Northbrook, IL-based 3D printing firm develops an additive technology that can create ready-to-use, complex, high-strength parts with few geometric restrictions.

Impossible Objects goes after 'functional parts'

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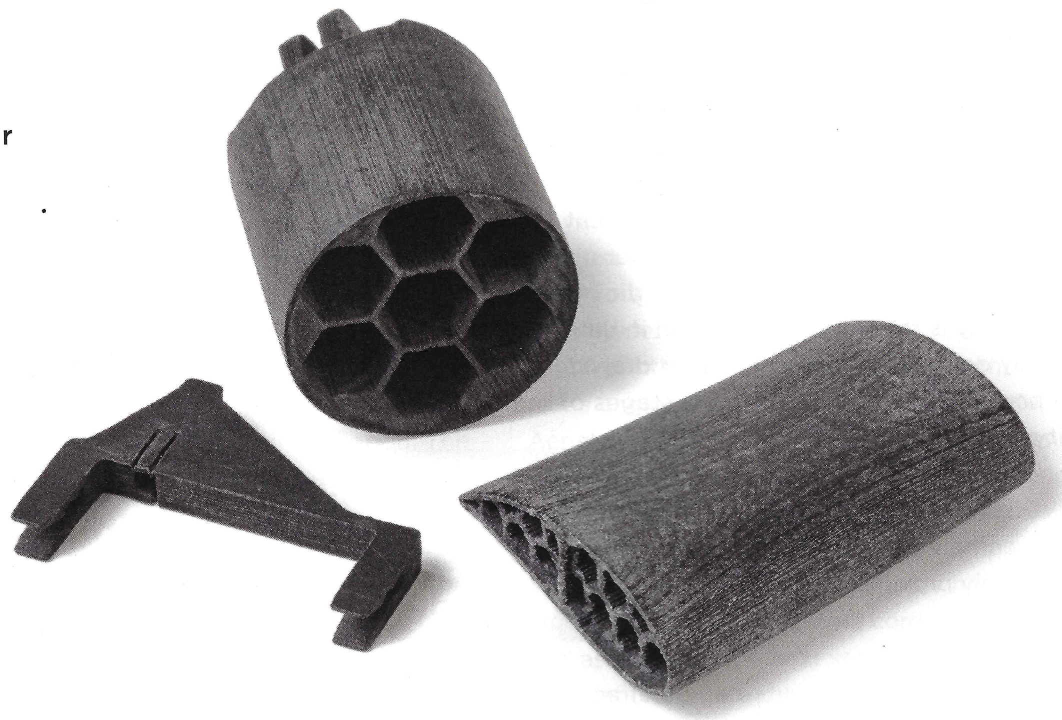

3D CBAM parts (left to right): Small aircraft rear stabilizer mount, aerospace clevis strut, automotive air foil.

When Bob Swartz first saw a 3D printer in person, at a MIT lab where he worked as a consultant, he was only casually interested in the technology. Swartz, a lifelong inventor and entrepreneur, had worked at his late father's manufacturing plant but had since moved away from the industry. He studied mathematics and computer science in grad school and went on to found several software and patent licensing companies.

But after reading an issue of "*The Mathematical Intelligencer,*" he realized the implications of 3D printing and how it could create physical representations of mathematical objects that were previously impossible to create. The geometric restrictions that had challenged companies like his father's were fading.

"I was fascinated by the notion that you could ... reflect the elegance of mathematics in a physical form," he said during an interview with *Manufacturing Engineering* in his Northbrook, IL, manufacturing facility. More than that, he was excited by the notion "that you could also produce objects that were not feasible by any other technique."

But when he sought to learn more about the process, he was disappointed. He found it expensive, slow and the parts to be inferior, or not as good as they could be. "And so I became obsessed with it and started thinking about it and trying to figure out if maybe there was a better way of doing it," he said.

And that's how Impossible Objects was born.

In 2009, Swartz began developing what he calls CBAM—a composite-based additive manufacturing process unlike anything else in the industry. The company he founded, Impossible Objects, said CBAM is unique in that it creates functional parts using high-strength materials such as carbon fiber, fiberglass and Kevlar.

Industry, in turn, is taking notice: Impossible Objects won SME's RAPID 2015 Outstanding Innovation Award in May—an impressive feat for a first-year exhibitor.

Understanding CBAM

So how does CBAM work?

The process starts with a CAD model sliced into layers and converted into a digital bitmap. That bitmap is printed onto sheets of composite material using an aqueous solution and thermal inkjet technology. Polymer powder is applied to the sheet of material, clinging to the solution in the shape of the bitmap.

The layers are stacked, then placed into an oven and heated to the melting point of the powder in order to consolidate the part to its designed height. After the part cools, the excess, uncoated material is removed by abrasive blasting (in the case of carbon fiber or fiberglass) or a chemical process (in the case of Kevlar).

At first blush, this may seem more complex than popular technologies for 3D printing or additive manufacturing, in which objects are formed by printing each physical layer at a time, one on top of another. But Swartz, CTO and chairman of Impossible Objects, said CBAM has advantages over other types of additive manufacturing processes, many of which are complex in their own right.

"The processes that exist today are all very old," he noted, adding that FDM (fused deposition modeling) and SLS (selective laser sintering) have been in development for 20–30 years. And many methods can only produce prototypes. Typically, he said, they can't create something with the strength of injection molding or better, and stronger parts that are created by selective laser sintering metal take much longer to make with machines that are substantially more expensive and have more geometric restrictions.

While every process has its particular purpose, "the future of additive manufacturing is functional parts," said Swartz. CBAM allows for parts with few geometric restrictions created with high-strength materials that can be used immediately. Additional milling can be done after the part is finished in order to make the part more accurate, but most of the parts Impossible Objects delivers do not need additional processing.

"This is really the first new process in the last 25 years that solves a lot of the problems with present 3D-printing speed, material properties and material selection, and that's what distinguishes it from existing processes," he said.

One advantage of CBAM is its speed. Impossible Objects uses relatively inexpensive, thermal inkjet heads to apply the aqueous solution, and because the solution is low-viscosity, the inkjet heads can run very fast. Right now, the printer is being developed to print about 12 pages of 8 × 10" (20 × 25 cm) sheets of material in a minute, and Swartz said he sees the capability of going five times faster. This doesn't include the heating step or the removal of the excess material, of course, but Swartz said other processes still can't compete with CBAM's speed.

Another advantage is the strength and selection of materials for both the substrate and the polymer powder.

"Because we're adhering the powder to this aqueous solution, we can use pretty much any thermoplastic powder," so the printer can use polyethylene, nylon and high-performance materials like PEEK, Swartz said. The finished part is durable due to both the strength of the substrate used and the strength of the underlying polymer.

CBAM also allows for the creation of high-strength parts without tooling costs. Sometimes, at machine shops, people use CNC machines to create low-volume metal parts without tooling costs, which is still expensive, he said. But most of those parts don't necessarily need to be made out of steel or aluminum. CBAM offers a faster, less expensive way to create parts with specific material properties.

"3D printing is fundamentally a material science problem," Swartz said.

Dave O'Neil, Group Publisher of Advanced Manufacturing Media, presents the Impossible Objects team with the RAPID 2015 Outstanding Innovation Award. From left to right: Dave O'Neil, Bob Swartz, Larry Kaplan and Jeff DeGrange.

Developing the Business

The new approach has attracted customers, and Impossible Objects has grown. Today, the company has about 10 employees, several major investors, and has brought on key leaders from within the 3D printing sector.

CEO Larry Kaplan officially joined the team in June 2014. Previously, he was CEO of Eudora Global, a company that develops and operates new companies. Before that, he spent 16 years at NAVTEQ, a provider of digital maps and navigation systems. He left as CEO.

In April 2015, Jeff DeGrange joined as chief commercial officer. DeGrange was previously vice president at Stratasys and before that led additive manufacturing efforts at Boeing.

John Bayldon came on in July 2014, after having worked with Swartz as a consultant for the company. He specializes in manufacturing and mechanics of composite materials.

In December, the company announced it received $2.8 million in seed financing led by OCA Ventures, a venture capital firm based in Chicago that focuses on "companies with dramatic growth potential, primarily in technology and highly-scalable services businesses." Northwestern University is also an investor.

Most of the parts the company is producing are for the aerospace, defense and automotive firms, Kaplan said. Two of its customers are Aurora Flight Sciences and Horton, Inc. Impossible Objects made a stabilizer mount for a small aircraft for Aurora Flight Sciences. It made a fan blade for trucks for Horton.

Both parts were initially created using SLS, Swartz said, but would frequently break. In the case of the aircraft, the stabilizer mount couldn't withstand the force during landing, and the fan blades would snap under the pressure of actual use testing. With CBAM, those parts can be created using a much stronger composite, so they no longer break.

The company has also produced electronics enclosures for rockets and brackets for aerospace.

Impossible Objects also recently entered into a research pact with Oak Ridge National Laboratory to develop carbon fiber tooling using PEEK, and Swartz called the agreement a recognition of the company's capabilities by industry experts.

The Future for Impossible Objects

Kaplan got to know Swartz at Eudora Global. Eudora was looking at investing in a different technology of Swartz's, and as the two got to know each other, Swartz shared his new process with Kaplan.

Kaplan began working with Swartz on an informal basis in early 2014. After he became CEO in June that year, the company stepped up commercialization and sales efforts.

While the company is making parts for customers today, the ultimate goal is to sell CBAM machines to manufacturing companies.

"Our long term goal is to compete with injection molding," Swartz said, adding that Impossible Objects would like to be a leader in functional parts for manufacturing. The company expects to have a prototype of its CBAM machine soon, he said.

Kaplan sees the company selling CBAM machines and materials to a growing and dedicated user base.

Even though the company is in its early stages, the response from industry has been validating, he said. "We've had a lot of people from companies who use additive, as well as other additive companies, look at us and really express fascination with what we're doing."

"I feel like we've got something that's really different," he said.