eBook

Efficient and Effective Production Support with 3D Printed Jigs and Fixtures

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3D SYSTEMS
Additive Manufacturing Solutions

Contents

Increasing production value with jigs and fixtures

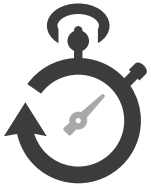
Jigs and fixtures offer manufacturers a reliable process for delivering accurate, high-quality outcomes, whether for a specific part or feature, or for consistency across multiples of parts. Although the methodologies and materials for producing jigs and fixtures have evolved beyond the conventional metal tooling of years past, their position as a manufacturing staple remains constant due to the benefits they offer.

This eBook discusses the use of additive manufacturing (AM) for jig and fixture applications, and demonstrates how production support can be improved in terms of speed, cost and functionality. The applications included within this eBook offer a mere glimpse at what is possible with AM for production support. The examples chosen illustrate opportunities for applying design principles and technology capabilities that are transferable across a wide range of applications.

Effective jigs and fixtures help companies:

Lower the cost of production

Ensure precision/ repeatability



Increase productivity

Improve worker safety

Reduce scrap/waste

Leveraging AM to optimize production timelines and costs

AM is a standout technology for manufacturing jigs and fixtures that frequently surpass conventional components in speed of delivery, cost of production and performance improvements.

Speed of Delivery

Access to AM (also termed "3D printing") within the engineering or production environment shortens the supply chain for optimized tools, increases organizational self-sufficiency and reduces uncontrolled downtime.

Cost of Production

3D printing delivers true-to-CAD parts directly from the design file to significantly reduce production expenses. The advanced material properties available through 3D printing make it possible to forgo machining for a wide variety of jig and fixture applications to directly print effective components.

In instances where machining is required for final components, 3D printing can be deployed for prototyping to accelerate design iterations and lower development costs to ensure a sound investment in final production.

Performance Improvements

In addition to the quantifiable gains AM provides in speed and cost savings, 3D printing also opens new opportunities in jig and fixture design that improve workflows, enhance worker safety and prolong equipment life. Discover the strategies AM enables to improve jig and fixture performance on **page 6**.

Specialized fixtures for CNC milling

When a final assembly includes parts with mating surfaces, milling is typically required. A common challenge with CNC milling is spindle failure, which is frequently caused by an improperly mounted part. This is where secure CNC milling fixtures can vastly improve operations and prevent damage to the milled part and CNC machine.

3D printing helps ensure secure fixtures by enabling them to be created to match the actual dimensions of the part produced as opposed to the idealized dimensions of the part design. Using a digital workflow with 3D scanning, design and printing, an accurate, stable CNC milling fixture can be achieved to hold parts more reliably than any other method, every time.

Because 3D printing fixtures is faster than producing them conventionally, 3D printing opens new opportunities for modular fixture designs. By identifying the major mode of deviation in a production part and 3D printing a range of assembly options for a matching fixture, 3D printing offers a quick and cost-effective way to increase the security of a fixture to reduce wasted material and time, and in turn, generate more profit.

Pictured here is a modular CNC milling fixture 3D printed using 3D Systems' Selective Laser Sintering (SLS) with DuraForm® PA, a nylon-12 material that is tough, durable, and can withstand vibration.

SLS parts offer up to a 40% cost savings vs. conventionally produced parts, and are delivered at accelerated speeds

Improving functionality with new design capabilities

As demonstrated by the CNC machining fixture on page 5, additive manufacturing enables increased complexity and customization for jig and fixture design and production. Because 3D printing builds parts layer-by-layer, the design approach is not constrained by the same limitations of subtractive manufacturing. When paired with the material options available, these new design freedoms enable new features to improve functionality overall.

Beyond delivering components faster and more cost-effectively, 3D printing enables complex and customized shapes to be produced that would otherwise be impossible. The recommended approach to taking full advantage of 3D printing is to set goals around part performance and design to those goals.

Here are a few thoughts to consider as you get started:

- Could unnecessary weight be removed to reduce machine wear and tear?
- Would creating an ergonomic shape enhance worker safety?
- Are there any optimization opportunities that would simplify downstream processes?

3D printing is highly cost-effective for producing a wide variety of shapes that can be optimized in any number of ways, from light-weighting via topological optimization, hollowing, or assembly consolidation; to customization for the application or user; to complex, finely-featured details that are beyond the scope of machining.

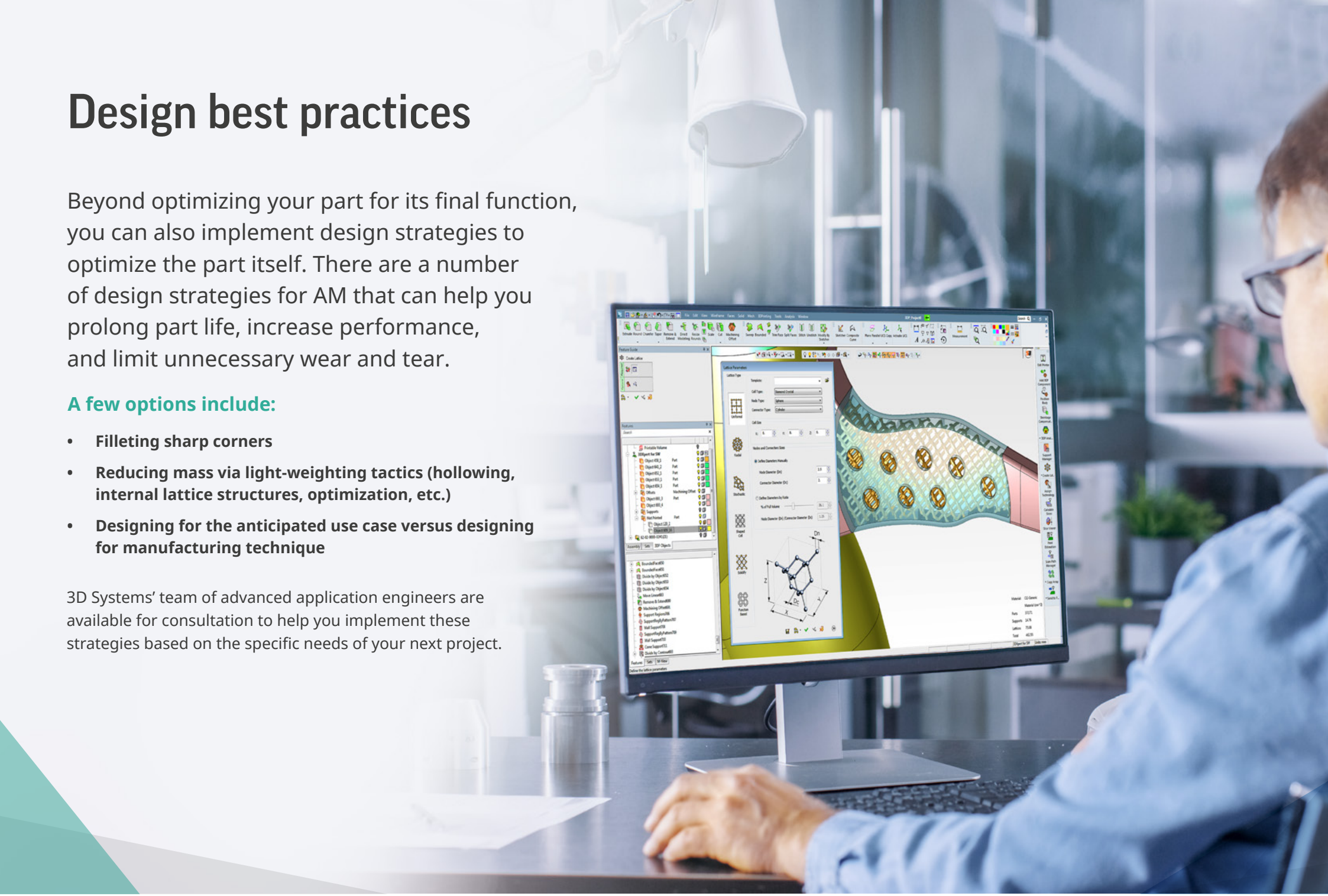
Design best practices

Beyond optimizing your part for its final function, you can also implement design strategies to optimize the part itself. There are a number of design strategies for AM that can help you prolong part life, increase performance, and limit unnecessary wear and tear.

A few options include:

- **Filleting sharp corners**
- **Reducing mass via light-weighting tactics (hollowing, internal lattice structures, optimization, etc.)**
- **Designing for the anticipated use case versus designing for manufacturing technique**

3D Systems' team of advanced application engineers are available for consultation to help you implement these strategies based on the specific needs of your next project.



Optimized drill guides

Drill guide fixtures need to be durable and deliverable at a low manufacturing cost. Traditionally this has led to drill fixtures that are bulky, heavy, and the result of fast and simple designs. However traditional manufacturing is not the only way to achieve quick and cost-effective drill fixtures. 3D printing is highly competitive in speed and cost, while enabling several performance efficiencies to enhance implementation and improve downstream workflows.

One of the benefits 3D printing offers is weight reduction, which makes drill fixtures easier for operators to maneuver. Because lighter weight 3D printed designs require less material, lowering the weight of a design for additive manufacturing also means lowering cost.

Speed is a multi-faced benefit of additive manufacturing. In addition to delivering final fixtures quickly, the fast production speeds of 3D printing accelerate design iterations to maximize tool effectiveness in a shorter design cycle. Furthermore, the complex features that can be 3D printed allow engineers to tailor their tools to their specific needs. Features like ventilation or coolant channels can be added with no change in final manufacturing time or cost.

The SLS drill guide fixture pictured here was printed in DuraForm® PA and includes dust removal piping with a pulling vacuum to reduce operator exposure to airborne debris. The same channeling concept could be applied to incorporate a route for cooling fluid, or to vent in an inert gas to reduce oxygen and flame.

Same-day production fixtures: bead blasting

Many parts can be stabilized for bead blasting using clamps or pliers, but these methods are not suitable for parts with delicate features. Yet the inability to use standard holding tools should not impose delays on production schedules.

3D printing enables specialized fixtures to be printed within hours, which is extremely useful in addressing needs as they arise. Fixtures for bead blasting delicate parts are a good example. Using 3D Systems Figure 4™ technology, holding parts can be designed, printed, post-processed and used within the same workday. If anything about the bead blasted part were to change in size or shape, a new fixture could be designed and implemented with the same rapid turnaround to keep project momentum going forward.

Although complexity can be part of the printed outcome with additive manufacturing, the AM workflow itself is simple and approachable.

Engineers with minimal knowledge of 3D printing can easily update and produce effective parts using CAD. This ease of addressing issues offers companies a streamlined iterative process that removes downtime, empowers their workforce, and reduces waste by securing higher part yields with more effective tools. In a fan blade bead blasting application for which a fixture was printed with Figure 4 technology, it was estimated that the operator would have broken 20% of the parts with conventional tools. Use of the specialized, same-day fixture enabled 100% part yield.

Figure 4 is powered by non-contact membrane technology, and can print parts at up to 100 mm/hr.

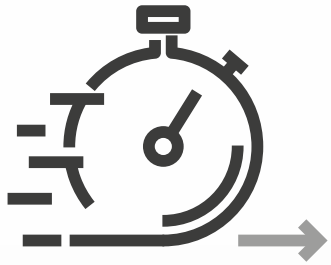


FIGURE 4 NON-CONTACT MEMBRANE TECHNOLOGY CAN PRINT PARTS AT UP TO 100 MM/HR.

Go/No-go gauges

The purpose of a go/no-go gauge is to ensure parts are produced within allowable tolerances. It is therefore paramount that a go/no-go gauge be accurate as well as durable to provide reliable feedback over time without deformation.

For close followers of 3D printing, Stereolithography (SLA) has long been considered the gold standard for accuracy, making it an ideal technology for these kinds of parts. Because a go/no-go gauge also demands durability, material selection is an important factor. As with any 3D printing application, consideration of the performance requirements will inform the part outcome, from design strategies and technology selection through to the material used.

3D Systems Accura® Bluestone material is an excellent option for go/no-go gauges due to its rugged material properties. As one of several available composite materials, Accura Bluestone is highly stiff, abrasion resistant, and heat resistant, making it a perfect match for this and other jig and fixture applications.

Snap-fit enclosures

Although there are plenty of production tasks that can be completed manually, significant efficiency gains can be unlocked by incorporating 3D printing. This fixture was devised by contract manufacturer PPI-Time Zero to protect expensive motors throughout cleaning and shipping.

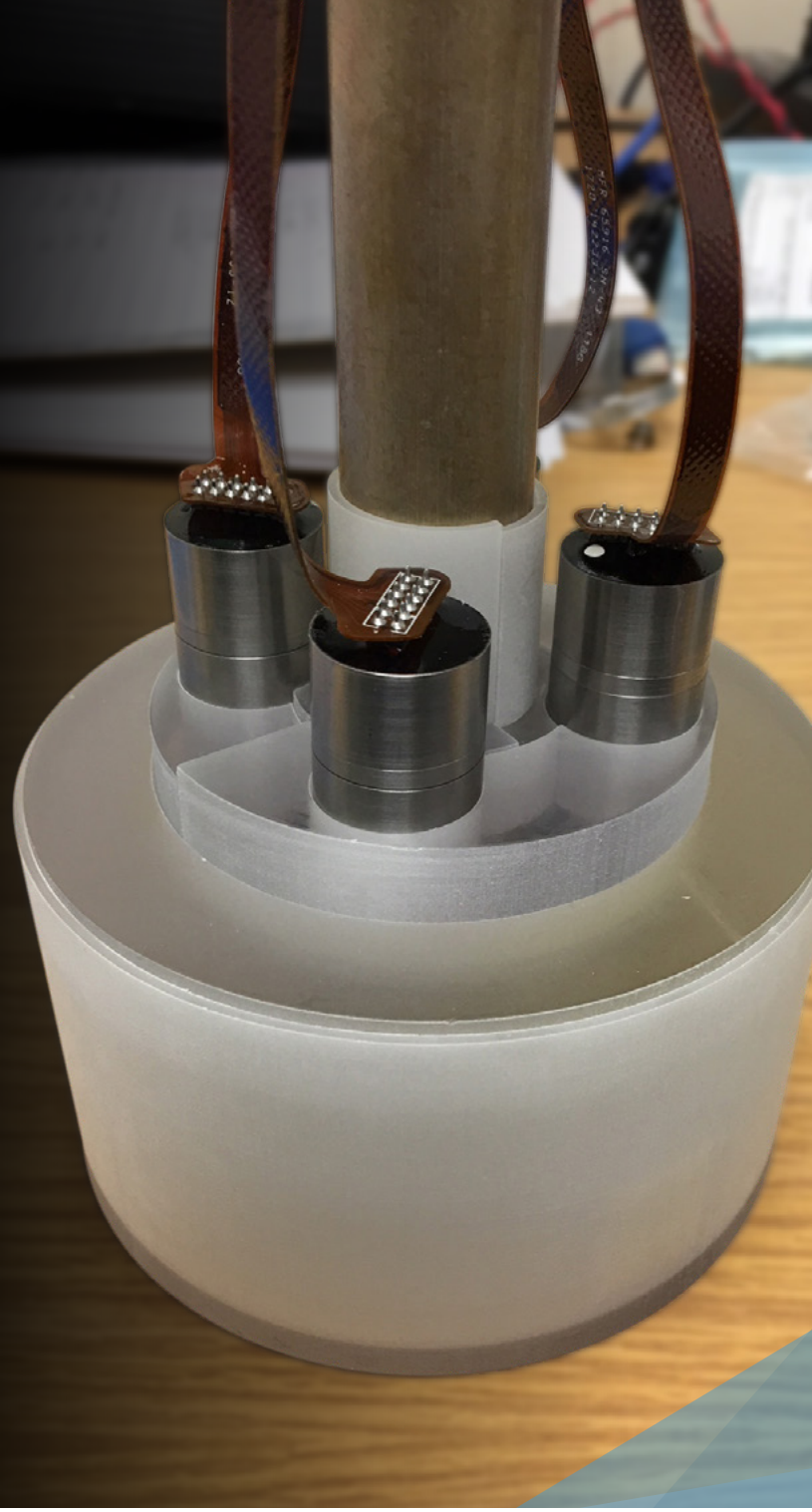
These covers are dimensionally stable without being brittle, and can be assembled around the motors as snap-fit components. The company is able to seal the covers simply by clamping the seam, instantly making them watertight for cleaning. Prior to this solution, sealing the motors for cleaning took upwards of half an hour per motor. On a contract for 50,000 units, the man-hours saved by 3D printing this fixture added up very quickly. As an additional bonus, these covers double as re-usable protective shipping cases to insure the safe delivery of these expensive parts.

This application uses 3D Systems' MultiJet Printing (MJP) technology and VisiJet® engineering-grade materials. The low modulus, semi-rigid material properties of VisiJet ProFlex delivered the right combination of durability and functionality for this task.

To read the full experience click here

This application of 3D printing saves PPI-Time Zero an average of

40 - 50 HOURS A WEEK



When to Use AM

Using AM for your jig or fixture application can bring significant benefits to your project. The following considerations will help you determine if AM is a good fit for your use case.

RIGHT FIT FOR AM

- Low run plastic parts
- Fast access to parts required
- Iterative design approach beneficial
- Single-use applications
- Novel approaches to design that are otherwise cost prohibitive

WRONG FIT FOR AM

- Large quantities of parts designed for traditional manufacturing (i.e. injection molding)
- Parts with simple geometries

Another variable to consider is the cost-efficiency of designing and producing with additive manufacturing versus traditional manufacturing. In some cases, additive will offer a better option. In others, traditional may still be the right fight. For feedback on your specific application, contact an application expert.

Selecting the right solution for your needs

The key to success with 3D printing is selecting the right solution for your needs. The fastest and most foolproof way to identify the best technology and material combination for your application is to consult with an additive manufacturing expert. Together, you can review key requirements to help you narrow your options to the ideal solution.

To prepare for this conversation, consider the following aspects of your application:

Size and physical requirements

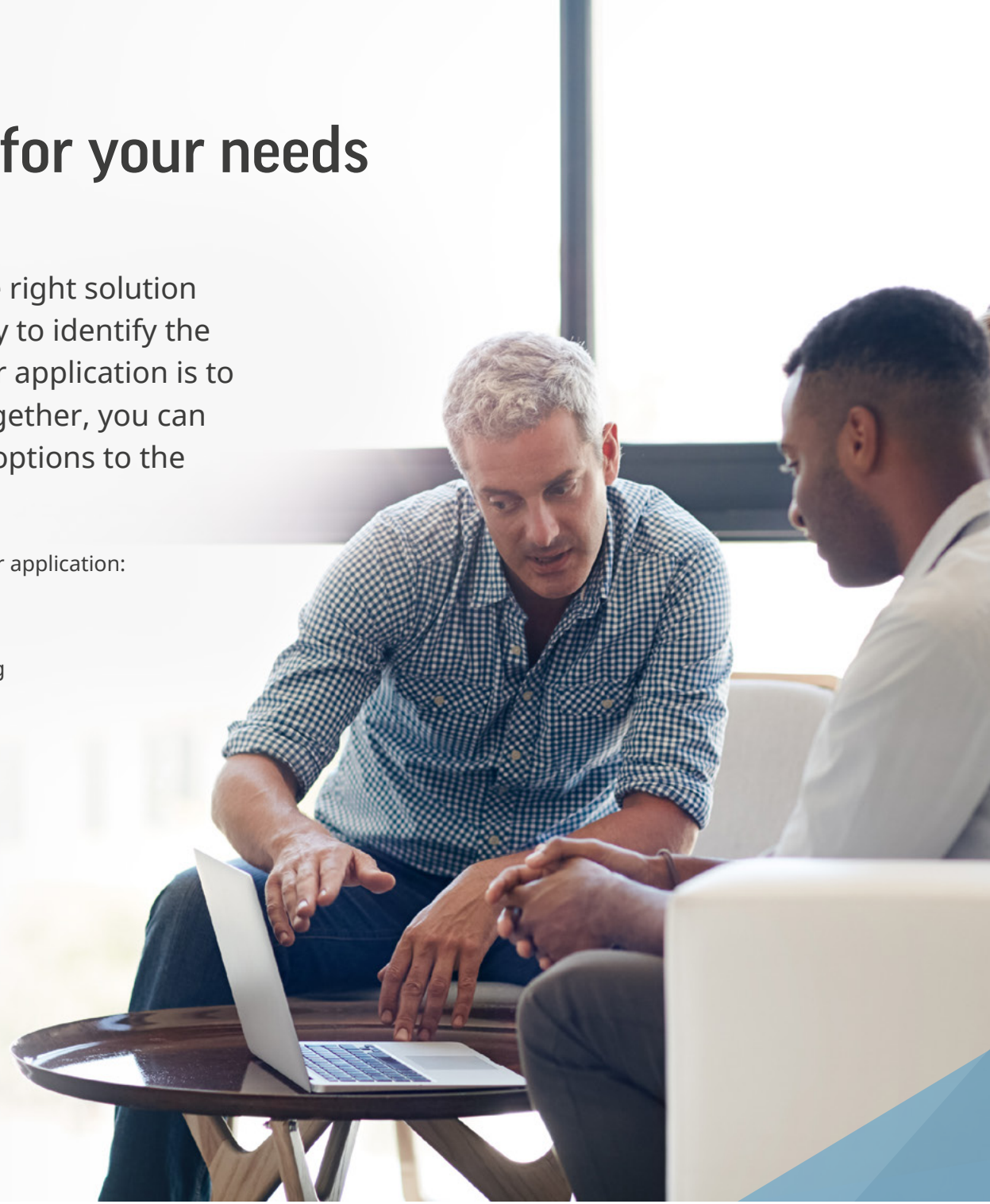
- Precision and accuracy
- Surface finish

Environment of use

- Temperature considerations
- Humidity and/or fluid contact
- Chemical resistance requirements

Performance needs

- Load bearing
- Rigidity
- Vibration
- Soft-touch

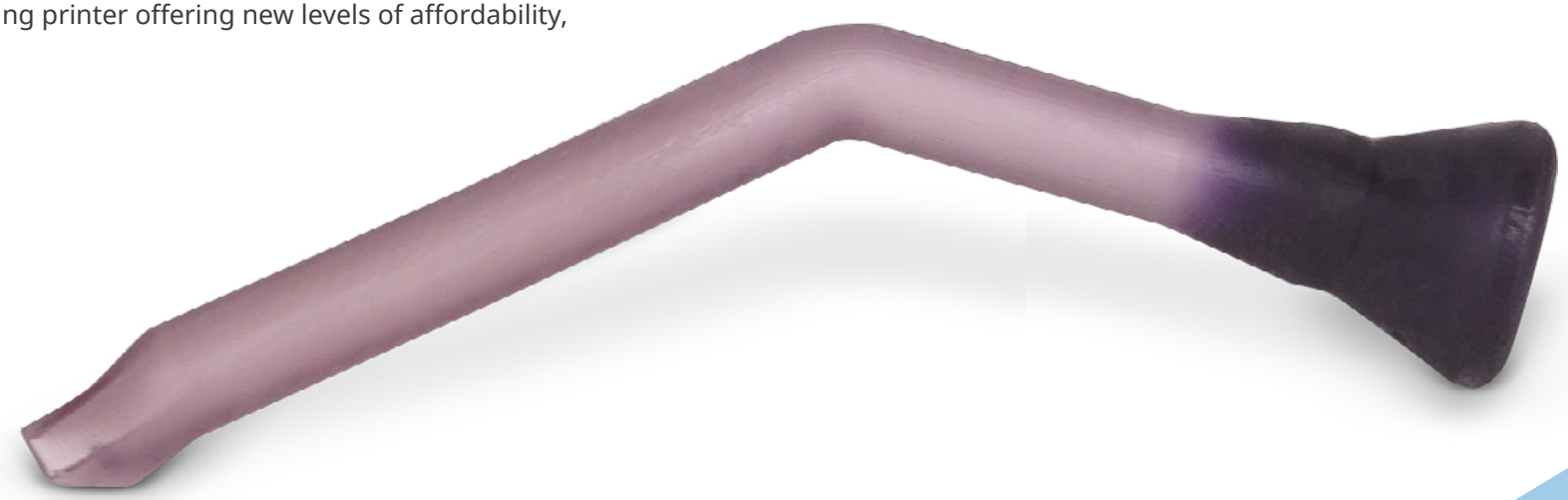


Customized coolant delivery

Coolant delivery is important to grinding applications for high precision parts. Rather than relying on standard nozzles and hoping to get the right amount of coolant to the right location, the University of Dayton Research Institute (UDRI) designed and 3D printed custom nozzles to ensure the desired outcome.

Whereas standard nozzles are typically designed and manufactured using conventional methods, this custom nozzle takes advantage of the design and delivery capabilities enabled by 3D printing and was quickly designed, prototyped and produced to match the exact needs of the application. The ability to deliver one-off parts as well as batch parts makes 3D printing a great option for quick iteration in prototyping as well as for the production of on demand, low volume components.

The part pictured was created using 3D Systems' FabPro 1000 3D printer, an entry-level industrial-grade, projector-based imaging printer offering new levels of affordability, ease-of-use and quality.



Comparing technologies

The below chart provides a quick overview of the technology and material types 3D Systems offers to help you with your next jig or fixture application. All of 3D Systems' plastic printers also include 3D Sprint®, a powerful all-in-one additive manufacturing software for quickly preparing and printing files.

Beyond hardware, software, and materials, a complete solution includes support. 3D Systems' application engineers and global On Demand services team are ready to help you at any stage, whether you're just getting started or looking to build momentum.

	FIGURE 4 AND ENTRY-LEVEL INDUSTRIAL PRINTING	MULTIJET PRINTING	STEREOLITHOGRAPHY	SELECTIVE LASER SINTERING
BENEFITS	- Rapidly produce jigs and fixtures with ultra-fast print speed (up to 100 mm/hr) - Exceptional surface finish for small jigs/fixtures - Custom textured detail	- Fine details captured in print - Sharp edges - Easy post-processing with wax supports for easy removal - User-friendly	- High accuracy and precision - Near isotropic parts - Abrasion-resistant parts - Exceptional surface finish - Ideal for both small and large geometries - Low waste process aiding cost-effectiveness	- Large build sizes - Uniform surface quality - Uniform part quality
BUILD SIZE	Up to 4.9 x 2.8 x 13.7 in	Up to 11.6 x 8.3 x 5.6 in	Up to 59 x 30 x 22 in	Up to 15 x 13 x 18 in
MATERIAL OPTION	- Rigid - Elastomeric	Engineering-grade materials (ABS-like and Polypropylene-like)	- High heat resistant options available - Clear materials available	- Industrial-grade thermoplastics - Production-grade nylon

Additive manufacturing allows effective tools to be produced directly from CAD, enabling high accuracy while lowering the time and costs involved.

What's Next?

Are you ready to take your production capabilities to the next level?

We're here to help.

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