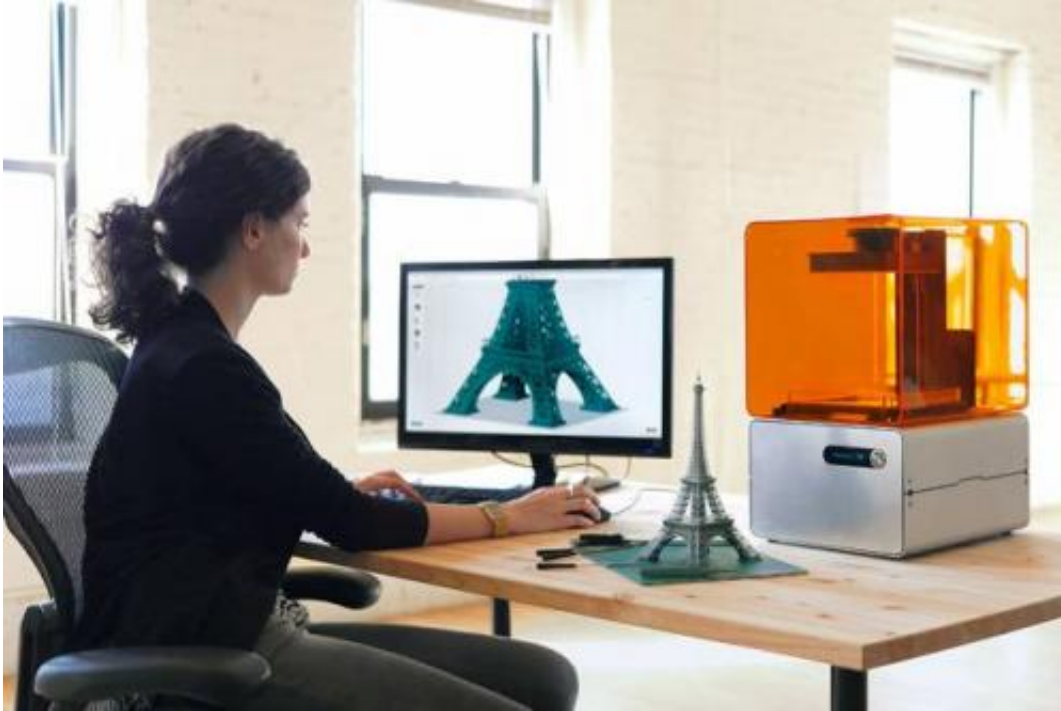


Affordable precision 3-D printing for pros

June 3 2014, by Rob Matheson



A user works away on Formlabs' Form 1 3-D printer and PreForm software.
Credit: Formlabs

Against the backdrop of today's burgeoning 3-D printing landscape—with an ever-increasing number of machines popping up—MIT Media Lab spinout Formlabs has carved out a precise niche.

Combining a highly accurate (but usually expensive) light-based printing technique with engineering ingenuity, the Formlabs team invented a high-resolution 3-D laser printer, called the Form 1, that's viewed as an

affordable option for professional users.

The desktop printer—standing about a foot high and weighing about 20 pounds—runs on stereolithography, a fabrication technique usually reserved for massive machines that cost hundreds of thousands of dollars. (Form 1 sells for about \$3,300.)

In the Form 1, a violet laser moves around a bath of light-sensitive polymers, or resin, tracing a predetermined pattern. After each layer is cured, a mechanical platform lifts the object upward, where the layer is rapidly dried and another melded to it. This process is repeated layer-by-layer, taking several hours and delivering layers as thin as 25 microns—much more finely detailed than other low-cost 3-D printers.

"We've always seen the Form 1 as a valuable middle point," says Maxim Lobovsky SM '11, a Formlabs co-founder and inventor of the printer, along with classmates Natan Linder SM '11 and David Cranor SM '11.

"With the really low-cost printers, it's a hobbyist or educational thing. The high-end, detailed machines have been useful for years for product design, but are unavailable to many," Lobovsky says. "We're making that high-end usefulness available to an order of magnitude more people."

Engineers, designers, and inventors—from small businesses to movie studios such as Pixar—have printed out intricate figurines, toys, replacement parts, jewelry, and prototypes. Reviewers from *Wired* and *Popular Mechanics*, among others, have praised the printer for its high resolution at a low cost.

Backed by more than \$22 million in funding and growing profits, Formlabs is now renovating another 10,000 square feet in its Somerville headquarters to ramp up production.

Forming philosophies

Formlabs started just three years ago in the MIT Media Lab, whose "maker" philosophy and entrepreneurial ecosystem inspired the co-founders to build a higher-precision 3-D printer for the masses.

In 2009, their interests merged in 4.140 (How to Make (Almost) Anything), taught by Neil Gershenfeld, director of the Center for Bits and Atoms.

Previously, Lobovsky had been involved with the Fab Lab project, a global network of small-scale workshops pioneered by Gershenfeld and equipped with low-cost, computer-controlled tools and machines—including 3-D printers—to help people invent.

"From that world, it was compelling to see how engaged people are when they have access to these tools. But it was also frustrating to imagine what these tools could do," Lobovsky says. "That was a big inspiration: We could make a better tool for the world like this."

In Gershenfeld's class, Lobovsky and Cranor (who left the company in 2012) began making a prototype, which involved cramming hardware into a \$2,000 machine.



A lattice structure clings to the mechanical lift after finishing printing in the Form 1. Credit: Formlabs

In particular, they utilized the lasers from Blu-ray DVD players for the printer's laser —usually the most expensive component—and leveraged cheap computer components for its print engine. Buzz around the Media Lab caught the attention of Linder, an experienced entrepreneur looking to jump aboard an early-stage venture.

Before coming to MIT, Linder had founded and run an Israeli research and development center for Samsung. Subsequently, he became lead product designer on the Baxter robot by Boston startup Rethink Robotics—a company founded by MIT professor emeritus Rodney

Brooks.

Linder had, in fact, come to the Media Lab specifically for its hands-on, entrepreneurial ecosystem. "It's like an incubator, but not in the venture sense," he says. "It's this hands-on, learn-by-doing environment where you just get things done."

Not surprisingly, that "maker" philosophy has now found its way into Formlabs' business model, which emphasizes independent research and experimentation. "Very early on, we cultivated a culture to let our employees do their thing—show them a path, and then stay out of their way," Linder says.

Rapid rise

Throughout 2011, the trio grew Formlabs with guidance from MIT's Venture Mentoring Service and the Martin Trust Center for MIT Entrepreneurship. In between writing their master's theses, they prototyped—"as a pacifier from the act of academic writing," Linder says.

Initially, they found little interest from investors. But a fateful dinner in a Harvard Square seafood restaurant, where Lobovsky and Cranor pitched Formlabs to a venture capitalist, changed that.

The venture capitalist didn't bite, but the pitch was overheard by Lotus Development co-founder Mitch Kapor, who sat a few tables away. After dinner, a friend sent the two a screenshot of a tweet from Kapor, who said he'd heard two entrepreneurs pitching a 3-D printing company at the same restaurant.

Following an exchange of emails, the Formlabs team met with Kapor, who said 3-D printing reminded him of the early days of computers,

when new hardware was trying to find a market. Enthused, Kapur backed the company, quickly inspiring Google Chairman Eric Schmidt and other angel investors to jump on board.

"From there, we got right to work in turning that pile-of-metal prototype into the Form 1," Lobovsky says.

Among other things, they cased the printer in an aesthetic design that included an orange-tinted viewing window and a plain silver body.



A small-scale Eiffel Tower printed with the Form 1

The rest happened quickly: In 2012, a year after the co-founders graduated from MIT, Formlabs launched a successful Kickstarter campaign, raising nearly \$3 million—well beyond its goal of \$100,000.

Last December, the team finally finished shipping to Kickstarter backers, and now has a new batch ready to ship in July.

One small step for 3-D printing

Despite its impressive hardware, much of the Form 1's innovation comes from its software, called PreForm, which automates the stereolithography process and makes it simpler for users.

A challenge with other stereolithography printers, Lobovsky explains, is that the object has to be specially oriented on the "support structures"—minute columns of resin that connect the object to the mechanical platform—to ensure a clean break once the object is finished.

Traditionally, a technician working on high-end stereolithography machines does this manually, using expensive, complicated software. But PreForm includes automatic object orientation and support structures that ensure the finished product can break from the platform without breaking.

By continuously advancing the software, the long-term goal, Lobovsky says, is to achieve "one-click printing," where a user can design a model, press "print," and set the printer to churning out a model rapidly.

"The idea is to make the process of 3-D printing as seamless as possible, by minimizing all the work that goes into 3-D printing, so people can spend as much time as possible in the first part, which is designing," Lobovsky says.

Although there's a lot of hype around 3-D printing today—especially the idea of ubiquitous personal use—the Formlab co-founders remain practical about the limits of the technology.

"We made one significant step to making 3-D printing more like 2-D printing, where you've got some content and just want to print it quickly—but in the grand scheme of things, we made only a small step," Lobovsky says. "We've got a lot of work ahead of us to make that possible."

But the work is important for several reasons, Linder says. "We're hoping to move the technology faster and proliferate, and change how people design and engineer products—whether it's the next car, or medical device, or toy," he explains. "In the process, we're building a real tech company that's sustainable, which is good for our community, for Cambridge, for Massachusetts, and for the world."

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