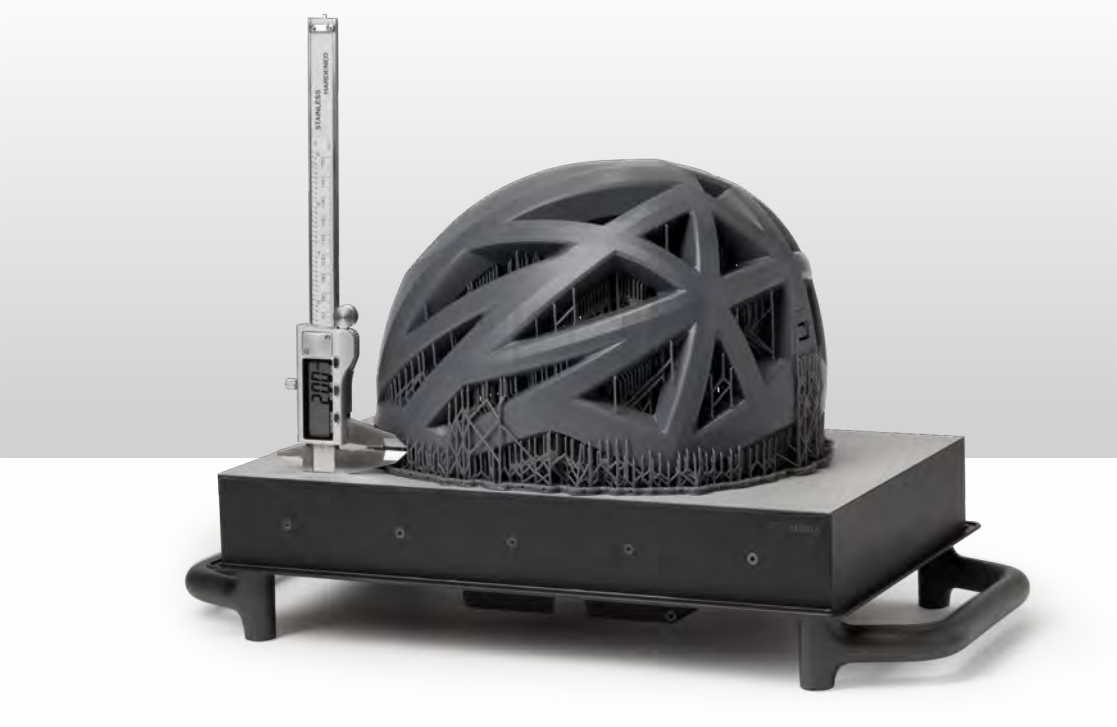
EMPOWERS BETTER PRODUCTS THROUGH MORE ITERATIONS

Rapid prototyping stops being rapid when an outsourced part takes multiple days or even weeks to arrive. This becomes even more apparent when a project requires dozens or more iterations. For hospitals printing large anatomical models for an upcoming surgery, or a product design firm that wants to gather user feedback, the time it takes to create prints is vital.

Black Diamond Equipment has created innovative climbing, skiing, and mountain gear. Known for comfort, durability and performance, Black Diamond’s products go through a rigorous design, testing, and iteration process before they come to market. They were also one of the first companies to get a Form 3L to complement their additive manufacturing fleet. They immediately put it to work to reduce outsourcing of large-scale parts, saving time, money, and improving their products.

Outsourcing - Time to Final Part	In-House - Time to Final part
One to two weeks	24-36 hours

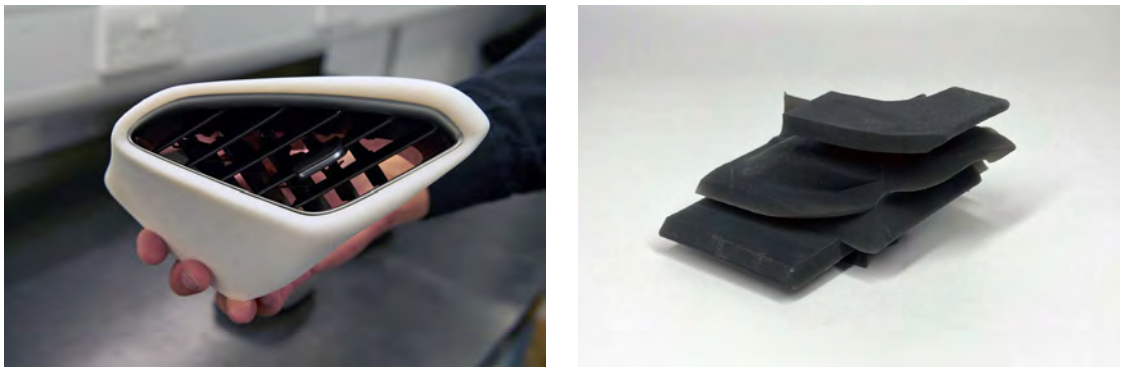
The Form 3L allows R&D Technician Matt Tetzl to create to-scale models in-house. The benefits are immense: the turnaround for large prototypes is cut to three days or less depending on print time. Being able to hold a full-size 3D printed avalanche shovel enables the design teams to immediately start visualization and ruminating ways to improve the design. Those ideas can quickly be implemented in CAD to start the next print.



Reducing lead times while increasing the number of iterations can have a dramatic effect on part quality. It allows designers to focus on tweaking and testing their parts, ultimately resulting in better final parts for customers.

Located in the heart of the UK's auto industry, Vital Auto is an industrial design studio with deep expertise in automotive design. The company’s illustrious clientele includes many of the major automotive manufacturers, such as Volvo, Nissan, Lotus, McLaren, Geely, TATA, and more.

In order to stay ahead of the competition, Vital Auto has invested in a large fleet of Form 3L and Fuse 1 printers to create high-fidelity prototypes for their concept cars, rapidly working through in-house iterations to find the perfect design.



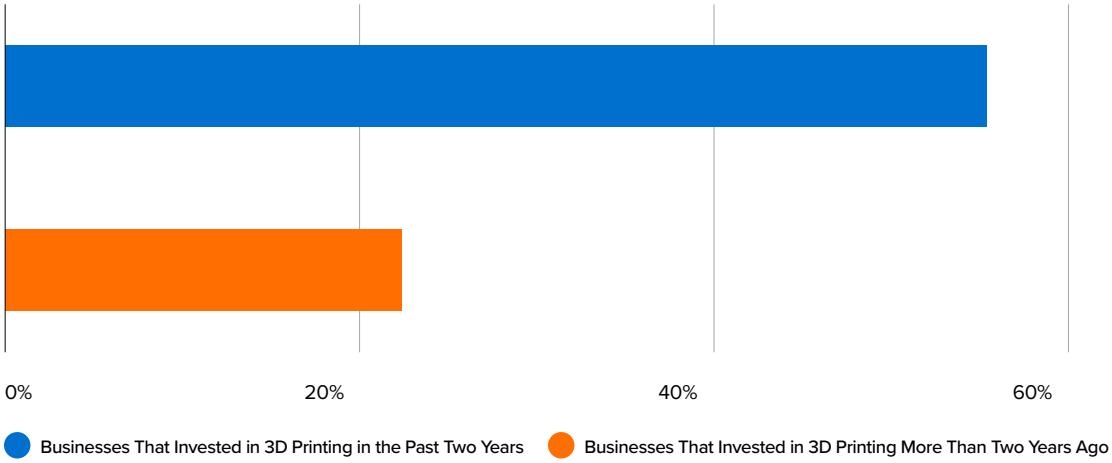
An air vent (left) and a door seal (right) printed on the Form 3L by Vital Auto.

“Typically, door seals for automotive applications can be incredibly costly to produce. There's simply no other way other than extrusion molding to produce them. This comes at, not only a very large tooling cost, but also a long lead time as well. We were able to experiment with one of Formlabs’ newest materials, the Flexible 80A Resin. The Form 3L enabled us to produce sections of this door seal overnight to test various geometries and was printed within 50 microns of the actual design,” said Anthony Barnicott, design engineer in charge of additive manufacturing.

ADDRESSING SUPPLY CHAIN BOTTLENECKS

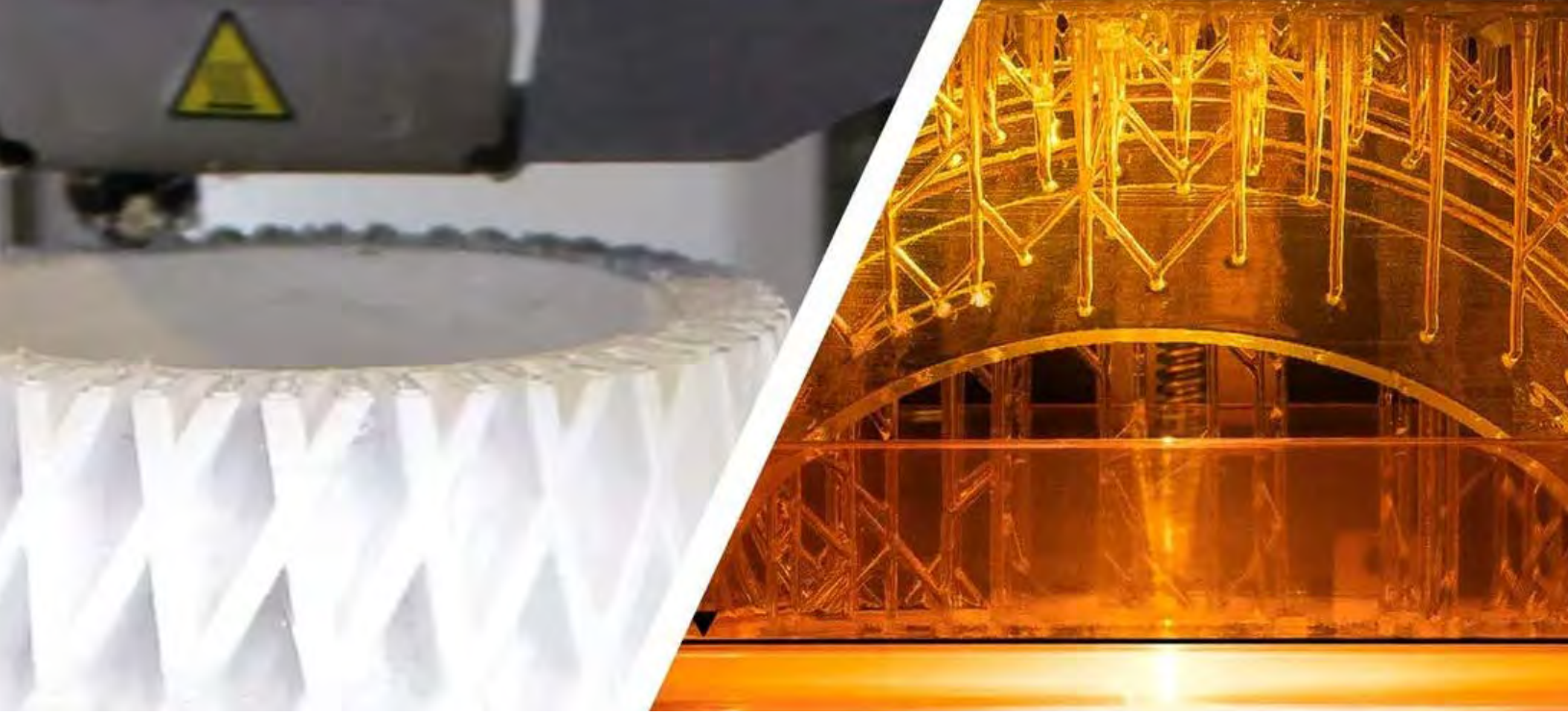
In a recent research paper conducted by Formlabs, users that adopted 3D printing in the past few years have looked to 3D printing to help them address supply chain shocks, with 57% of them “agreeing” or “strongly agreeing” that their internal 3D printing capabilities are helping to solve supply chain issues. Unforeseen global events can severely impact the supply chain of businesses that rely on outsourcing for critical projects.

% of Users Who Say 3D Printing is Helping to Solve Supply Chain Issues



Addressing supply chain challenges comes in multiple forms, be it the ability to replace broken machine parts or to keeping projects on deadline despite external shipping delays. In-house printing allows businesses to keep their own inventory of printing materials, reducing reliance on the service bureau to keep critical materials in-stock. In-house printing with large-format machines allows for a level of control over production that wasn't possible before: control the costs, the time, and your business's ability to respond to unforeseen circumstances.

This point drives home the versatility of in-house production with a large-format printer such as the Form 3L. It grants major flexibility around part production, enabling full-sized prototypes. Post-processing units such as the Form Wash L and Form Cure L are compatible with small-format SLA printers like the Form 3+, should your business invest in smaller machines in the future to expand throughput. For many businesses, early investment in large-format SLA will be the best option when considering addressing supply chain shocks.



2. Large-Format SLA Compared to FDM

FDM and SLA are the two most popular types of 3D printers on the market. Both 3D printing technologies have been adapted and refined for the desktop, making them more affordable, easier to use, and more capable. FDM has traditionally been purchased as an entry point for businesses looking for their first investment into 3D printing due to its low price point, and this includes investment in large-format printers. Furthermore, large-format SLA printers were simply not available at an affordable price for most businesses before the Form 3L.

Oftentimes, businesses are not choosing between FDM or SLA, instead using each technology for different prints. Both FDM and SLA 3D printing are commonly used in engineering and manufacturing to create prototypes, jigs, fixtures, and other tooling. FDM is often chosen for simple parts and its relatively simple workflow, while SLA is a better solution for complex designs and parts that demand better quality. But that doesn't mean the workflow for SLA 3D printing is necessarily complex either; Formlabs has automated the entire process from start to finish with the Form Wash L and Form Cure L.

FDM is the most widely used form of 3D printing at the consumer level, fueled by the emergence of hobbyist 3D printers. Large-format industrial FDM printers are, however, also popular with professionals. Some reasons why you may choose to use a large-format FDM printer:

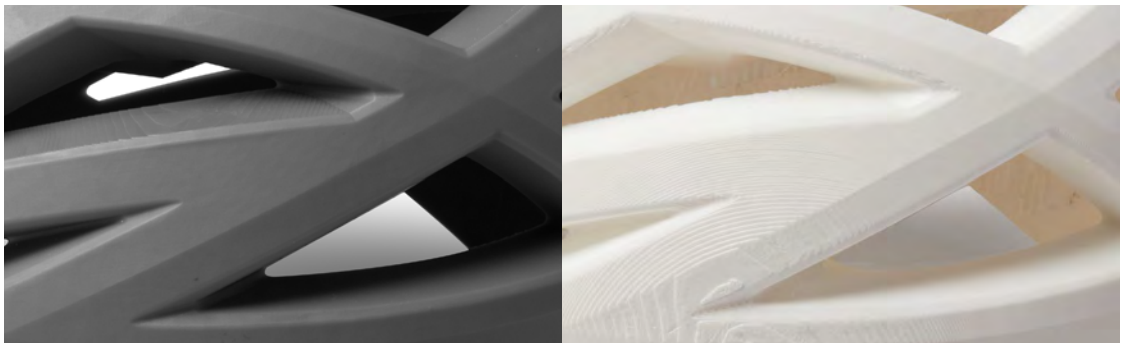
- FDM works with an array of standard thermoplastics, such as ABS, PLA, and their various blends resulting in a low price of entry and materials.
- FDM is best suited for basic proof-of-concept models and the low-cost prototyping of simpler parts.
- FDM is best suited for low-cost prototyping of simpler parts, often used as a basic "proof-of-concept" model.

There are some limitations as well which include:

- Large-format FDM has the same low resolution and accuracy as the smaller, desktop FDM machines. When compared to other 3D printing technologies for plastics such as SLA or SLS, FDM is often not the best option for printing large, complex designs or parts with intricate features.
- Higher-quality finishes on large FDM parts require labor-intensive and lengthy chemical and mechanical polishing processes. Some industrial FDM 3D printers use soluble supports to attempt to mitigate these issues and offer a wider range of engineering thermoplastics, but they also come at a steep price.
- When creating large parts, FDM printing also tends to be slower than SLA, depending on the materials used.

OBJECT	FDM PRINT TIME	FORM 3L PRINT TIME	FORM 3L PRINT TIME DRAFT RESIN
Vacuum Nozzle	19 hours	16 hours Grey Resin	5 hours
Full Sized Helmet	125 hours	42 hours Tough 2000 Resin	23 hours
Ventilator Enclosure	125 hours	60 hours Grey Resin	33 hours

FDM print times are based off estimates from Cura, printing at 100 microns, February 2022



SLA parts (left) offer a smooth finish, while FDM parts (right) deliver lower quality especially with complex designs or parts with intricate features.

SLA parts have the highest resolution and accuracy, the clearest details, and the smoothest surface finish of all plastic 3D printing technologies, but the main benefit of SLA lies in its versatility. SLA resin formulations offer a wide range of optical, mechanical, and thermal properties to match those of standard, engineering, and industrial thermoplastics.

Some advantages of using large-format SLA printers:

- Can produce high-accuracy, isotropic, and watertight prototypes and parts in a range of advanced materials with fine features and smooth surface finish.
- SLA resin materials have the benefit of a wide range of formulation configurations: they can be soft or hard, heavily filled with additives like glass and ceramic, or imbued with mechanical properties like high heat deflection temperature or impact resistance.

Compared to FDM, some common concerns business have historically had about SLA include:

- SLA prints require post-processing, including removing excess liquid resin from parts. These steps can now be automated with machines such as the Form Wash L and Form Cure L.
- Oftentimes, when printing small parts, SLA printers can be slower than FDM machines. Formlabs has addressed this concern by developing fast-printing materials such as Draft Resin, which is significantly faster when printing both large and small prints.

SLA is a great option for large, highly detailed prototypes requiring tight tolerances and smooth surfaces, as well as molds, tooling, patterns, medical models, and functional parts. It also offers the material with the highest heat deflection temperature of 238°C—which makes it an ideal choice for certain engineering and manufacturing applications—as well as the widest selection of biocompatible materials for dental and medical applications. When using Draft Resin, the Form 3L is also the fastest option for 3D printing large parts, up to 10X faster than FDM.

The Form 3L operates exactly the same as its desktop counterpart, the Form 3+, creating high-quality prototypes and parts with a smooth surface finish. As a project moves forward in development, SLA 3D printing is ideal for detailed concept models or functional prototypes that might require better quality and materials with different properties.

The Form 3L brings all of these SLA benefits to large-format printing.

A helmet which can be created on the Form 3L in one print has to be split into four parts when printing on the Form 3+.

3. Printing Large Parts Compared to Joining Several Small Parts Together

For businesses which do not yet own a large-format 3D printer, splitting a model into smaller parts that can be combined after post-processing is a great solution for 3D printing large objects bigger than their printer's build platform.

When selecting a bonding method, the primary consideration should be the strength of the bonded joints, which is dependent on the ultimate use case of the parts:

- Chemical fastening: Use a bonding agent for art, scale models, and complex shapes that are not meant for functional use or for sustaining impact.
- Mechanical fastening: Add screw thread or pockets to functional engineering parts that require a robust mechanical connection or if the components need to repeatedly attach and detach.

An example of several smaller parts joined together to make a larger object by gluing, patching, and then sanding before painting.

When using smaller-sized printers to create multiple parts, it is often necessary to alter the CAD design. This may be because the design now requires screw threads, or tabs to hold pieces together. The addition of glue and other adhesives may slightly change the weight or dynamics of a part, and this has to be taken into account when designing the CAD file. The part produced through this method will not 100% mimic the final part, and that should be taken into account when moving to production or further along in the development process.

Significant changes to the object may require the user to print all or many of the parts again; if only a few, or one, 3D printer is available, then this could take considerable time. Additional time spent tweaking designs, printing parts, bonding or fastening them together, and then post-processing the assembly to hide any possible defects adds additional labor costs to a project, and this should be taken into account when doing a cost/benefit analysis of using a large-format printer instead.

PRINT HIGH QUALITY LARGE-SCALE PARTS WITH THE FORM 3L

Whether you are currently using a large-format FDM printer, outsourcing, or you assemble multiple parts into larger objects, the Form 3L offers clear-cut advantages to your business. The Form 3L boasts incredible part quality, providing the smooth surface finish and fine detail that SLA 3D printing is known for. When printing large parts on the Form 3L, businesses should expect:

- Smooth surface finish. Models printed on the Form 3L resemble polished injection-molded parts for realistic looks-like prototyping.

- Consistent precision. A system of lasers and mirrors ensures uniform print quality, for an XY resolution of 25 microns across the entire build platform.
- High translucency. With precise layer registration and smooth surface finish, translucent materials print clearer than ever, right off the printer.
- A deep and growing material library. Our extensive resin library contains 30+ materials catering to your workflow and application.

Formlabs is known for designing end-to-end additive workflows you'll be excited to use, and the Form 3L is no exception. The printer is supported by fully automated post-processing solutions to make printing seamless, so you can focus on putting your prints to work.

Looking for more information on how the Form 3L can help your business? Watch our free educational webinar that will walk you through the entire Form 3L ecosystem.

Curious to see the quality firsthand? Request a free sample part of a large vacuum nozzle printed in Grey Resin on the Form 3L shipped to your door.

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