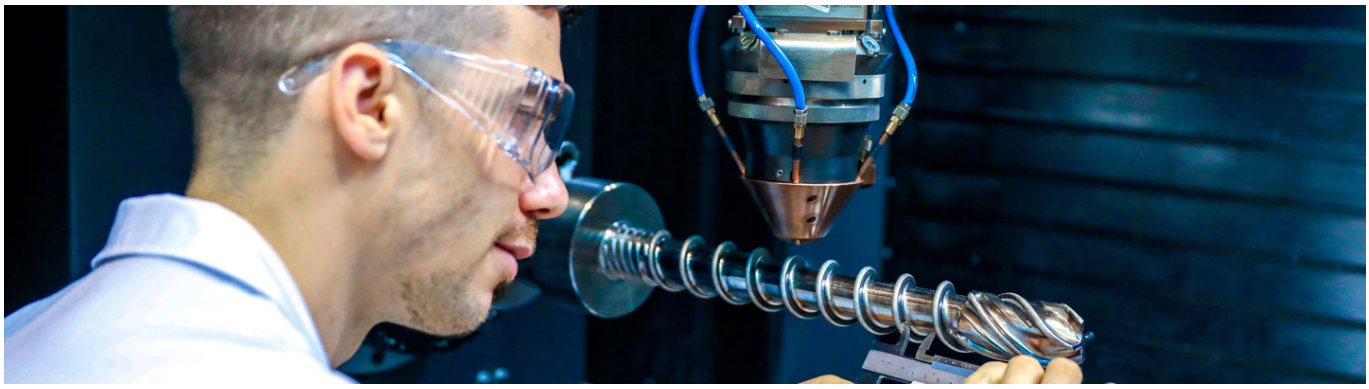

Additive Manufacturing

CNC Machining vs. 3D Printing: What's the Best Option for Your Job?

Kip Hanson | May 03, 2022

Stereolithography inventor and 3D Systems founder Charles Hull began selling 3D printers in 1986. A few years later, Scott Crump of Stratasys commercialized his fused deposition modeling technology. Others soon followed, and it wasn't long before entrepreneurs everywhere were buying these "rapid prototyping" machines and opening "service bureaus," companies that focused solely on 3D printing.

Today, each of those once cutting-edge terms is mostly obsolete. Additive manufacturing is no longer limited to prototyping, rapid or otherwise. And service bureaus have given way to e-manufacturers, whose owners and managers maintain that 3D printing complements CNC machining and other more traditional manufacturing processes, and has become just another tool in their toolbox (albeit a very powerful one).

Compensating for strengths and weaknesses

That's certainly the case with Los Angeles-based Stratasys Direct Manufacturing, where vice-president of operations Greg Reynolds explains that deciding what manufacturing technology to use for any given project depends on numerous factors, beginning with part complexity.

Heidenhain says its TNC 640 and Acu-Rite MillPWR G2 controls are ideally suited for manufacturers seeking fast, flexible programming and advanced capabilities, whatever the machine tool. Image courtesy of Heidenhain Corp.

“Additive manufacturing brings several important advantages over conventional processes, particularly where metal is concerned," he says. "High on this list is part consolidation. Instead of machining a bunch of parts and then bolting or welding them together, metal 3D printing allows you to produce the assembly as a single, often much lighter, workpiece. With that come features like internal passageways, complex swept surfaces and other organic shapes, and thin-walled lattice structures. Each of these is either very costly or downright impossible to machine. For additive, however, they’re quite easy.”

On the flip side, simpler, more monolithic parts such as brackets, shafts, housings, and a host of other “blocky” components remain firmly in the machining realm, whether the shop is making a prototype part or a production run of many thousands.

And because 3D printing can’t compete with machining in terms of accuracy, parts with tight tolerances and very smooth surface finishes are also more suitable for a CNC lathe or machining center.

Because of that, many plastic parts and virtually all metal ones require a post-build trip to the machine

shop to finish critical part features and remove supports, the bane of most 3D printing processes.

3D printing: Good for complex geometries, intricate features

“For lower production volumes where part accuracy and surface finish is not the highest priority, 3D printing is certainly the way to go,” says Gisbert Ledvon, director of business development for machine tools at Heidenhain Corp. “This is also true for parts with very complex geometries, and where 3D printing can produce features that would otherwise be difficult to manufacture. Even though they might require secondary machining, these kinds of parts are increasingly produced via metal additive manufacturing.”

A plastic injection mold is one example, Ledvon says. Instead of drilling a Swiss cheese-like series of cooling holes throughout the mold base or its inserts, as with traditional mold making, laser metal powder bed (LPBF) machines can print the entire mold and fill it with strategically placed cooling channels, which conform to and surround the mold cavity. The results, he says, are molds with much faster cycle times and higher part quality than would otherwise be possible.

This H350 3D printer is used to produce a range of high-quality, end-use products, some in large quantities, at Stratasys Direct Manufacturing’s facility in Austin, Texas. Image courtesy of Stratasys Direct Manufacturing.

Here again, secondary operations to finish-machine the mold cavity and other critical surfaces are needed; as Ledvon and Reynolds both point out, metal additive manufacturing leaves behind a surface finish comparable to that of a casting or forging.

Both experts say that transferring these and other parts from a 3D printer to a CNC machine calls for a robust fixturing strategy. "It would be ideal if your 3D printer has some kind of a pallet system that

integrates with your machining center, as this will save a lot of time and headache," says Ledvon.

Gripping a 3D printed part is similar to gripping a casting, Reynolds adds, in that there's often not a fixed datum point to reference. "As with castings, you're starting the machining process from a near-net-shape, so you have to mill or turn a zero-point first and then proceed from there. It varies from job to job, but overall, I would say that dimensional control is definitely more challenging with 3D printed parts."

CNC meets the need for speed

Another feather in CNC machining's cap is speed. Where CNC lathes and machining centers can rip material from a bar or billet at great rates, laser-based metal and polymer 3D printers are notoriously slow, taking many hours to produce most parts and even days for larger ones.

Yet lasers are far from the only way to bind materials. Additive manufacturing boasts seven distinct technologies and numerous offshoots, some of which have become downright speedy in recent years.For instance, 3D printer manufacturers such as Markforged have developed binder jetting machines able to print large quantities of "green" parts that are then sintered, mimicking the decades-old metal injection molding process. And fused deposition modeling printers like those from MakerBot and parent company Stratasys have not only become much faster than in Scott Crump's early days, but are now able to print certain metals.

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Similarly, Chuck Hull's stereolithography process has expanded to include digital light processing, which cures entire layers of photopolymer resin in a single pass rather than painstakingly tracing them line by line with a UV light source.

These and other polymer printers are also much more accurate than they once were (though still far less accurate than machining), and when used in conjunction with so-called "vapor polishing" equipment, can produce exceptional surface finishes.

The METHOD X from MakerBot can print tooling, functional prototypes, and even end-use production parts quickly and accurately using manufacturing-grade materials. Image courtesy of Stratasys Direct Manufacturing.

Then there's selective absorption fusion from Stratasys. Though currently limited to eco-friendly PA11 Nylon, it prints parts using a proprietary ink that lowers the melting point of any polymer powder it touches. When exposed to an infrared heat source, these areas fuse to produce fully functional parts. "It doesn't matter whether it's one part or 1,000, the build speeds are the same," says Reynolds. "This makes it ideally suited for higher production volumes, and since it doesn't put as much heat into the part as selective laser sintering (SLS), material integrity is generally greater."

Trimming production time

Tooling is yet another important distinction between 3D printing and traditional manufacturing. Because the former is an entirely digital process, there's no need for jigs, fixtures, and other tooling (aside from that used in secondary processing) required with traditional manufacturing processes.

That offers numerous benefits, the most obvious being the elimination of some or all tooling costs. But there's also the lead time needed to manufacture the tools, and when ready, install them on the machine tool, pick up program zero, and then prove out the CNC program. A 3D printer, on the other hand, can go from CAD model to finished part in as little as a few hours.

Reynolds notes that 3D printing has become more automated lately with regard to decaking and support removal, although automation is also playing a bigger role in other types of manufacturing.

Regardless, choosing how to produce any given part is a complex decision, one that depends on the job quantity, the part geometry, its accuracy and surface finish, what material it's made of, and a host of other factors.

Metalworkers trying to decide between the two techniques can upload a part to Stratasys' website for an instant quote and find out which way is fastest and most effective.

"For those who might have considered investing in their own 3D printer at some point and found it either too expensive or not capable enough, I would encourage them to take another look," he says. "It's become a very mature technology and, as with CNC lathes and machining centers, is just one more way of making parts."