ADDING ADDITIVE MANUFACTURING ADDS GROWTH

Burloak Technologies evolves with revolutionary part-building technology

Jim Glover (left), CEO, and Peter Adams, president, of Burloak Technologies are shown in front of their new facility in Dundas, Ont.

By Sue Roberts, Associate Editor

Dundas, Ont.-based Burloak Technologies has evolved from an engineering and virtual manufacturing company to a state-of-the-art manufacturer of highly engineered components. In July 2014 it opened its new facility with capabilities that included additive metal and plastic manufacturing, precision multiaxis machining, plus all the associated manufacturing engineering software and tools. Since moving, the company has almost doubled its employees to 11 and plans to double that again in the next 12 months.

Peter Adams, mechanical engineer, company founder, and president; and Jim Glover, mechanical engineer, venture capitalist, and CEO, laid the groundwork for incorporating the new technology and managing the growth prompted by what they call "a $2.5 million experiment." That investment represents the first installment in an $11.5 million, five-year strategic plan for the 10-year-old company.

"We began looking at additive manufacturing about five years ago," said Glover. "In January of 2014 we decided the technology was ready for prime time. It was now mature enough to produce functional end-use components and positioned for rapid adoption by a variety of industries." They agreed that the company could be well-positioned for leading the additive manufacturing industry forward.

Adams elaborated, "Our hypothesis was that the market needed a company that could produce parts from start to finish. To do this properly and professionally, and in a way that truly industrializes the additive technology, we needed to offer the engineering on the front end, the building of parts by providing the additive, subtractive, and finishing technologies, and have the metrology capabilities to prove that what we've made meets specifications."

"We take a technology agnostic approach," Glover said. "We adopt the technologies and equipment that are best-suited for the company and our customers. We will continue to invest to lead the market."

NEW LOCATION, EQUIPMENT, AND CUSTOMERS

The first step in Burloak's evolution included a new, climate-controlled, clean room-like, 10,000-sq.-ft. facility to house an EOS M 290 production direct metal laser sintering (DMLS) system and P 396 selective laser sintering (SLS) system for plastic parts; Matsuura CNC machining systems including 3-axis and 5-axis milling machines; a Nakamura-Tome 4-axis turning machine; and a Zeiss CMM system. The most recent arrival on the shop floor is a Renishaw AM250 laser additive manufacturing system.

In less than two years the experiment has proven out so well that the company is preparing for the next investment in productivity that will incorporate robotic part loading and unloading. "The initial idea with adding additive manufacturing was to first prove out the technologies, become comfortable with them, and see if our customers would buy in. That worked, so now we are driving towards efficiency—robotic cells will be next," said Adams. "The robots will load the additive-manufactured parts for machining, the machines will do the automated measuring, compare results to the CAD data to accept it and adjust for machining, or reject it and grab a good part. The focus will be on building automation. A real beauty of the automation is it will completely eliminate the possibility of a bad part."

Attention to quality for every process is paramount. Certifications are already in place for ISO 9001:2008

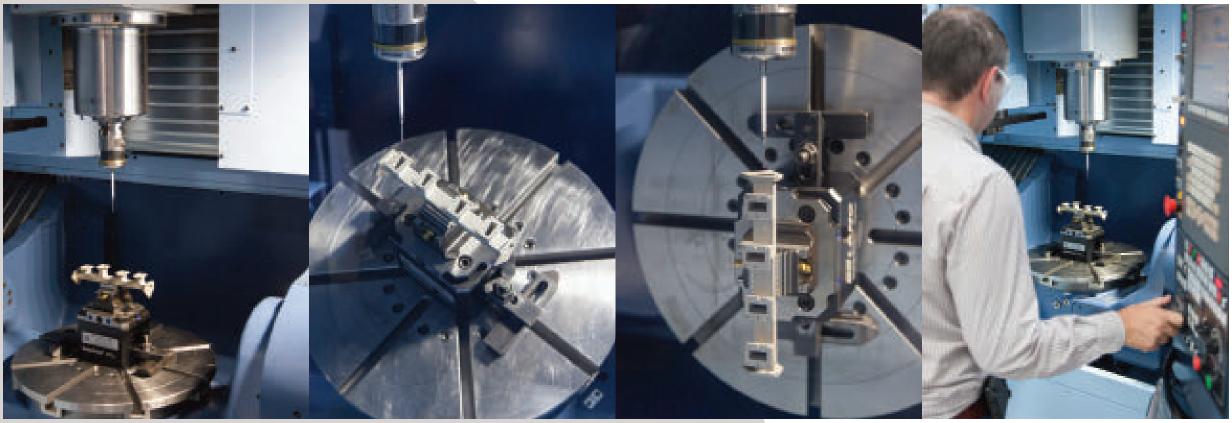
UNLOCKING POSSIBILITIES

Burloak Technologies was one of two winners chosen from 89 participants in the April 2015 GE Aviation open innovation challenge, Alternative Manufacturing of Aviation Castings. The challenge is designed to encourage innovation in alternative technologies to casting for producing complex engine structural components.

Participants submitted proposals based on a detailed engineering model of a simulated structural casting. Evaluation criteria included meeting a 25 percent cost reduction, driving cycle time to less than 12 weeks, annual production capability for 125 units, and improving tolerance and controls to allow reduction of material while maintaining wall thickness.

The company's award-winning proposal lightened the weight of the component by 50 percent and substantially reduced production time.

The opportunity for rapid expansion was one of the advantages to Burloak Technologies' new, 10,000-sq.-ft. facility in Dundas, Ont.



Measurements taken by a Renishaw probe are used with the CAD geometry to automatically determine the best position of the part for efficient machining in a Matsuura 5-axis mill.

and AS9001C. Procedures are in process to complete ISO 17025, International Traffic in Arms Regulations (ITAR), and Customs–Trade Partnership Against Terrorism (C-TPAT) registrations.

Initial customers for additive-manufactured parts were from industries where many OEMs have garnered their own additive manufacturing experience, such as aerospace, energy, and medical instruments. But other industries are quickly discovering how the technology's ability to produce small, complex, or customized parts can improve a component's functionality and the manufacturing process.

"The phone rings every day with someone looking at additive as a new production opportunity," said Adams. "There are real benefits to be had by combining additive and subtractive technologies, but additive is not for every part. It is a complementary technology. Simply taking a part that has been produced with subtractive processes for 50 years and producing it using additive is a waste of time. There won't be any benefit, and it may cost significantly more. There is a whole degree of engineering that has to go on the front end to design for the additive process, and there needs to be a reason for that.

"We ask each prospect if he needs lighter-weight, lower-cost, or more dynamic structures and if they are willing to consider re-engineering. If not, the part should simply be made on a traditional CNC."

When Additive Technology Works

Digital design data guides the building of a component one layer at a time during additive manufacturing. A laser melts a layer of material about the thickness of a human hair that has been deposited on the build platform, fusing the powder together in any configuration. Another layer of powder is applied and the melting process is repeated, bonding the new layer to the layer below.

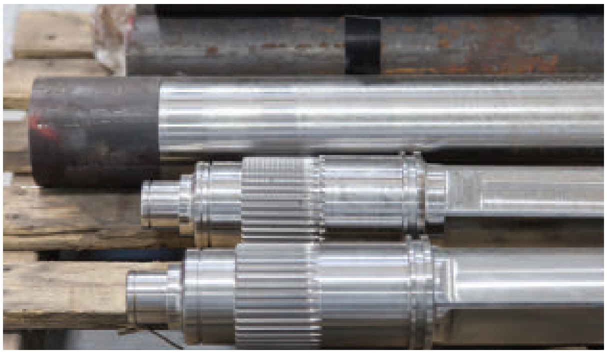
"When the laser dances around melting a layer of powder, it also melts through the previous two layers," explained Glover. "So, in essence, every layer is melted three times. You get rid of porosity and get nearly 100 percent density."

Features like complex internal channels and thin wall thicknesses not possible with conventional machining can be built, which effectively extends design options. Virtually any design can be incorporated in a component that fits on the 10-in. by 10-in. build plate in the 1-ft.-tall chamber. At the end of the build, nearly 100 percent of the unused powder can be recycled to form another part.

Die inserts are good prospects for additive manufacturing. "The speed

Eugene Bradley (left), operations director, and Mike Locke, CNC machinist, inspect a part from the Nakamura-Tome 4-axis lathe.

Additive manufacturing can create parts with very thin, strong walls like the one being held. A cross section of a die insert shows conformal cooling channels that mirror the shape of the die to allow for faster cooling.



Splined shafts were produced on the Nakamura-Tome lathe.

of creating an injection molded part is dictated by how fast you can get the plastic on and off the mold, and that is dictated by how fast the part can be heated and cooled," said Glover. "With traditional drilling you gun-drill holes only in straight lines and then come through the sides and cross bores. Additive manufacturing gives us the ability to have the cooling channels shadow the outer profile, to be conformant, for faster cooling. In some dies we've added another channel so the insert can be preheated to bring the temperature back up for the next part. Both hot and cold liquids cycle through the molds.

"Some Canadian tool and die companies that know about conformal cooling had to go to the United States for the dies before they were aware of us."

Building a part layer by layer does take time, perhaps several hours depending on size and complexity, but it can deliver some components much faster than traditional technologies.

Switching a part from traditional processes to additive manufacturing resulted in a time savings of 370 percent for one customer. Adams said, "The customer said that before coming to us it took him three months to get a casting in titanium and three months for machining. We took the order to make the part in INCONEL® to see if we could do better on timing. On the first day we started printing the part in plastic, measured it, added material for machining, and designed the fixture. By day two we had the sample part and fixtures in our hands and went to machine finishing. By the fifth day we were running programs on the plastic parts to prove the CNC machining while we were building the mantle for the INCONEL part. The finished product was in the company's hands in 10 days rather than nine months. That was starting from scratch."

Mark Beltrame, a mechanical engineering co-op student, empties a canister of used titanium powder into a sieve that will separate reusable material for recycling. Ninety-nine percent of powder not fused into a part can be used for another build.

EXPANDING PRODUCTION KNOWLEDGE

Additive manufacturing customers have varied levels of knowledge and experience. Some large companies with their own in-house capabilities approach Burloak for assistance. One Tier 1 aerospace company is working with the company on designing manufacturability guidelines.

Other customers are new to the technology and rely on the company's engineering background to guide, and often re-create, component specifications. "A lot of times a customer doesn't know what the additive capabilities are, so we show them how we can build a lighter-weight part, or create a feature at an angle, or combine several pieces of an assembly into one component," said Glover.

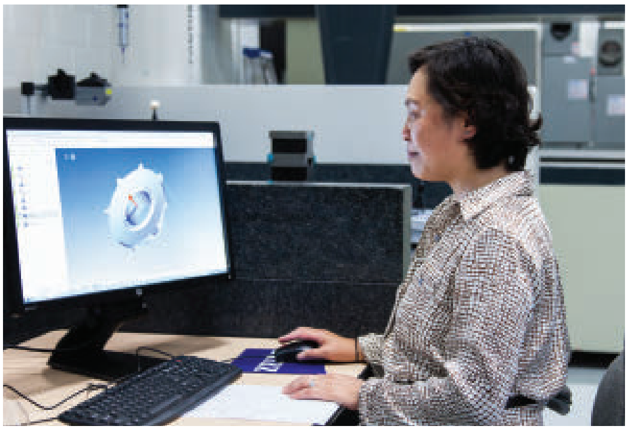
Most CAD programs have conversion software to provide the polygonal mesh files used to slice a part design into layers for additive manufacturing, but fine-tuning based on experience can make a difference in production cost and part functionality. Adams said, "When a customer outputs a polygonal mesh, they are setting tolerances without being aware of it. We look at the program and can say if it's the right way to grow the part. Any manufacturer who uses a customer's program as-is and ships the result is not taking ownership for the part quality."

Test bars are built into components to allow for metallurgy checks. "We often add test bars to either side of the build plate so a customer can test the metallurgy without being destructive to the part itself," Glover said.

FROM PROTOTYPE TO PRODUCTION

Materials used to produce the additive-manufactured parts are nearly as varied as the customers. As with traditional machining, chemical and mechanical properties of the finished part determine which plastic, metal, or composite powders to use. Industrial-grade plastics produce parts with mechanical properties close to those

Daniel Adams, programmer and operator, initiates a build on the EOS M 290 direct metal laser sintering (DMLS) machine.



Dr. Rudy Si, quality control and metallurgy expert, reviews the final inspection of a part measured on a Zeiss CMM system.

Aerospace parts built by an additive manufacturing process can weigh substantially less yet maintain structural integrity like the part in the front. Additional functionality can also be incorporated into a part's internal structure to improve fluid mechanical performance.

produced by injection molding and very close to nylon.

Plastic parts can also be produced in a variety of composite powders as the application requires. For example, carbon fiber-reinforced plastic increases strength; aluminum-filled plastic increases thermal conductivity; and some polymers provide rubber-like flexibility.

Metal powders produce stainless steels, tool steels, aluminum, INCONEL, and titanium components.

"One of the chief things that moved this industry along quickly was the metallurgy available in a select group of metal powders," said Glover. "And research continues to offer new options. We are working with McMaster University on developing new materials and applications. Our customers want more options, so we are working on new ways to meet their needs."

Burloak is also working with its customers to move additive manufacturing from a prototyping technology to a production technology. "We work with our customers on prototyping and qualifications as a means to move into the production phase. The technology has proven out, and we're ready to provide production parts," Adams said.

"When a customer is open to design without restrictions—that's when it gets really exciting. I'm being called into customers' customers to present ideas about what they can do with products," said Glover. "And to think a little company in Dundas is leading this technology is entertaining."

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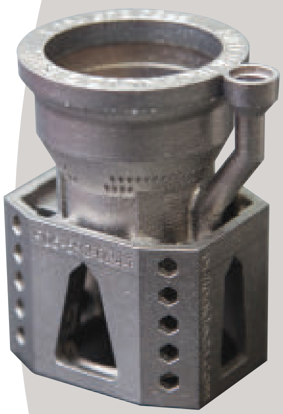
Photos by Tomasz Adamski Photography

Very complex structures to deliver liquids for heat exchange (front center) or plastic injection (right) can be made using additive manufacturing.



A highly complex aluminum aerospace component incorporates exacting internal and external details possible with additive manufacturing.

Built as a single-piece component using additive manufacturing technology, the pipes on the component allow fluid to be heated when flowing down the sides and back up before it enters the nozzle.

Additive manufacturing was used to build a titanium impeller with minute through-passages in the tip.