Will Hybrid Additive/Subtractive Fabrication Devices Prove to be the Key to Unlocking an Even More Successful Manufacturing Future?

By Joshua Johnson, November 20, 2012

Joshua Johnson has been interested in the 3D printing sector for many years and has watched ongoing developments closely. With a background in design and manufacturing his skill set was originally built up around traditional subtractive techniques for manufacturing. However, as 3D printing technologies have continued to evolve Josh's focus has been on developing a solution that offers the advantages of both additive and subtractive tech — bringing together the best of both worlds. Here, in an article written exclusively for 3DPI, Josh takes a look at some of the key developments in this area and the impact that this could have on manufacturing in the future.

Additive technologies (also called 3D printing) and their many uses and applications have risen exponentially over the last few years in terms of consciousness and adoption by industry. More traditional subtractive technologies have also been on the upswing with improvements in controllers, algorithms, motion control and software. As these two technology bases have improved so too have peripheral devices such as 3D scanners, robots and metrology systems. For manufacturers this is all good, but more often than not the additive/subtractive techniques are viewed as mutually exclusive. However, recently a new breed of manufacturing technology has begun to evolve — the hybrid, all-purpose fabrication machine.

Devices that 'print' additively in a range of materials and those that can rapidly cut or mill metals and wood are very different beasts when optimized for those specific purposes. Zach "Hoeken" Smith Co-Founder of Makerbot Industries and sole proprietor of Hoektronics explains the differences:

"The key difference between the mechanical systems for additive manufacturing (3D printing) and subtractive manufacturing (CNC) is in the positioning system, and the requirements each one has. For 3D printing, the requirement tends towards lower accuracy and faster speeds. For CNC, it tends to be on the opposite end of the spectrum: lower speeds, but higher accuracy.

One big reason for this is that the forces required for CNC work are much higher than for 3D printing. This requires that the axes are much more rigid, and typically made from metal. This added weight makes moving at high speeds much more difficult. It also tends to add a lot of cost, since typical drive systems from the world of 3D printing (belts + pulleys) don't really cut it anymore. For this reason, most CNC machines are driven by (threads) instead."

Neil Gershenfeld, a professor at Massachusetts Institute of Technology (MIT) and head of MIT's Center for Bits and Atoms (originally of MIT's Media Lab) initially promulgated the idea of a hybrid fabrication center in 2005, which resulted in the ensuing expansion of Fab Labs across the world (163 at last count). Although at that time no single device was created as part of this effort, recently MIT's CADLAB Ilan Moyer and Nadya Peek have developed a

hybrid machine named PopFab. PopFab can not only handle additive and subtractive processes, it is able to fold into a carry-on size case as well. Similarly, variants of the now famous RepRap project, including the Hydra-MMM prototype and a German demonstrator, can manipulate material in a hybrid — additive and subtractive — manner.

One commonality that most open source 3D Printers and almost all CNC devices share is their use of G-Code and simple extrapolation from 2D vectors to physical shapes and motions. Because of this common language many controllers, as well as linear motion components, can be used for both processes in the same machine.

On the semi professional front many hybrid variants already exist in one form or another. Mach3 is a popular low cost control software that is used by professional machinists. Darrin of fabitrabbit has developed a fused deposition modelling (FDM) head that will run off of any Mach3 driven device (a video demonstration can be viewed below) and Nuri Enginer has developed a plugin that will 3D print right out of Mach3.
Both use Slic3r, an open source, .STL to G-code translator. You can also buy all metal FDM heads from QU-BD for this purpose. QU-BD plans to release its own sub $2000 heavy duty all machined hybrid machine in the next few months.
Other semi-pro demonstrator variants include the SUMPOD combination machine and one that I myself am working on, the ProtoBot VB1.

So why are hybrid additive/subtractive manufacturing systems so desirable? I believe it is because hybrid devices can be used to improve the precision of parts prior to being enclosed by the FDM process. They can also be used to create threads, remove otherwise trapped support material or break moveable parts free from the surrounding matrix. In many cases it might just be faster to machine a complex part section rather than print it.

And then there are those that are taking this even one step further. Inventor Mark Knighton of NextEngine applied for and was granted patent #US20110282482 for a combination scanner, 3D printer and machining center system. The patent describes the device as: ‘A set of fabrication tools (to) include at least a coarse deposition head and a fine additive head, a fine subtractive head or both employed concurrently within a single housing.’ His patent has no prior citations or ensuing references and was granted in 2011. While there is no further information at this time, this is one to watch out for I believe.
For the professional user many options exist depending on the quality you need and available budget. Rachel Park at 3D Printing Industry recently highlighted the Matsuura Lumex Avance-25 in an article also illustrating the benefits of combination machines. Robert Ganter who

represents Trumpf's additive laser technology, called Deposition Line, illustrates its benefits in the video below.
Trumpf claims it can "produce metallic material depositions on existing components as though it were cast: without loss of quality, well-sealed and free of pores and cracks". In an email they acknowledged that these lasers can also be "used to subtract layers of material" and link to Mori Seiki and GFH as technology integrators.

There are also many articulated robots, such as FANUC, that are designed and have been used for additive and subtractive purposes. Dirk Vander Kooij, a Dutch artist is just one example – he has made headlines with his continuously extruded furnishings.

As this article hopefully demonstrates, there are many exciting developments focused on hybridizing existing additive and subtractive manufacturing technologies. For me it is a no-brainer, developing methods for manufacture that utilize the advantages of both techniques in a single system to reduce capital costs and improve production techniques. As these developments continue and become realistic alternatives within the manufacturing arena, it is my hope that education and information about the possibilities will flourish and uptake and results will improve. In realistic terms, as with any other product or idea it will be marketability and functionality that will dictate these things. I am convinced, by the developments I have seen that it will come to pass, but being the impatient type, I want it to be sooner rather than later!