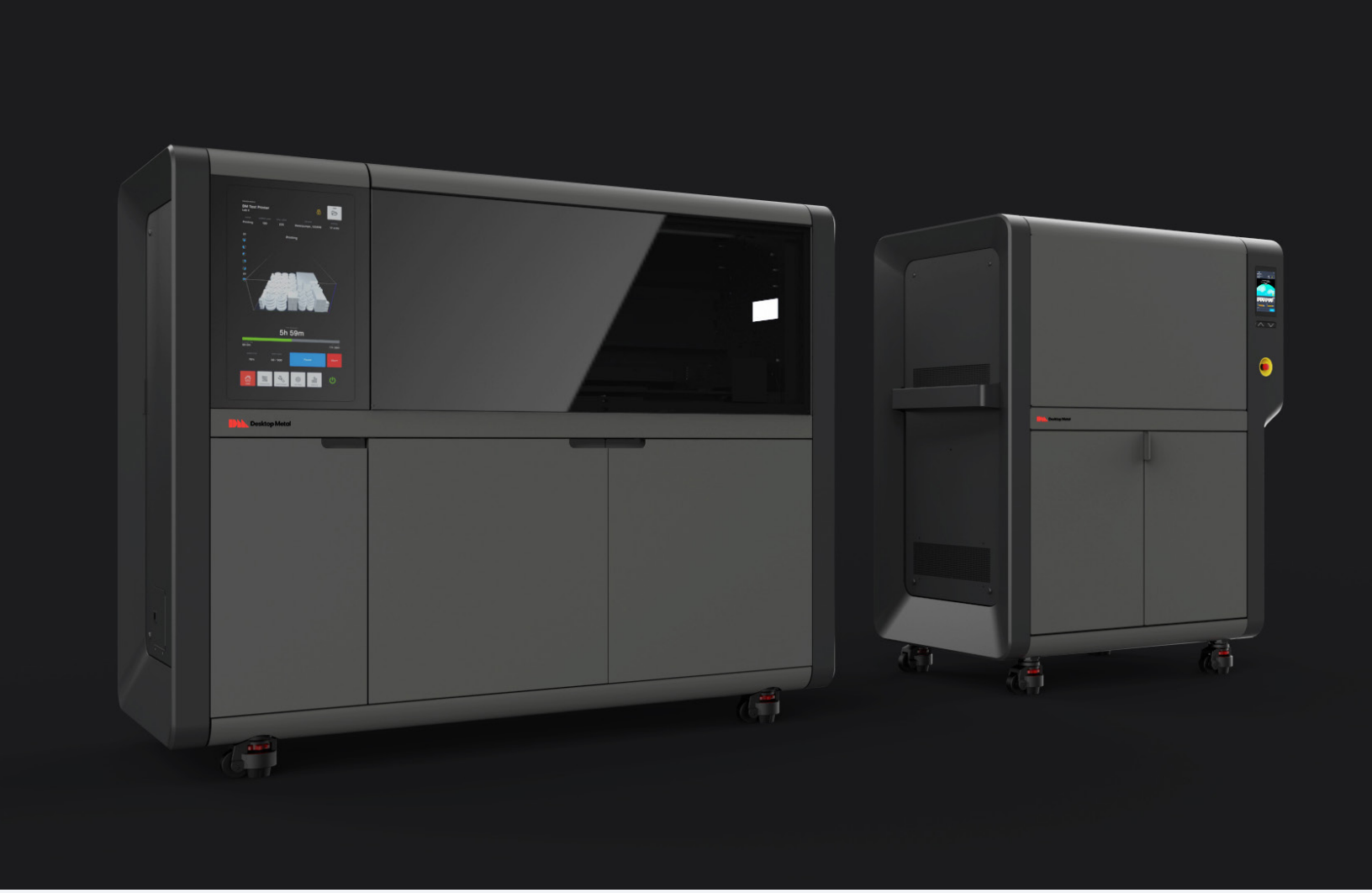

[Article]

The Shop System™

The world's first metal binder jetting system designed for machine shops, the Shop System is capable of printing complex metal parts with the benefits that standards machine shops expect: unparalleled productivity with superior print quality while maintaining high levels of accessibility throughout the entire process.

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Desktop Metal.

01
Benefits of
binder jetting

The benefits of binder jetting

The binder jetting technology at the heart of the Shop System offers a host of advantages for manufacturers, spanning both process and product innovations.

Process innovations

Like other 3D printing methods, binder jetting requires no tooling, meaning parts can often be produced faster and more affordably than traditional manufacturing processes. But unlike legacy metal 3D printing technologies like DMLS, SLS, SLM, and EBM, Binder Jetting allows for these parts to be produced in high volumes. As soon as designs are finalized, printing can begin, and hundreds of parts can be printed overnight, as opposed to waiting weeks for the fabrication of hard tooling common with traditional manufacturing methods like MIM, casting, forging, extrusion, and high volume machining.

Since fabrication is not tied to a particular tool, binder jetting significantly simplifies the process of changing a design - simply update the CAD file and send the new designs to the printer. That ability to update designs as needed enables unprecedented design freedom and allows for the development of products with improved performance and specialized designs that can be customized to meet end-users' exact needs.

This tooling-free manufacturing process leads to a very agile manufacturing environment, often resulting in reduced warehousing and inventory needs. Manufacturers simply print the parts quickly when they need them, and no longer need to store old tools indefinitely on the off chance they may be needed, but can instead create "digital warehouses" to store part files and call them up for printing when needed.

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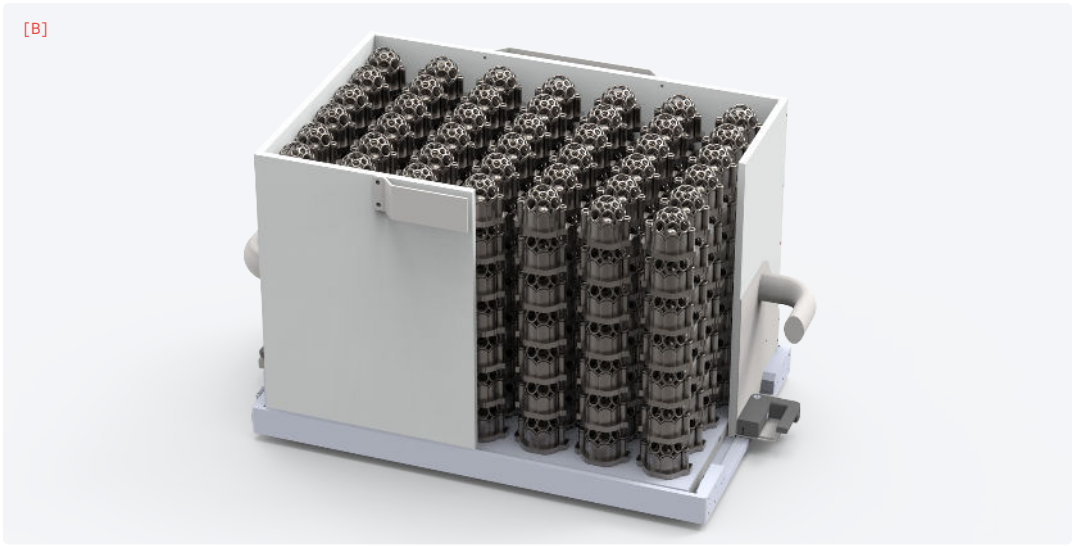
01
Benefits of
binder jetting

[A]

[B]



Process Innovation Example:
Cosmetic Ornament

The complex designs and organic shapes found in jewelry make it an excellent application for metal 3D printing as they are often difficult to produce via traditional manufacturing methods. Investment casting would require significant expenditure in tooling, and would lock designers into a single design early in the process. When different sizes are needed (rings, bracelets, etc) new tooling is required for each size, dramatically increasing part costs and logistical hurdles.

[B] **Build Box Nesting** Cosmetic Ornament

[A] Cosmetic Ornament

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01
Benefits of
binder jetting

Product innovations

To ensure parts can be produced efficiently and affordably, traditional manufacturing design often comes with restrictions intended to enable ease of manufacturing. Such restrictions are necessary to ensure part success, economics, and throughput for subtractive methods like machining and hard tooling-based manufacturing methods like MIM and casting.

A prime example of the restrictions traditional manufacturing faces is in machined parts. Though designers may want to add new features to parts, doing so translates into increased machining time, and often results in significant cost increases. Other traditional manufacturing methods - like MIM, casting or forging - face similar challenges; new features mean significant increases in tooling complexity and costs, and may even make parts impossible to produce. By restricting the features a part can utilize, manufacturers wind up with designs that, while easy to produce, often make sacrifices in part performance.

Unlike these traditional manufacturing processes, 3D printing is an additive process, building parts up layer by layer. This allows for the creation of many features - like organic shapes, undercuts, noncircular holes, consolidated assemblies, and lightweighting features like lattices - that otherwise aren't possible or cannot be justified due to manufacturing difficulty and cost with traditional methods.

Those features can be seamlessly integrated into binder jet parts, and often reduce the cost of producing the components. Lightweighting features, for example, remove material, reducing the cost of printed components, but almost always increase the cost of a traditionally-manufactured part due to the increased number of cuts for machining or tool complexity for MIM and casting.

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01
Benefits of
binder jetting

[C]

Product Innovation Part Example:
Sensor Holder

This part is used to hold sensors in place as they take constant measurements of a rotating component. Keeping the weight as low as possible was essential for this component to ensure it did not add any additional weight to the rotating motor. By printing on the Shop System, this part was able to be optimized with six thin flanges, significantly reducing both the mass and footprint when compared to a machined component. With printing, gyroid infill was incorporated through the entire part, further reducing the weight while maintaining stiffness and strength. The speed and low per-part cost of the Shop System allow for this optimized design to be produced affordably in volume for the end-use application.

Additive manufacturing also enables assembly consolidation, the combining of multiple parts into fewer, multi-functional assemblies. Traditionally, those assemblies have been created from relatively simple parts, which can be manufactured far more efficiently and affordably than a single, complex part. Those simple components are then combined with welding, screws, rivets, and other fasteners. As an additive process, binder jetting makes it easy to combine all the components of an assembly into a single printed part, which is often more affordable to produce than the separate components. These consolidated assemblies can greatly simplify logistics by reducing the number of parts in the BOM that need to be sourced, warehoused, assembled, etc.

[C]
Sensor Holder
Size: 44 x 44 x 13 mm
Cost/part*: $7.86
Parts/build*: 251
Parts/week*: 1,766

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01
Benefits of
binder jetting

[D]

Product Innovation Example:
Connector

This fluid connector features complex geometry, including internal channels, that would require it to be produced as a multi-part assembly, rather than a single component.

Printing, however, made it easy to produce this component as a single part, and also resulted in higher performance than the traditionally-manufactured alternative, while simultaneously reducing part cost and manufacturing lead time.

A host of other features - like lattices, generative design, and internal channels - that would be impossible to create with traditional manufacturing methods can easily be 3D printed. Because it produces parts layer by layer, binder jetting makes it easy to incorporate those features into parts, bringing designs to the next level and increasing part performance (strength, stiffness, cooling rate, minimizing footprint,) lowering weight, and reducing part costs.

While it has been possible to incorporate those features into printed parts for some time via powder bed fusion, most applications were generally too expensive to justify printing in anything other than very low quantities. With the emergence of new binder jetting systems with new levels of ease of use and lower part costs like the Desktop Metal Shop System, it is now possible to produce these parts in higher volumes at lower part costs, greatly lowering the hurdle to justifying 3D-printed metal parts. For the first time, it is possible to go to mass market with metal 3D printed components.

[D]
Connector
Size (mm): 70 x 53 x 31 mm
Cost/part*: $5.88
Parts/build*: 410
Parts/week*: 3,170

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02
Breakthrough performance

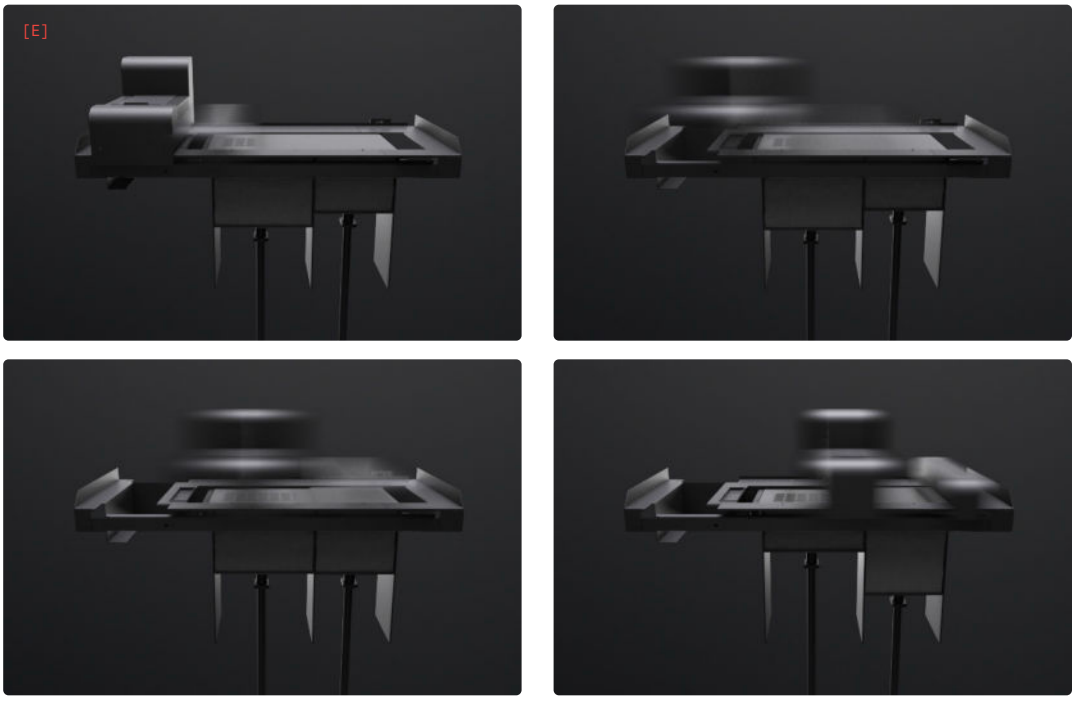
Breakthrough performance

In addition to unlocking process and product innovations, the binder jetting technology at the heart of the Shop System is capable of delivering reliable high performance that meets the demands of a modern machine shop.

With the ability to produce high-quality, fully-dense, near-net shape parts right out of the furnace, the Shop System's high-throughput and flexibility make it an excellent manufacturing choice for low-, medium-, and high-volume end-use applications.

Unparalleled productivity

The Shop System's innovative single-pass print engine allows for rapid production of metal parts. Because the print bar spans the entire width of the print bed, entire layers of multiple parts can be printed in just a few seconds.



[E] Stills of Video

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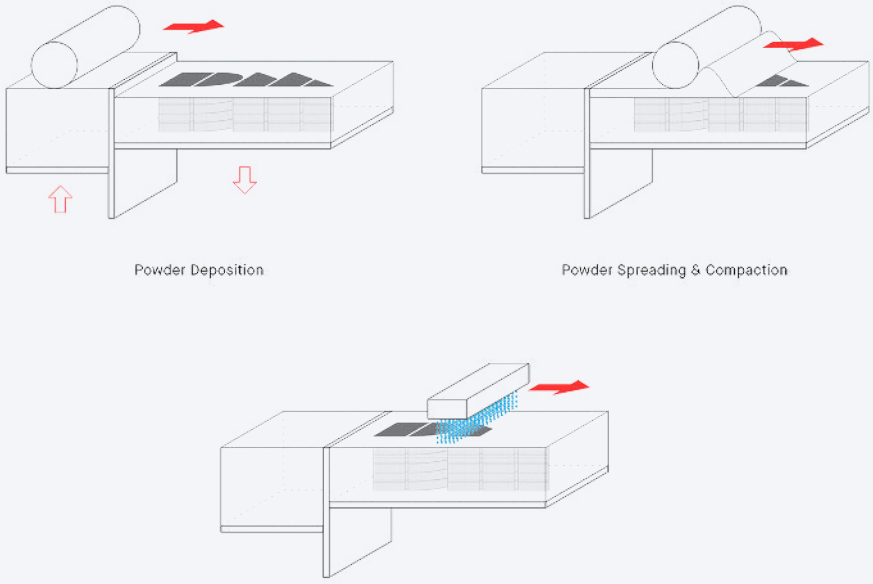
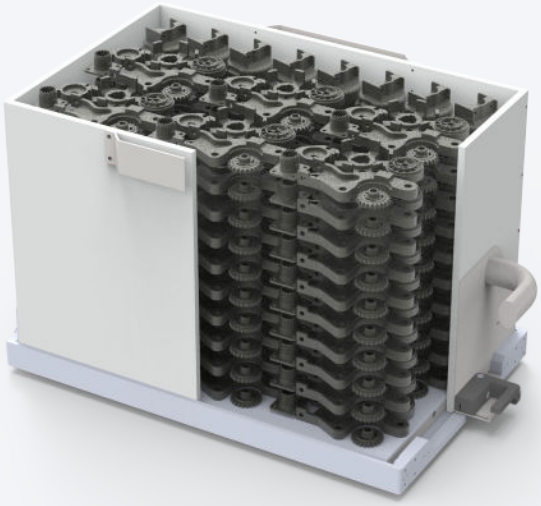
02
Breakthrough
Performance

That printing speed - up to 10x faster than laser powder bed fusion systems - allows the Shop System to print an entire build volume in a single 6 to 12 hour shift, depending on the height of the build. Build times are flexible and determined by factors like build depth and layer height. This means users can easily adjust build time to fit their shop schedule—running a six-hour build during the day, then turning the printer over to a longer build overnight with minimal operator burden, enabling effortless productivity with very high utilization.

[F]



[G]



[G] **Configurable Build Volume** The Shop System can print variety of different geometries within a single build without requiring custom tooling and setup per part.

[F] **Process** Shop System binder jetting technology

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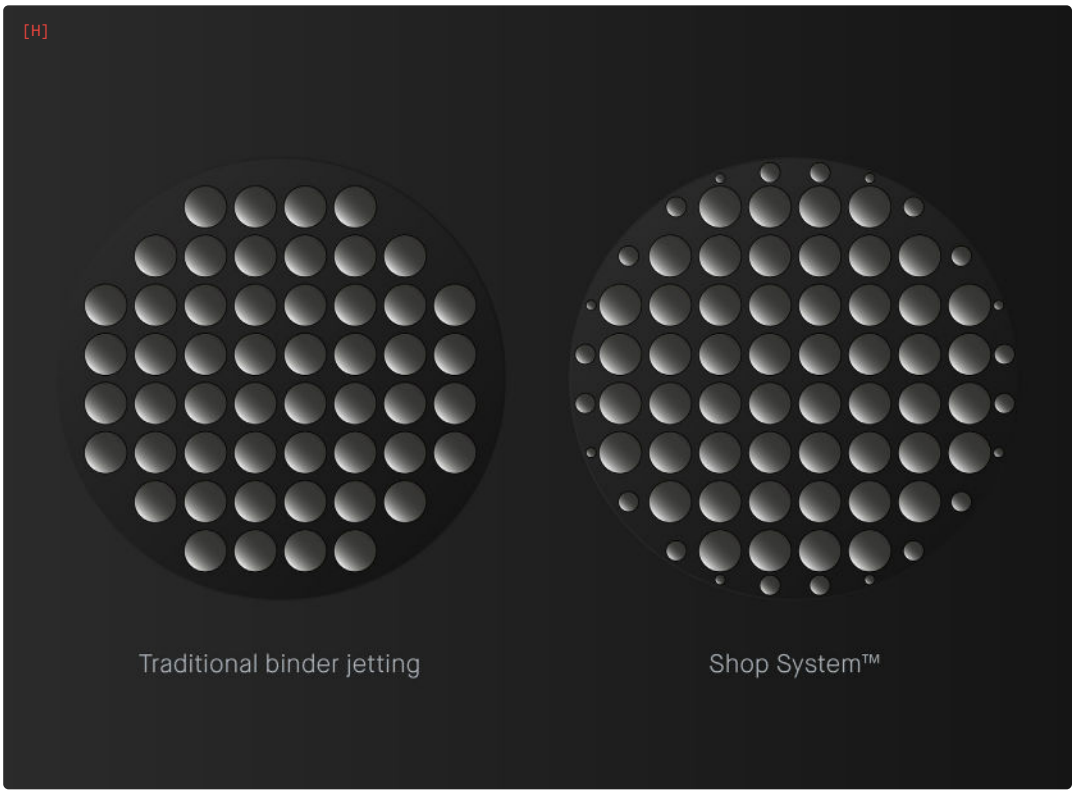
02
Breakthrough
performance

Superior print quality



The Shop System prints customer-ready, high-resolution parts with incredibly fine detail. With a native resolution of 1600 x 1600 dpi (dots per inch) - 33% higher than competitive systems - the ability to produce more than 670 million drops per second and layer heights between 40 µm and 100 µm, the system is the highest-resolution single pass binder jetting system on the market.

To deliver both fine details and fast print speeds, the Shop System uses an adaptive print engine that produces 1.2 pL droplets and automated drop multiplexing up to 6 pL, resulting in surface finishes as low as 4 µm Ra, superior bleed control and fine feature detail, all while maintaining high print speeds.

[H] **Adaptive Print Engine**
Traditional binder jetting print resolution vs. Desktop Metal Shop System print resolution

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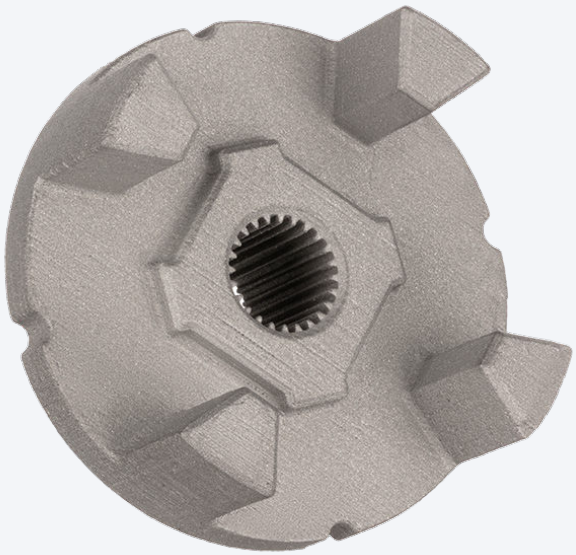
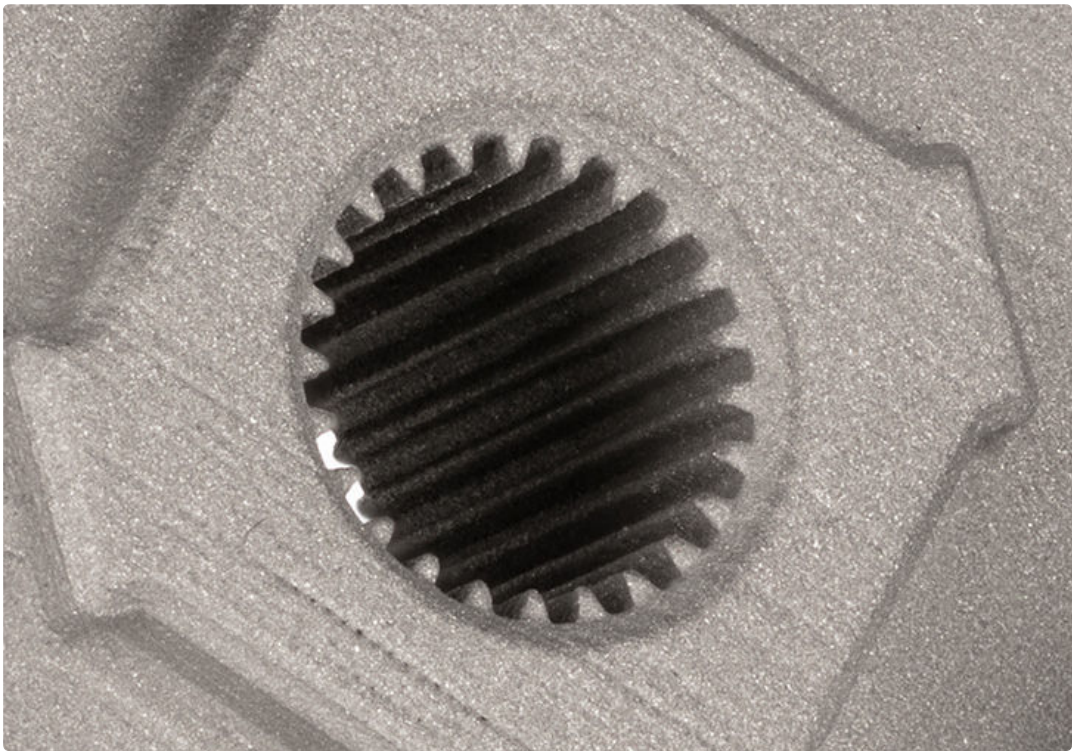
02
Breakthrough performance

Common mass finishing options can improve surface finish even further, to less than 0.1 µm Ra. In addition, Shop System parts emerge from the furnace fully-dense, isotropic and ready for end-use applications.

[I]





[I]
Power Steering Joint
Internal spline is printed directly into the part, avoiding additional post processing.

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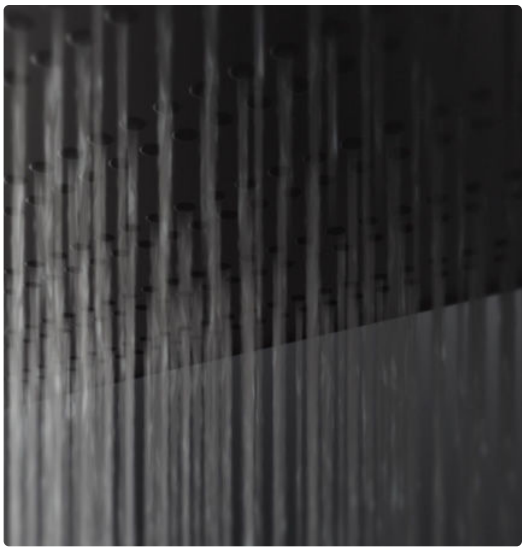
02
Breakthrough
performance

Excellent reliability

With over 70,000 jets spread across five rows, the Shop System print bar provides enough redundancy to ensure that any jet outs (caused by clogged nozzles) do not result in print defects. Built-in, automatically-programmed cleaning cycles ensure print head performance is always optimized for its full, extended lifetime, resulting in enhanced print quality and reliability.



Taken together, the Shop System's productivity, print quality and reliability add up an ideal solution for machine shops and metal job shops hoping to amplify their productivity with metal 3D printing.

With the ability to print tens to hundreds of parts with the tolerances that are compatible with machining, the Shop System allows shops to take on new and larger customer jobs, while reserving machinist hours for refining critical features.

[2] Shop System Printhead
70,000 jets spread across five rows

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02
Breakthrough
performance

[K]

Part Example:
Clipper Blade

This part is a clipper blade used with an electric hair trimmer. As shown, the Shop System is capable of printing the thin geometry needed to guide hair into the trimmers.

Manufacturing this clipper blade would traditionally require expensive tooling for production via stamping or metal injection molding. Mass producing on the Shop System eliminates tooling costs and drastically reduces manufacturing lead time.

Furthermore, additive manufacturing enables mass customization - allowing real-time adjustments to the part. The Shop System was more than able to print the incredibly fine, thin details of the blade.

[K]
Clipper Blade
Size (mm): 36 x 35 x 3.5 mm
Cost/part*: $4.17
Parts/build*: 684
Parts/week*: 5,376

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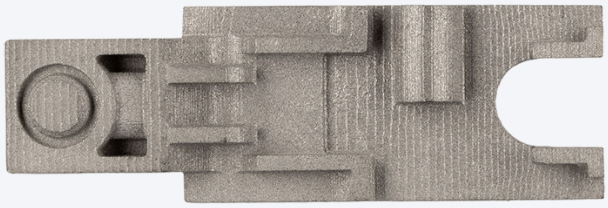
02
Breakthrough
performance

[L]

[M]



Part Example:
Medical Device Closure/Latch

This assembly is used to latch and hold other components in place in a medical device assembly. The parts require geometry that is very small and precise that would require extensive machining, which would be challenging on these fine, thin features. To produce these parts via metal injection molding would require an extremely large investment in hard tooling, but since the parts do not need to be produced in very large volume - only about 10,000 were needed - the tooling couldn't be justified.

The Shop System allowed the parts to be produced in high volume quickly and affordably, without any tooling costs. The high performance of the Shop System allowed for excellent printing of the fine features while maintaining high resolution and quality required for the application.

[L]
Latch A
Size: 59 x 26 x 10 mm
Cost/part*: $6.33
Parts/build*: 160
Parts/week*: 1,287

[M]
Latch B
Size: 37 x 12 x 9 mm
Cost/part*: $1.99
Parts/build*: 745
Parts/week*: 5,809

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02
Breakthrough
performance

[N]

Part Example:
Custom Bolt

This custom-designed bolt is used in specific applications where footprint and weight needed to be limited.

Due to the high cost of hard tooling, most bolts are manufactured in quantities of millions. For this bolt, however, only a few thousand were needed. By printing on the Shop System this bolt can be produced with no tooling at a dramatically reduced cost per part. The fine feature resolution of the Shop System allowed for easy printing of the male thread, just requiring a quick chase to clean up the profile after sintering.

[N]
Latch A
Size: 60 x 14 x 10 mm
Cost/part*: $5.76
Parts/build*: 319
Parts/week*: 2,499

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03
Reduce costs,
increase revenue

Reduce costs, increase revenue

In addition to process and product innovations, exceptional productivity, print quality and reliability, the Shop System delivers another key benefit - the ability to both reduce costs and increase revenue.

The Shop System's unparalleled productivity - as much 70 kg of metal parts can be printed in a single day - allows it to deliver per-part costs that are competitive with traditional manufacturing methods like casting and forging, making the system a viable option to produce end-use metal parts across a wide range of industries and applications.

Reduce costs

The tooling-free nature of metal 3D printing means manufacturers do not need to factor tool amortization into part costs. For many quantities of parts, this leads to significant per-part savings, since tooling costs often add up to tens of thousands of dollars. While machining can sometimes be done with a significantly smaller investment in tooling, 3D printing still produces cost saving by reducing wear on cutting tools, and the minimal operator burden associated with printing parts saves on labor costs.

Printing also dramatically reduces the number of steps involved in manufacturing, building parts layer by layer, as opposed to machining, where different features may require multiple machines and orientations. Similarly, entire builds can be set up in just one to two hours, regardless of the number of parts and complexity. Fixturing for each machined part, meanwhile, must be carefully considered and implemented, a process that requires hours for each unique geometry.

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03
Reduce costs,
increase revenue

Increase revenue

By enabling the creation of parts with features that would previously have been unattainable and allowing for batch production of parts with different geometries, the Shop System can help machine shops win new business and unlock new revenue streams. The system also makes it easy for users to quickly and reliably predict part costs and quote jobs, helping shops win more bids.

Once orders do come in, the Shop System dramatically reduces lead times for many components. Prints can begin almost immediately, and hundreds of parts can be produced over night, allowing shops to quickly deliver parts to customers in just days, and freeing up capacity for new jobs.

The elimination of tooling and the ability to simultaneously print jobs for multiple customers in a single build also makes small- and medium-sized jobs more economically-viable, allowing powder metal manufacturers to offer smaller jobs to customers at much lower per-part costs and lead times. This means that part cost stays the same whether you print 1 or 1,000 parts.

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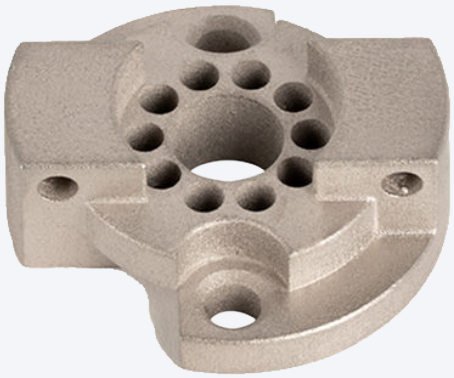
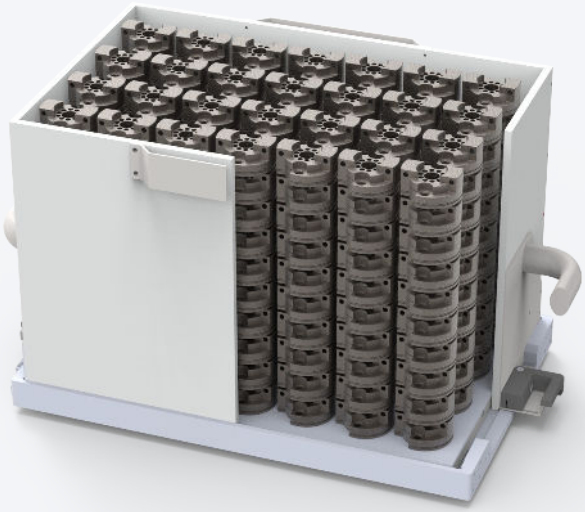
03
Reduce costs,
increase revenue

[0]





Part Example:
Seatbelt Pulley

This output pulley is an essential component of the retracting mechanism in a car seat belt.

This part features an undercut radial groove that, without printing, would require advanced sliders during the press-and-sinter process. Printed on the Shop System eliminates the cost and complexities associated with complex press and sinter tooling.

[0]
Seatbelt Pulley
Size (mm): 36 x 35 x 3.5 mm
Cost/part*: $4.17
Parts/build*: 684
Parts/week*: 5,376

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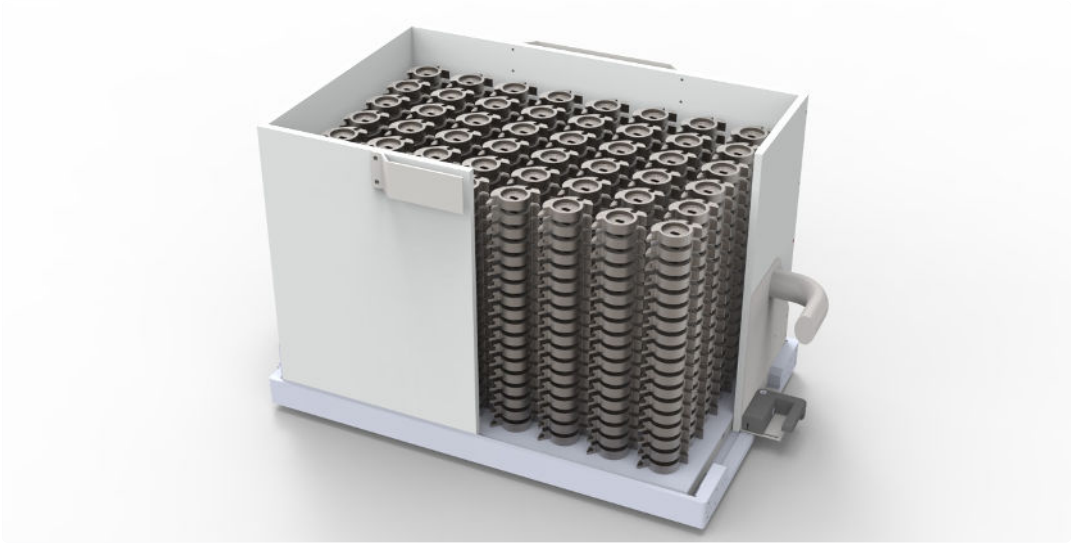
03
Reduce costs,
increase revenue

[P]



Part Example:
Adapter

This adapter is used to hold a gyro sensor in place in a rotating machine component.

To create this part's features across multiple planes via traditional manufacturing would require extensive machining as well as multiple fixturing set ups and orientations.

The designer only needed to produce these adapters in a low quantity (≈1,000 pieces.) The lower volume of this part makes it infeasible to justify the capital for permanent machining fixtures or molds for metal injection molding. Using the Shop System, all of the parts could be produced in about a week.

[P]
Adapter
Size: 40 x 40 x 15 mm
Cost/part*: $13.09
Parts/build*: 293
Parts/week*: 1,928

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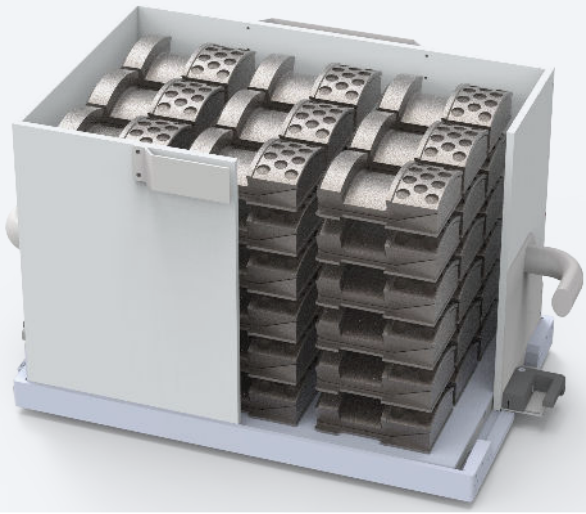
03
Reduce costs,
increase revenue

[Q]



Part Example:
Down Hole Tool Slip

This part provides a frictional hold between a packer and a pre-existing pipe during oil extraction.

A consumable that is lost after pumping is complete, it is essential to keep the price and lead time for this part as low as possible. The Shop System allows this part to be manufactured with an accelerated lead time and at lower cost than traditional manufacturing. The system's tooling-free nature means the design can be easily changed to fit different pumping scenarios. Just modify the CAD file and send it to print.

[Q]
Down Hole Tool Slip
Size: 57 x 23 x 82 mm
Cost/part*: $61.49
Parts/build*: 57
Parts/week*: 418

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