Desktop Metal

CASE STUDY

Ti64 Part Production with Single Pass Jetting

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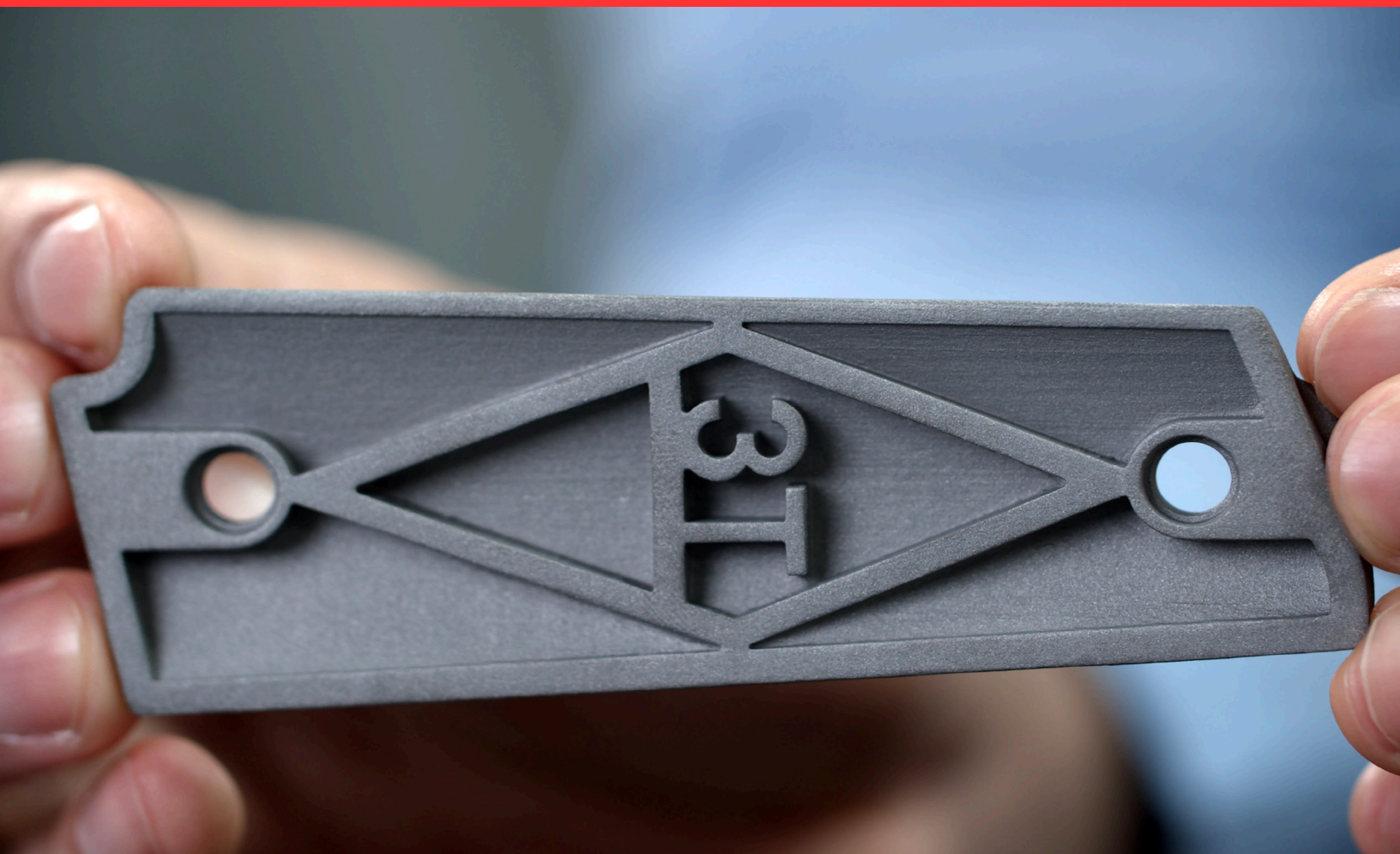
TriTech Titanium Parts delivers binder jet 3D printing with high-performance reactive material



Robert Swenson, Owner and President of TriTech Titanium Parts with his Desktop Metal Production System P-1 at his Detroit, Michigan titanium manufacturing facility

Customer
TriTech Titanium Parts

Location
Detroit, MI

Industry
Net shape titanium part production

Machine
Desktop Metal Production System™ P-1

Material
Ti64

Website
www.tritechtitanium.com

Titanium trailblazers

Detroit-based TriTech is an experienced manufacturer of titanium parts for the commercial and industrial markets, including aerospace, marine, medical, and automotive. The company prides itself on uniquely offering three production methods – investment casting, metal injection molding (MIM), and binder jet 3D printing.

"Nobody else in the country is doing what we're doing," said Robert Swenson, Owner and President of the company. "TriTech focuses on getting customers the best products. We generally find that there's a good fit with a process, with a customer, and with a part. So that's our business strategy: to offer a range of production processes so the customer can find the best one for their application," he said.

Swenson, who has a graduate degree in Metallurgical Engineering from Purdue University and an MBA from Harvard Business School, founded TriTech in 2022 as a spin-off of AmeriTi Manufacturing Co., which he sold to Kymera International after nearly three decades of operations. He takes pride in the amount of internal growth his companies have achieved throughout the years, honing expertise in titanium production. He admits it's probably more expensive than an acquisition, developing everything in-house, but that allows the company to solve customers' problems organically, without funneling them straight to design changes or product adjustments based on manufacturability.

TriTech also valued a solution that allowed the company to deliver results for its customers quickly. Binder jetting eliminated setup fees, tooling cost, and delays or time associated with getting tooling made.

The company installed a Desktop Metal Production System P-1 at its ISO 9001:2015 certified 25,000 square foot facility in Detroit, Michigan. “With binder jet 3D printing, titanium production of even the most complex geometries can be greatly simplified and achieved at a lower cost,” said Swenson, “Desktop Metal is leading the field in what they do and our team is incredibly proud to be the first P-1 customer worldwide to binder jet 3D print titanium.”

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Capitalizing on sintering synergies

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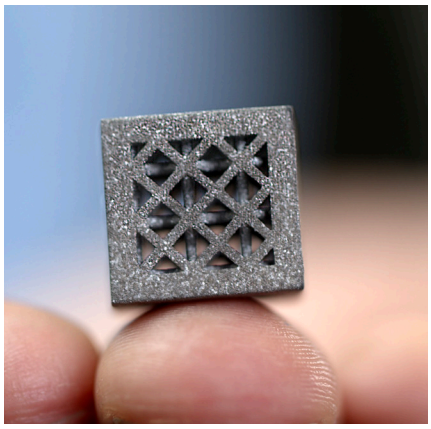
The 14x14x14 mm cube below features a 0.8mm lattice strut size, and the brackets at bottom undercuts that both showcase the fine details achievable with binder jet 3D printing.



Titanium is a popular material because of its excellent strength-to-weight ratio, corrosion resistance, and biocompatibility. However, Ti64 is also known for being expensive to manufacture. The material’s strength, as well as its low thermal conductivity and ductility, make it challenging to machine or produce with traditional manufacturing methods. For example, Ti64’s strength requires more force to cut and remove material. In turn, the material has a tendency to work-harden during machining, which can lead to tool wear and breakage. To mitigate this, special tools, coolants, and process approaches are needed during machining.

With binder jetting, however, the process can be simplified and made more economical. “Titanium isn‘t as expensive as perceived because of its performance characteristics,” Swenson explained. “It costs a little bit more, but you can achieve more with it and we get an excellent yield with the material that we‘re using in binder jetting as compared to machining operations - we are able to use all the powder that we purchase.” In the end, titanium is an economical material because of its exceptional performance.

In binder jetting, an industrial printhead selectively deposits a binder into a bed of Ti64 powder particles creating a solid part one thin layer at a time, just like printing on sheets of paper. The form or shape produced by the printer is then sintered to high density and accuracy in a furnace, similar to the MIM process, while unbound material can be reused in the next printing process, adding to its cost efficiency.

Because of TriTech’s sintering experience, binder jetting on the Production System was the best option to complement its MIM offering. “When a customer comes to us with a very complex part that typically we would have to redesign to produce in our MIM process, we can offer

them a solution via binder jet printing," said Victor Villarini, Engineering Manager at TriTech. "In our injection molding process we often deal with tooling and design constraints that the Desktop Metal P-1 helps us solve."

With several additive manufacturing technology choices on the market, binder jet was the best fit at TriTech. Finishing with a sintering process was not only compatible with the MIM already offered at the facility, but getting the particles to densify in the furnace at one time was a faster process compared a tracing the geometries with lasers to melt the part together as in a powder bed fusion process. "And of course, faster means lower cost," Swenson emphasized.

The rapid heating and cooling that occurs during laser powder bed fusion results in a slower process with a lower surface quality, but also creates internal stresses within a part 3D printed that require stress relief or annealing after printing. "With binder jetting we don't have to do that," Swenson explained. "It finishes with a sintering process and the part cools slowly, so it is stress relieved and annealed when the part is done."

Binder jetting allows TriTech to produce parts fast with complex designs like varying lattice structures or internal channels. At the same time as achieving results that weren't previously possible, 3D printing on the Production System allows the company to avoid designing complex and expensive tooling, printing parts directly from CAD files with fast turnarounds. 3D printed parts can be sintered together with MIM components or in dedicated furnace runs with profiles tailored for binder jet printed parts with optimized properties.

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Victor Villarini is responsible for the investment casting, metal injection molding, and additive manufacturing operations as TriTech's Engineering Manager

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>
> Victor Villarini, Engineering Manager, TriTech

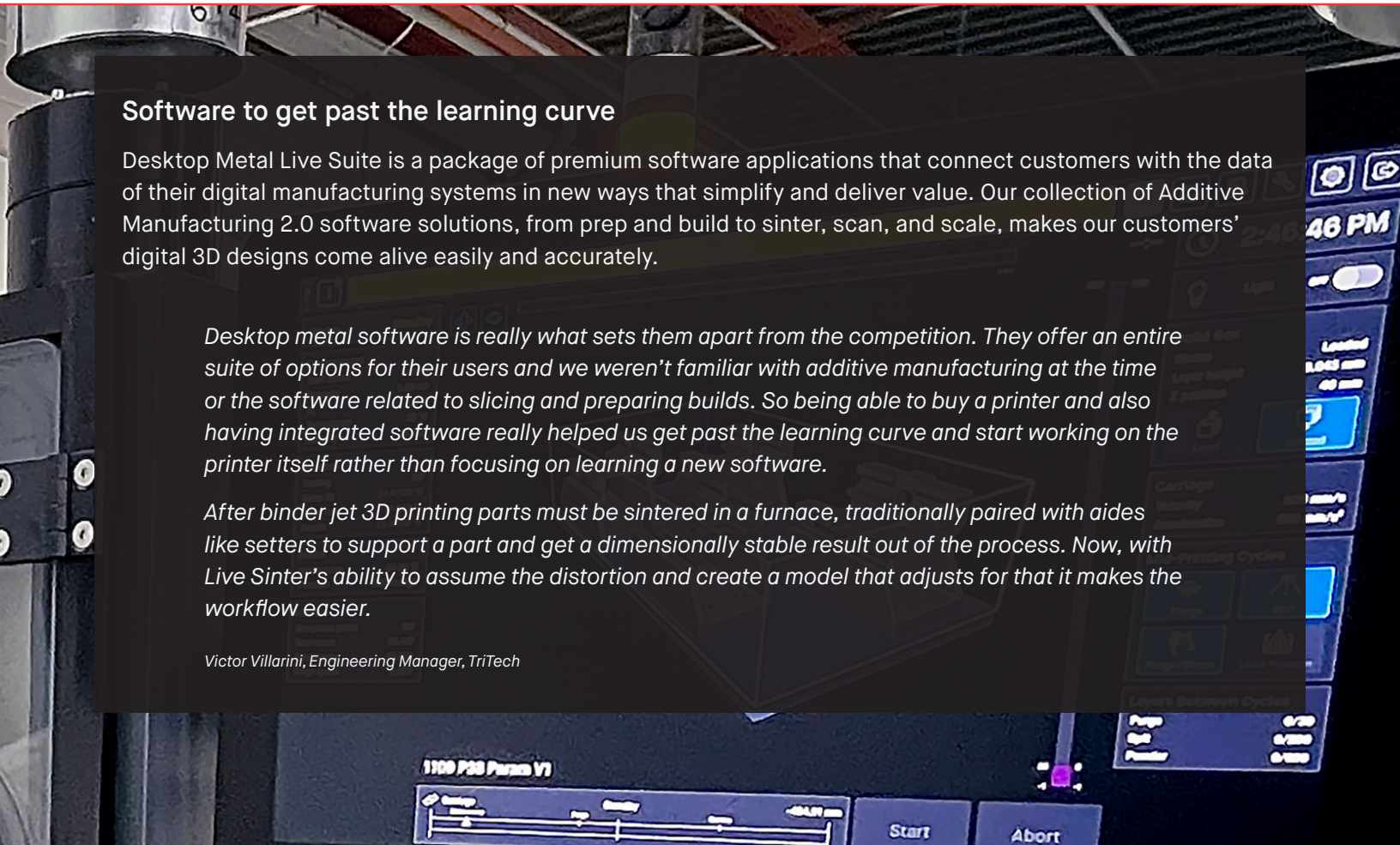
Variation is the enemy

"The customer is paying for a perfect part and that's what we want to deliver," Swenson said, emphasizing TriTech's motto of Variation is the Enemy. "It's very important that these processes operate the same over and over again."

While metal binder jetting has been researched and implemented in industrial settings for decades, TriTech was forging a new path using reactive materials.

The lower density of titanium compared to other commonly-printed materials, such as stainless steel, affects the standard binder jetting process. The TriTech team worked extensively with Desktop Metal to fine tune print parameters, binders, and thermal cycles to optimize binder jetting for reactive titanium powder. The Production System at TriTech operates in an inert argon atmosphere for printing the 25 micron particle size powder, coupled with inert crosslinking, depowdering, and sintering.

The development work has led to TriTech leading the market in providing 3D printed titanium parts. "The P-1 allows us to achieve some of the best surface finishes we've ever seen on an additively manufactured part – compared to other AM techniques like powder bed fusion and other binder jet printers on the market today," Engineering Manager Villarini said. "Out of the printer we're achieving in the three micron RA range on almost all features." He explained how those consistent, high-quality results encourage customers that



Software to get past the learning curve

Desktop Metal Live Suite is a package of premium software applications that connect customers with the data of their digital manufacturing systems in new ways that simplify and deliver value. Our collection of Additive Manufacturing 2.0 software solutions, from prep and build to sinter, scan, and scale, makes our customers' digital 3D designs come alive easily and accurately.

> *Desktop metal software is really what sets them apart from the competition. They offer an entire suite of options for their users and we weren't familiar with additive manufacturing at the time or the software related to slicing and preparing builds. So being able to buy a printer and also having integrated software really helped us get past the learning curve and start working on the printer itself rather than focusing on learning a new software.*
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> *After binder jet 3D printing parts must be sintered in a furnace, traditionally paired with aides like setters to support a part and get a dimensionally stable result out of the process. Now, with Live Sinter's ability to assume the distortion and create a model that adjusts for that it makes the workflow easier.*
>
> *Victor Villarini, Engineering Manager, TriTech*

previously wrote off 3D printing over surface finish concerns to take another look at binder jetting solutions.

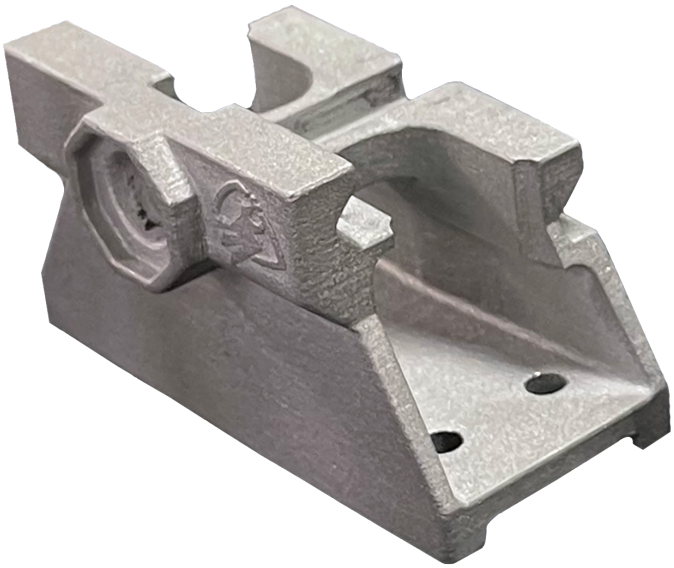
TriTech meets Grade 5 properties for strength and elongation requirements, producing finished 3D printed parts with 96-97% density. The repeatability of binder jetting on the Production System P-1 opens a new realm of cost-competitive titanium parts. “Some MIM processes, even if you have the money to make a mold, are just not able to produce some of the very porous or lattice-type structures consistently over wide batches,” Swenson said.

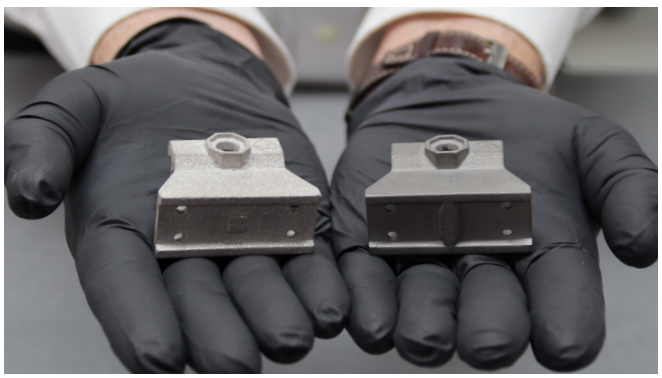
3D printed custom titanium mounting bracket

This titanium bracket would traditionally be produced with investment casting or machining, neither of which was ideal for the complex geometry of the part. Casting the part would require several weeks to create a mold in a very manual, time consuming process. Machining would be very expensive, and features like blind holes or tight corners would be impossible to achieve in a machining set up.

“The printing process really allows us to think of new ways of doing things, and binder jetting allowed us to do something like this quickly and inexpensively that we otherwise wouldn’t be able to achieve,” Swenson said.

Built in 50 micron layers with Ti64 powder and Desktop Metal FluidFuse binder, four brackets were nested into one print that took about one and a half hours to complete. After printing, the build was cured in an oven before depowdering and sintering the parts in a furnace at about 2,300°F.





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A custom mounting bracket 3D printed on the Desktop Metal Production System P-1 in under two hours. The as-printed part, above left, was then blasted with alumina grit for the final surface finish, above right.

Closing deals with end-use parts delivered faster than ever

TriTech is proud of the company's established process capable of producing Grade 5 titanium 3D printed parts, however investing in the technology was a business decision for Swenson, the company's owner. "We expect to grow with binder jetting," he said. TriTech's capabilities align with the needs of the growing number of manufacturers that demand net shape parts, shorter supply chains, and materials that improve part performance.

Vallarini, Tritech's Engineering Manager agrees, noting how the exponential time savings from eliminating tooling means TriTech can often deliver parts in-hand to customers one week after an initial meeting. "Sometimes when they're on the wall of do we want it, do we not want it? being able to put something in their hands that they can fit and test can help seal the deal for us."

"We're continuing to develop the market for binder jet and get all of our customers on board with trusting the process," Vallarini continued. "In the same way that 25 years ago the market had to accept metal injection molding as a production process for titanium parts, we're now encountering that with binder jet and we're on course to achieve it."

Looking to the future Swenson muses over the similarities between binder jetting titanium and other reactive materials, such as aluminum. By establishing an entire system and parameters developed to create high-quality titanium parts, he sees an avenue to use those lessons learned toward next steps in developing more reactive alloys.

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Binder jet 3D printing on the Production System P-1 enables fine features to be integrated directly into part designs, like the small notch circled on the turbine runner above,

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> **Robert Swenson, Owner and President, Tritech Titanium**

About TriTech

With three leading-edge technologies for manufacturing precision net shape titanium parts in-house, TriTech Titanium Parts matches the best production method to each part to optimize custom characteristics. As an experienced company with a team of passionate experts in manufacturing titanium parts, TriTech collaborates closely with clients to help fine-tune each part's design for the best manufacturability to provide titanium parts of the highest quality, reliability and repeatability.

The company offers 3D binder-jet printing, investment casting, and metal injection molding all under one roof at an ISO 9001:2015 registered facility in Detroit, Michigan.

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