GOING 3D

Ontario firm sets growth sites on additive manufacturing

BY MARY SCIANNA

Top: Complex part made on the EOS Formiga P 100 for plastics. Below: Polished dental bridge made on the EOSINT M 280 additive manufacturing machine.

The Additive Manufacturing Machine

The Formiga P 100 from EOS of North America Ltd., Novi, MI, is available for laser sintering of plastic or composite parts. The compact machine is considered a suitable model for entry into additive manufacturing, according to EOS, and is designed for small-series production, customized products with complex geometries and rapid prototyping applications. It provides users with the capability of manufacturing product designs directly from CAD data within just a few hours. The effective building volume is 200 x 250 x 330 mm (7.9 x 9.8 x 13 in.) and the building speed, depending on the powder material, is up to 20 mm/h (0.79 in./h). It is equipped with a CO2 30 W laser.

The equivalent machine for metal is called the EOSINT M 280. The machine is based on the Direct Metal Laser Sintering (DMLS) system developed by EOS. It produces components by means of selective laser sintering. It's equipped with a 200 W or 400 W IPG Photonics fiber laser that melts the fine metal powder and builds up the product layer by layer. The building volume is 250 x 250 x 325 mm (9.85 x 9.85 x 12.8 in.) The machine can process a range of materials from light alloys to high grade steels, tool steels and super alloys.

WHEN THARWAT FOUAD decided to expand his manufacturing business in 2012, he investigated many options before finally setting his sites on additive manufacturing.

"We understood it was a new method of manufacturing and we could differentiate between the media buzz about how this technology would take over manufacturing, and the actual facts of the potential of it," says Fouad, who has an engineering degree. "3D printing began as a process for prototyping and I used it 20 years ago when I worked at Proctor and Gamble. The technology has evolved; today prototypes are produced faster and more accurately."

Of course the biggest change for additive manufacturing is the shift it is making into real-world manufacturing applications.

"3D printing with SLS [selective laser sintering] is similar to when CNC came out 50 years ago. CNC was a new method of manufacturing that saved time, was more accurate, and offered repeatability. Engineers learned how to design for CNC. 3D printing in SLS is the same thing; a new method for manufacturing parts. It has its advantages and its limitations. People in manufacturing need to learn how this technology works and how to master it; there is still a big gap of knowledge in industry. Once manufacturers master the technology, you will see it take a fair percentage of the market," says Fouad.

Anubis 3D is a division of Anubis Manufacturing Consultants Corp., Mississauga, ON. The intent of the new additive manufacturing division, formed in 2012, was to provide additional manufacturing services to existing customers, but the division

Design-Driven Manufacturing

Additive manufacturing is making significant inroads into conventional metal product manufacturing, and for good reason. Its ability to produce complex designs not possible in traditional manufacturing processes opens the doors to new manufacturing opportunities.

Indeed, it is additive manufacturing's design flexibility that is contributing to the growing use of it in industry; any possible form that can be created using a 3D CAD program can be produced using an additive manufacturing process.

One company that has been at the forefront of the technology is EOS, which says it invented the metal laser sintering process, known as Direct Metal Laser Sintering (DMLS) in the early 1990s.

"Additive manufacturing is best where you want to maximize product design," says Andy Snow, regional director for EOS North America, Novi, MI. "The newer generation of industrial designers develops products and then gives them to manufacturers and in many cases the complex designs can't be produced because they don't adhere to conventional manufacturing rules."

Snow says medical and aerospace applications are where EOS is seeing the biggest demand for additive manufacturing.

"Many companies are using it for making patient-specific implants, so it's customized implants. The aerospace sector is also taking advantage of this technology because of the ability to reduce part weight. You can incorporate complex lattice structures, maintain integrity but produce lighter weight parts. In injection moulding, more companies are beginning to use our technology for creating complex conformal cooling channels in moulds for even heat dissipation. This leads to a reduction in cycle times."

EOS cites an example of a customer using DMLS, SIG Blowtech. It was able to lower cycle times from 15 to 9 seconds. For a four-bottle blow die with DMLS-manufactured inserts, the company has achieved a 75 per cent increase in productivity.

The DMLS additive manufacturing process allows manufacturers to create complex, free-form geometries with fine details and thin-walled structure thicknesses in the 100 to 150 micron range. Part of what gives DMLS this ability is the fine powdered metal.

"EOS is the only supplier of [laser sintering] additive manufacturing technology that will guarantee the mechanical properties of the process because we spend a lot of time developing build parameters associated with each alloy," explains Snow. "It takes about a year to develop build parameters to process a certain alloy. Other suppliers will only give you rough starting points for factors that influence build parameters."

The EOSINT M 280 for metal is based on the Direct Metal Laser Sintering (DMLS) process (seen in action in inset image), developed by EOS.

Snow says EOS is seeing growth for its additive manufacturing machines. In North America alone he estimates EOS has approximately 130 machines in operation for metal product manufacturing.

has opened the doors to new markets and new customers. Anubis 3D is focused on the plastics market short term, but Fouad says he is "not removing the possibility of going to metal" some time in the future.

Anubis purchased an additive manufacturing machine, the Formiga P100, from Machine Tool Systems, Toronto, a distributor for EOS of North America Inc., Novi, MI.

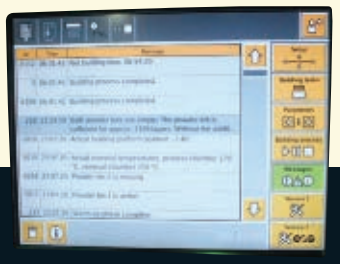
While there is much intrigue about the benefits 3D printing can bring to a manufacturing operation, there is also a steep learning curve. Indeed, Anubis is still in the midst of learning the intricacies and capabilities of the technology. "It took quite a bit of work to achieve repeatability for the products we were manufacturing and to be able to commit to customers what we could deliver," says Mona Louca, 3D deparment manager at Anubis. "There are many variables involved in getting the process right; you have the powder mix, recylce and storage conditions, party geometry features, etc. There are multiple parameters and you have to understand these parameters. You have to learn the technique of laying out parts to obtain a successful build. We tested parts by building them vertically and horizontally and analyzed the difference in terms of esthetics and part integrity. Right now we build parts at a layer thickness limit of 100 microns using selective laser sintering. Some of the other technologies have the capability of producing higher precision plastic parts with layer thicknesses between 50 and 60 microns, however the materials are brittle and are meant for show; they're not functional parts. The metal machines produce parts with layer thicknesses of 20 microns, depending on the material, which renders a surface roughness value (Ra) after shot peening of two to three microns."

Tharwat Fouad says there is still a big information gap for 3D manufacturing. As people learn to understand it, the technology will take off, he says.

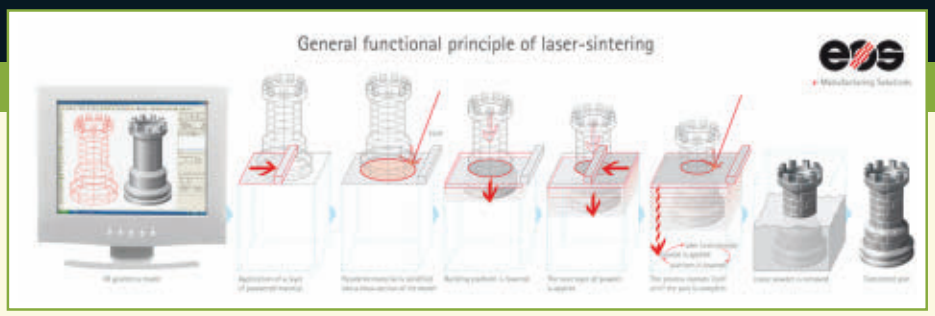
Small, Complex and Flexible

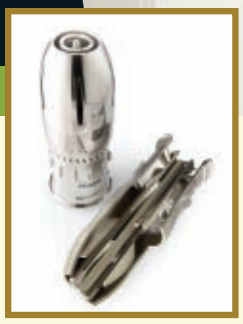
"To get into this market, you have to focus on the best possible products that suit additive manufacturing. For us, it is small, complex parts and short production runs," says Fouad.

Anubis has had its EOS machine for one year now, but it has only been manufacturing products for customers for the past six months because the first few months were spent on testing the machine's capabilities and learning to



A close up of the user-friendly icon-driven control panel.





Mona Louca, 3D department manager at Anubis 3D, with the Formiga P 100. Left image (EOS): An aerospace swirler 3D part.

better understand the technology.

One of the most recent products manufactured on the EOS machine were cell phone covers for the Apple iPhone. The customer designed the covers and Anubis manufactured them. The customer took the covers to a trade show in China in September, MAC WORLD, and won first prize in the product lifestyle category.

"He originally came to us to manufacture a prototype of his iPhone cover. He wanted to test the market and when he won the design, retailers came up to him and wanted the covers, so he came back to us with more orders. We've negotiated an order for 2000 parts to be shipped to China and have another order for 10,000 parts," says Fouad.

One of the advantages additive manufacturing brings to the manufacturing table is its design flexibility and the electronics market is a good example of how such flexibility comes into play. In September, Apple came out with two new models for its iPhone. "We may need to tweak the cover for the new phones and with additive manufacturing it's very quick to turn around a new design. Usually tweaks in a design may take an hour of work from a designer and once we have the new style in CAD format we can print the new design," explains Louca.

A mass flow meter for particulates that Anubis manufactured recently is another example that illustrates additive manufacturing's design flexiblity. Called the ARBOmeter, the product measures flow of materials in the mining, plastics, recycling and food processing industries. The plastics parts went through an extensive redesign and were revised more than 15 times, estimates Fouad. One of the designs included an innovative way to cool the enclosure of the device. Engineers created cooling channels, and added fins and baffles to maximize heat transfer.

"Being able to explore multiple iterations inexpensively was vital to this aspect of the project," says Fouad.

The meter's laser-sintered frames are built in batches of four nested sets, seven to a set, over about twenty hours, estimates Fouad. Each part is made of 100 micron layers, one on top of the other. Anubis has minimized the frames to optimize set sizes and plans to run five sets at once in the machine. It expects to make between 100 and 200 meters this year.

While Anubis currently has only one machine, Fouad estimates there is space for 40 to 50 additive manufacturing machines in his 11,000 sq ft facility.

"We're running almost every day now. We have customers asking for a variety of prototypes such as end of arm tooling and other customers investigating UAVs [Unmanned Aerial Vehicles]. We're focusing on industrial tools and accessories," says Fouad.

There is no doubt in Fouad's mind that additive manufacturing's role in traditional manufacturing will continue to grow, but unlike sentiments reflected in th "media buzz," the technology will not replace traditional manufacturing. Instead, Fouad envisions it enhancing manufacturers' capabilities.

He says the key to additive manufacturing does not lie in the machine; it's in the material. "There will be more development in the powder. Machines will become faster, but the big breakthrough will be in new materials and their capabilities for longer term durability," says Fouad. **SMT**

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