Desktop Metal

CASE STUDY

Binder Jet 3D Printing Delivers Automotive End-of-Arm Tooling

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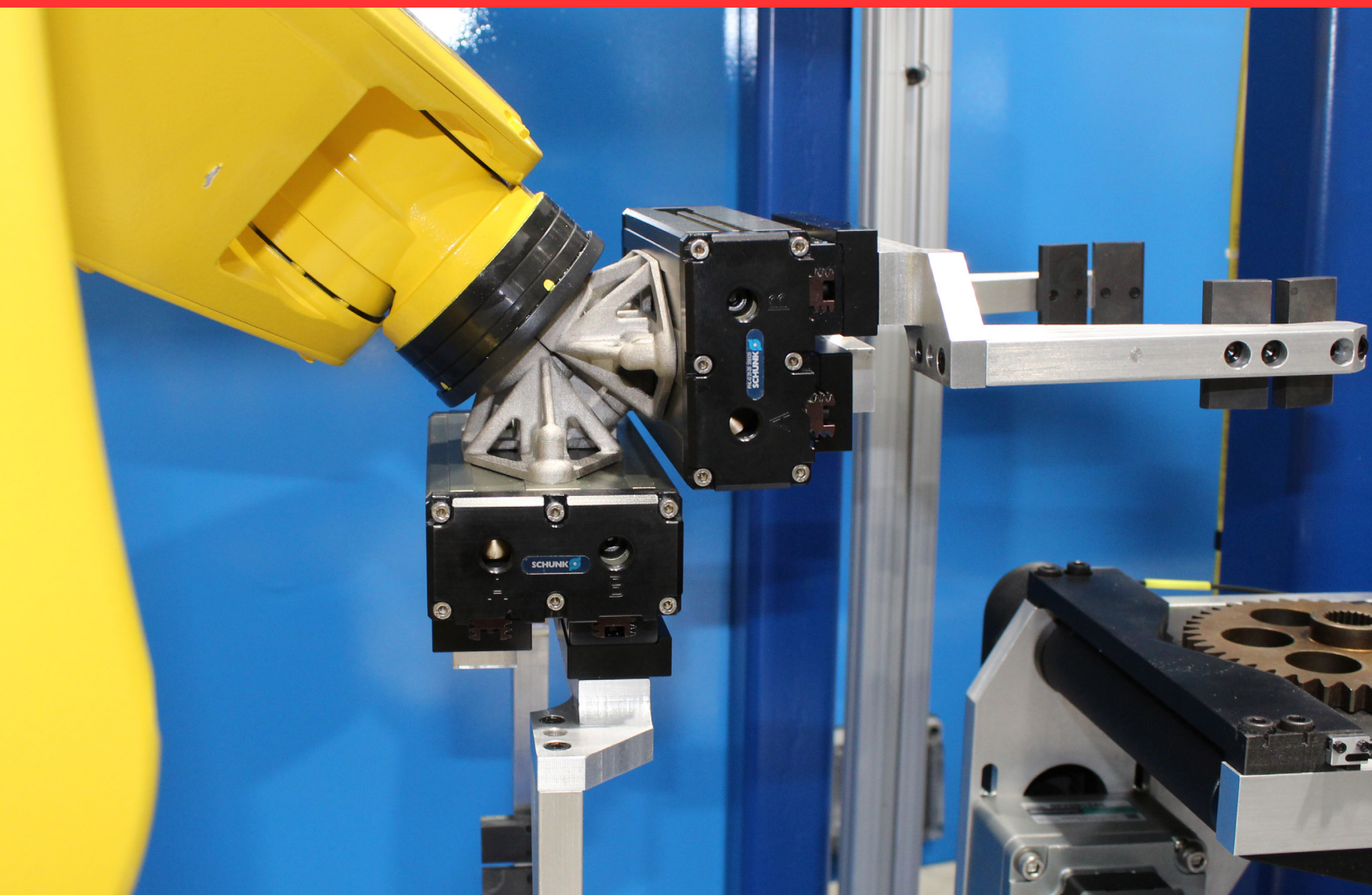
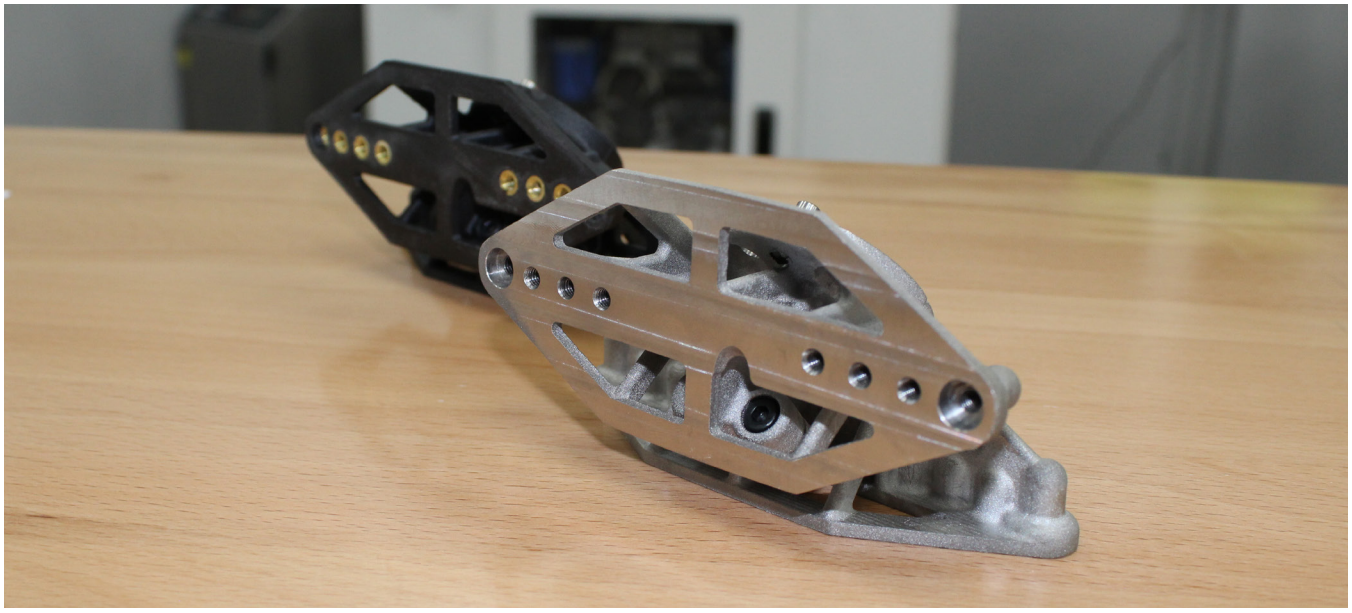
FreeFORM Technologies delivered a complex, lightweight solution for high-volume inspection





Customer
FreeForm Technlogies for
Allegheny Electric Service

Location
Saint Marys, PA

Industry
Automotive parts manufacturing

Application
Robotics - End-of-arm tooling

Machines
InventX®

Material
17-4 PH stainless steel
(D90 of 22 µm)

Website
www.freeformtech.com

The challenge

Allegheny Electric needed durable and lightweight end-of-arm tooling assembly for a robotic inspection process. A six-axis Fanuc robot needed to pick up and place six different parts, weighing between 5 and 10 pounds, for serial inspection running nonstop across three shifts. The number of parts being inspected in this factory environment ranges from 50,000 annually for the lowest-volume piece to 500,000 parts annually for the highest volume.

The 3D part needed to attach to two other end of arm tooling (EOAT) pieces that needed to sit 90 degrees to one another for a variety of different inspection techniques.

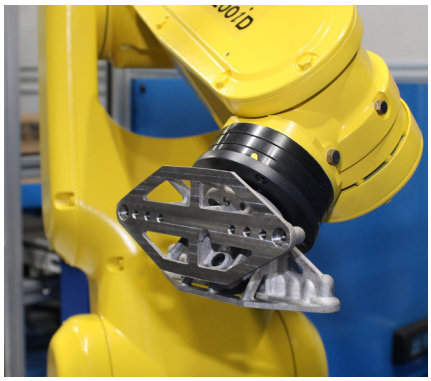
Oftentimes, an EOAT solution developed by Allegheny Electric would be 3D printed in plastic, carbon fiber-reinforced plastic, or machined in a strong, lightweight material such as aluminum. Although an initial prototype was originally printed on a carbon-reinforced plastic 3D printer, the weight requirements and processing volumes for this project eliminated this material from consideration for the final production application.

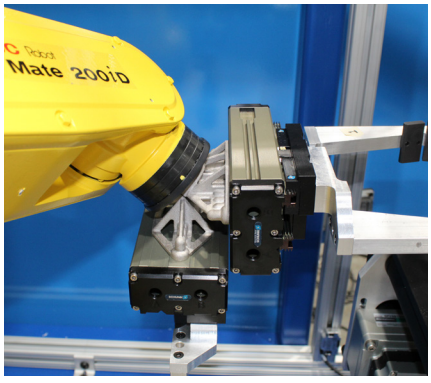
“It would have had less life, and they couldn’t afford the risk of dropping the part into the inspection station, which costs several thousands of dollars,” explained Chris Aiello, VP of Business Development at FreeFORM. “The rigidity and strength just wasn’t there for the biggest parts.”

Additionally, machining the desired functionality, even in lightweight aluminum, would have deliver EOAT that would have been at the upper edge of weight for the Fanuc robot arm being used, which was also not viewed as desirable.

Being an automation solution provider, Allegheny Electric wanted to explore whether metal 3D printing could offer weight and cost savings through new designs that could help them offer an innovative new solution to customers. The customer looked to both laser powder bed fusion, specifically DMLS, and binder jet 3D printing for a possible solution.

The solution





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The complex part designed in Solid Edge and 3D printed with binder jetting technology enables two tools to sit on th end of a robot arm at a 90-degree angle to each other. They must hold a variety of weights for a high-volume precision inspection application.

Jake Shannon, Design Engineer at Allegheny Electric approached Aiello to see what might be possible. Using generative software from Solid Edge, a CAD design and analysis software from Siemens, the two companies collaborated on a new lightweight design for the project that could only be produced with 3D printing.

The design was quoted for both DMLS and binder jetting on the Desktop Metal InnoventX, which is owned by FreeFORM Technologies. The part was quoted at $672 for DMLS, prior to any final finishing, and a comparable $150 on the InnoventX.

In binder jet 3D printing, the printer uses a digital file to quickly inkjet a binder into a thin layer of powder particles — metal, sand or ceramic — creating a solid part one layer at a time. When printing metals, the final part must be sintered in order to fuse the particles together into a solid object.

Because binder jetting is so much faster than other metal 3D printing methods, such as laser-based powder bed fusion, it offers much lower costs that are more competitive with traditional manufacturing processes. Binder jetting is also a sustainable method of manufacturing that reduces material waste to less than 5%, saves energy by consolidating many assembled parts and processes into one, and can deliver end-use designs that are 30-40% lighter — for more efficient cars, planes, military equipment, and other applications.

In fact, Aiello said that the unique lightweight design generated in this case could not have been produced outside of a 3D printing technology. The company was also able to use a traditional stainless steel MIM powder, 17-4PH. This was also desirable because of its durability and corrosion resistance in the factory where it would be used, where there are fluctuations in temperature.

The final part was printed on an entry-level InnoventX in 17-4 PH stainless steel with a D90 of 22 µm and exceeded MPIF Standard 35. Because the hardness met the customer's requirements, additional heat treatment wasn't required.

"They could have gone with a simpler design in aluminum, but the part would have actually been heavier to get the same strength as 17-4 PH," Aiello said. "By going with this kind of organic generative design, they were also able to reduce the overall payload on the machine, so it's likely going to extend the life of the robot for the customer."

In this case, it was decided to machine three critical features, including a few holes and one surface for final flatness, to further dial in accuracy. Aiello noted that binder jetted parts take to machining just like standard metal materials.

"It's very similar to machining wrought material," Aiello said. "It looks no different than a machined metal flat stock part."

In all, the initial printing on the InnoventX entry level system, with a build volume of 60 x 65 x 65 mm (6.3 x 2.5 x 2.5 in), took less than a day printing in 50 micron layers of standard MIM powders. The part achieved final material properties as desired, including a hardness of HRC 27 and final density of 98%.

Using the InnoventX, a printer that has been on the market since 2016, also delivered reliable parts. "The surface quality is superior to any of the other printers," Aiello said. "It's an easy machine to run. It was great for this kind of application."

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Chris Aiello, VP Business Development, FreeFORM Technologies

The future

While this project didn't have a high-volume part requirement for the final EOAT – only four parts were initially needed – Allegheny Electric Service was eager to do the project to explore whether binder jet 3D printing was ready to produce affordable parts in unique designs that could deliver higher performance in its automation applications. Now, it has a new solution option to offer customers that can deliver durable, lightweight parts in metal at affordable prices.

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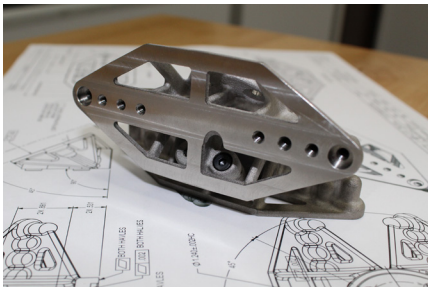
>
> Jake Shannon, Design Engineer, Allegheny Electric Service



"We are always working within the design constraints of traditional manufacturing. Now we can focus on design intent and process optimization to meet or exceed our customers expectations," said Jake Shannon, Design Engineer, Allegheny Electric Service. "We will definitely continue to offer our customers end of arm tooling produced with binder jet 3D printing. An important feature for us to offer our customers is how this technology reduced the payload on the robot."

For Aiello and the FreeFORM team, this project was an inspiration in how it showed the new design possibilities they can now offer in standard and durable metal materials at affordable prices. The FreeFORM team has deep experience in powder metallurgy and MIM, and they say the parts they are now producing with binder jet 3D printing are equivalent to the type of product they were producing with those traditional processes. However, now they can deliver them without tooling and with more geometric freedom than ever before.

"This project shows exactly why we started the company, to help customers solve challenging problems," Aiello said. "Binder jetting was really the only way to go for this project. It was one-fourth the cost of DMLS and we did it in a strong material that reduced that payload on the robot. As AES rolls this technology out, it's going to be a bigger savings for their customers."

About FreeFORM Technologies

FreeFORM is a first-of-its-kind metal binder jet 3D printing contract manufacturer. Founded in 2020 by a group of engineers, FreeFORM aims to bring binder jet technology to the masses through technology adoption. FreeFORM's co-founders bring a diverse outlook into metals manufacturing and are committed to providing world-class services to the customer while providing low cost of ownership and speed to market. Their vision is to be the benchmark for additive manufacturing. Learn more about FreeFORM at www.freeformtech.com

About Desktop Metal Inc.

Desktop Metal (NYSE:DM) is driving Additive Manufacturing 2.0, a new era of on-demand, digital mass production of industrial, medical, and consumer products. Our innovative 3D printers, materials, and software deliver the speed, cost, and part quality required for this transformation. We're the original inventors and world leaders of the 3D printing methods we believe will empower this shift, binder jetting and digital light processing. Today, our systems print metal, polymer, sand and other ceramics, as well as foam and recycled wood. Manufacturers use our technology worldwide to save time and money, reduce waste, increase flexibility, and produce designs that solve the world's toughest problems and enable once-impossible innovations. Learn more about Desktop Metal and our #TeamDM brands at www.desktopmetal.com