Desktop Metal

Five Steps to Evaluate Your Site for Metal 3D Printing

A quick guide for those looking to adopt metal 3D printing, with the steps you can take to compare various technologies and how they fit in your production environment.

Introduction

Metal 3D printing continues to gain adoption, allowing businesses to create complex and highly precise metal parts that would be difficult or impossible to produce with traditional production methods. While these additive manufacturing systems aim to be another tool in the manufacturers' toolbox, the facility requirements of "metal 3D printing" may require some consideration. Usually, customers are surprised how easy it is to integrate into existing site and operations.

First and foremost, the type of metal 3D printing technology you're looking to adopt will drive your facility considerations. The Bound Metal Deposition technology of the Desktop Metal **Studio System™**, for example, can be easily installed in just about any existing office or lab space with minimal facilities updates. In contrast, laser powder bed fusion processes, for example, require additional consideration for handling fine loose powder such as explosion-proof vacuums, sieving stations, and filter flooding stations that add up to high investment and come with new environmental, health, and safety requirements. Facilities requirements for metal 3D printing technologies like binder jetting with the Desktop Metal **Shop System™** fall somewhere in between.

Desktop Metal offers an extensive Knowledge Base including a complete Site Readiness Guide for each of our systems, and our experienced Customer Service team can work with adopters to ensure their layout is functional. Exactly how to best prepare your facility will depend on many variables, including your applications, building, and local codes and ordinances. However, if you're new to metal additive manufacturing and looking to adopt this technology, we've compiled some considerations below about how to evaluate your site for metal 3D printing.

- Determine your equipment and space needs
- Know your facility requirements
- Understand your feedstock and how to handle it
- Identify your operator burden, resources, and gaps
- Make an installation and maintenance plan

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How to Evaluate Your Site for Metal 3D Printing

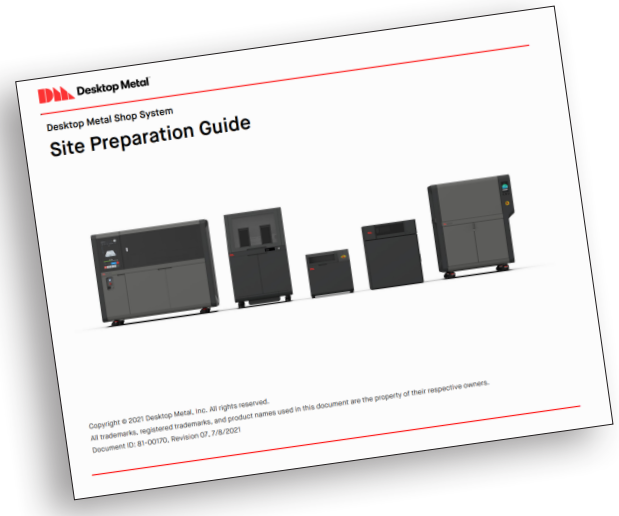
Determine your equipment and space needs

Metal additive manufacturing comes in a variety of sizes, from desktop printers to mass-production systems. The exact size of the printer you're looking at can be determined from the spec sheet and it's generally recommended to have about 3 ft / 1 m clearance around the machine for operation and maintenance. Entry level equipment requires as little as 400 ft^2 / 37 m^2 and the Desktop Metal **Studio System™** or Desktop Metal **Shop System™** only require a minimum ceiling height of 10 ft / 3 m, whereas the **Production System™ P-50** needs at least 2,652 ft^2 / 246 m^2 at 16 ft / 4.9 m tall.

Aside from the print unit, the type of technology you choose to adopt will also affect how much/what peripheral equipment will be needed in your metal 3D printing set up. The **Studio System** requires only a tabletop printer and a freestanding furnace for most materials. The **Shop System** handles loose powder, so requires additional pieces of equipment like a depowder station and drying oven, and accessories like a vacuum. Laser-based technologies may also require pieces of equipment like filter stations and external chillers. All of this is essential to your 3D printing operations, but often overlooked.

Post-processing equipment is another consideration beyond just your 3D printer, and understanding the workflow of the metal 3D printing technology you're investigating will determine which equipment you need. Many customers use the near-net shape parts straight out of the Desktop Metal Furnace as-is. Others have a tumbler or grit blaster to smooth the surface finish. 3D printed metals hold up to traditional post processing techniques, however, machining is only needed for tight tolerance specifications. Laser powder bed fusion, in contrast, uses metal support structures welded to the build plate that must be removed from the part after the print, typically requiring additional equipment like a bandsaw or machining center.

Desktop Metal sells easy-to-adopt metal 3D printing packages that include everything needed to get started, from printer to furnace. Our site readiness guides help customers ensure their layout is functional to get up and running fast.



Site prep guides for each machine are available on the Desktop Metal Knowledge Base to ensure customers are ready for installation of their metal 3D printer

Know your facility requirements

It should come as no surprise that the type of technology you adopt will also affect what utilities or facility requirements you might face. To ensure the accuracy of any system, a level, contamination- and vibration-free environment is ideal. Vibrations less than or equal to specifications for “office” in ISO 19137 is a standard we often use for our binder jetting systems.

The **Studio System** is designed to operate safely in any studio, lab, or classroom space without extensive upgrade requirements to fire-suppression systems or climate-controlled material storage spaces. The 214 lb/97 kg printer requires standard 100-120V/220-240V power and an optional ethernet connection, but not much more is required for successful metal 3D printing operations— even standard ABC dry chemical fire extinguishers are acceptable to use with the system.

Binder jetting systems that operate with loose powder require more facility considerations, such as the need for Class D fire extinguishers and tighter operating ranges for controlled temperature and humidity, mainly to keep the powder material performance optimized and flowable. Humidity should ideally be kept around 40% and operating temperatures between 65°-77°F / 18°-25°C. Our entry level binder jetting machines, like the **Shop System** and **InnoventX**, require only standard 100-120V/220-240V power. The Shop System’s humidifier requires deionized water while pneumatic vacuum will also require compressed air.

The **Desktop Metal Furnace**, used with Desktop Metal entry-level machines like the **Studio System** and **Shop System**, does require a dedicated 3-phase 208VAC circuit, a processing gas cylinder, and external ventilation. All effluent from the exhaust line must vent to the exterior of the building. Which processing gas is used will depend on the material being processed. One option, argon, for example, may create a risk of asphyxiation if large quantities are released into a closed room. Proper handling of compressed gases is also a consideration for powder bed fusion systems that operate in inert atmospheres and require gas to flood the chamber for each build. Facilities operating laser equipment are often equipped with a low oxygen alarm and sufficient air conditioning and ventilation capacity to clear the largest conceivable gas leak.

Understand your feedstock and how to handle it

If adopting the Bound Metal Deposition technology of the Desktop Metal **Studio System**, material handling requirements are very simple. Metal powder is pre-bound with binder into rods and shipped in vacuum packs. These sealed containers have a long shelf life without special storage requirements beyond being held between 41°-77°F / 5°C-25°C. Once needed, the rods are simply placed into hot-swappable cartridges without PPE requirements for handling.

This pre-bound material strategy also has the added benefit of making material changeovers much more streamlined than systems where powder flows throughout the machine, requiring extensive cleaning or part exchange to avoid cross-contamination between builds.

Left, pre-bound rods of metal and binder for the Desktop Metal Studio System, seen at right with a variety of material cartridges that make for easy machine operation and material changeover.

Powder bed additive manufacturing systems, including binder jetting technology (BJT), laser powder bed fusion (L-PBF), or electron beam melting (EBM), use, as the name indicates, loose metal powder to create complex shapes and come with additional safety measures. Any powder material has a high surface area to volume ratio that creates a quality risk because powders can absorb moisture, oxygen and other elements present in the air, affecting printability and the final material properties of the part. Metal powder also requires extra caution when being handled because of the risk of ignition or explosion— as a general practice, safety comes from people and procedures, not PPE.

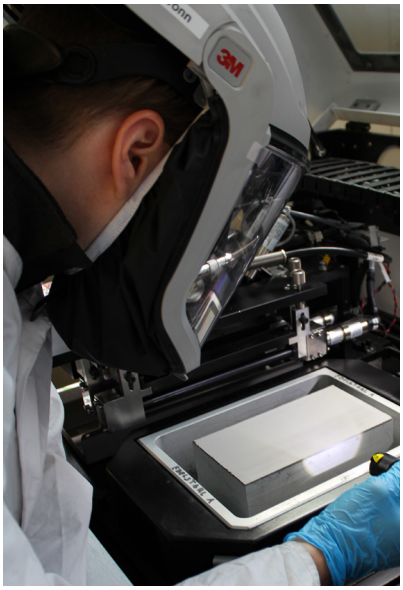
Binder jetting, deployed on the Desktop Metal **Shop System**, **X-Series**, and **Production Series** machines, is compatible with powders from traditional powder metallurgy processes, while

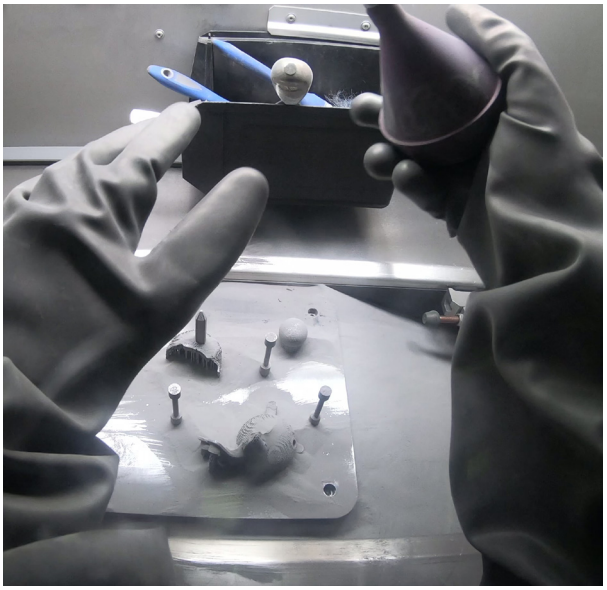
laser-based systems use much finer, and often more expensive, metal powders, typically with particle sizes ranging from 10 to 50 microns. The finer powders of L-PBF systems also mean that powder handling is more difficult in terms of operator safety. While PPE, such as gloves and a respirator, is required when handling any loose metal powder, the larger particle size of binder jetting powders means that they are less likely to become airborne, reducing the risk of inhalation or explosion. However, safe handling procedures are still required, for example ensuring that powder-rated vacuum cleaners are reliably connected to the printer's safety bonding terminal at all times during cleaning.

Metal powders should be stored in a dry, temperature controlled (68°-77°F / 20°- 25°C) location to prevent moisture absorption and oxidation. Unused material should be stored in sealed, grounded, and non-sparking containers labeled with the powder type, lot number, and expiration date. If reactive powders are being used, an explosion cabinet or dedicated storage room equipped with appropriate fire suppression systems may be required.

Because metal powders can be prone to static buildup, some facilities require the use of static dissipative flooring mats, ESD shoes, or grounded equipment to reduce the risk of electrostatic discharge. Additionally, adhesive mats placed at the entry and exit of rooms where metal powder is processed help prevent the unintended spread of metal powder to other areas of the facility.

Properly storing and handling powders helps maintain and optimize their performance and companies should always consult and follow local regulations and guidelines for the storage and disposal of metal powder waste and unused materials.





As a general practice, safety comes from people and procedures, however using systems with loose powder require appropriate PPE and equipment such as depowdering stations or handling gloveboxes.

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How to Evaluate Your Site for Metal 3D Printing

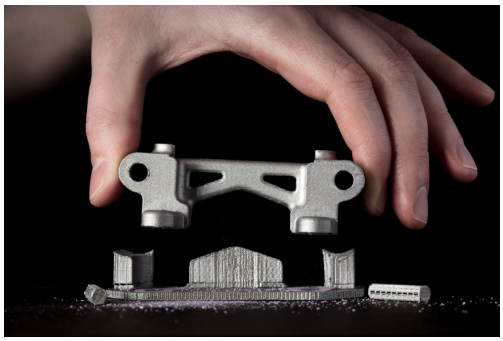
Identify your operator burden, resources, and gaps

A manufacturing machine tool is only as effective as the crew that operates it, and 3D printers are no different. Adopting metal 3D printing can require a team with a diverse range of skill sets, from design and engineering to materials science and safety, or it can be as easy to adopt as any plastic FDM machine widely available on the market.

Most importantly, to gain the most advantage out of the 3D printing process, design for additive manufacturing (DfAM) skills are essential. DfAM is a growing field, actively supported by many CAD vendors and increasingly offered by schools and universities. The Desktop Metal team of expert Application Engineers also offer trainings and services in this field to full exploit the new design freedoms enabled by digital production. By understanding the limitations of traditional methods, thinking additively can unleash new innovations not possible with conventional design for manufacturability mindsets.

For everyday operation, the basic operator roles in additive manufacturing include file preparation, print initiation and monitoring, post processing, and machine resetting.

The **Studio System** is designed as a plug-and-play metal 3D printing solution that requires no dedicated operators and only minimal training – ideal for environments like universities where students can run the entire process or in-house prototype shops that may be accessed by many colleagues. Design files are uploaded into Desktop Metal **Live Studio™** software for auto orientation, support generation, and printing parameter assignment. With easy-to-change material cartridges, a software-controlled process, and expert metallurgy built-in to the Desktop Metal Furnace, the Studio System can be easily operated like a tool without hours of training or adjustments needed. After one build is complete, the build sheet is replaced and the Studio System is ready for the next print.



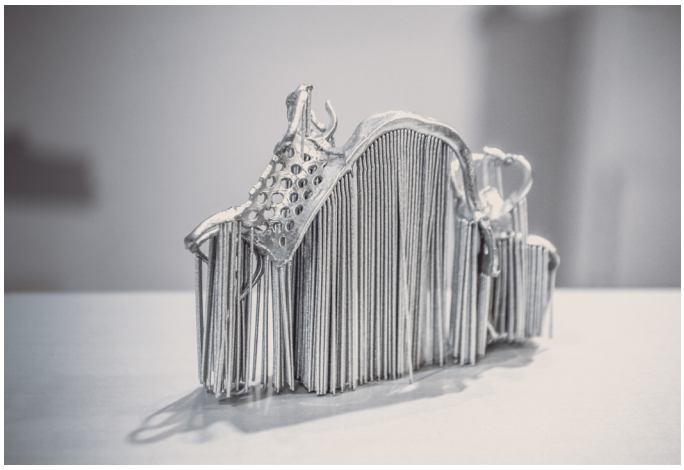
Supports printed on the Studio System break away by hand after sintering, allowing for easy post-processing of Bound Metal Deposition prints.

The **Shop System** was developed to offer the same easy-to-adopt approach with the more scalable binder jetting technology. While more training is required to ensure safe material handling procedures are followed, the same software guided workflows and integrated metallurgical optimization have made the Shop System the world's best-selling metal binder jetting machine. Desktop Metal's **Live Build™ MFG** software enables build success with automatic nesting, support generation, and slicing in a simple-to-use platform where users can configure part-specific settings. After a print is complete the build box is removed from the printer and taken to the oven for crosslinking. The chamber is cleaned, consumable and waste container levels checked, and the printer is ready to run again. Keeping the printheads hydrated will be an important routine maintenance role for a binder jetting system operator.

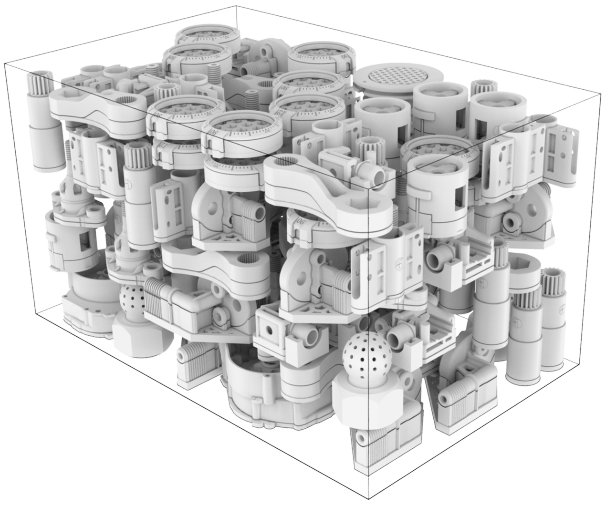
Laser-based systems, in contrast, can require more extensive machine resetting procedures that often take an experienced operator several hours to complete, including laser calibration and strict lens cleaning procedures or changing filters that contain potentially hazardous fine particles that need to be flooded to be rendered nonreactive.

Post-processing is where sinter- and laser-based metal 3D printing systems will differ most in adoption. For binder jetting, depowdering a bed to remove green parts, curing, and sintering are all core to the process. Many new adopters of the technology comment on how easy the 3D printing and curing steps are, with the most manual labor required for depowdering and the most trepidation around sintering. Desktop Metal's **Live Sinter™** software makes sintering easy by predicting and correcting for shrinkage and distortion in part designs in as little as 20 minutes, delivering sinter-ready, printable geometries. The complete package offers a solution for easy adoption in any manufacturing environment.

Because of the thermal stresses induced on a part built through the rapid heating and cooling during a laser powder bed fusion process, parts must be destressed before support removal. Unlike binder jetting, where unbound powder supports the components being built, laser powder bed fusion requires support structures welded to the build plate to anchor the part and help dissipate heat during the process. The finished component must then be removed from the build plate and the metal supports removed from the component.



Unlike laser powder bed fusion processes that require support structures welded to the build plate to anchor the part and help dissipate heat during the process, as seen left, binder jetting uses unbound powder to support the components being built, allowing entire build volumes to be nested with parts, as seen below, without the need for supports or their removal in post-processing.



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How to Evaluate Your Site for Metal 3D Printing

Make an installation and maintenance plan

Once you've made the decision to adopt, it's time to get your printer installed and to start your additive manufacturing journey. Desktop Metal offers a Knowledge Base of articles including site prep guides, installation surveys, and best practice articles.

For most systems new adopters find about a week of install time will be necessary, with the installation of the furnace often the most time consuming because of the required drying cycle that must be run. On-site operator training is provided to ensure the on-site team understands that system functionality. Additional Advanced Training is available to support production on-boarding and workflow optimization.

Because laser-based systems typically have more operating parameters, these systems can require more extensive training to understand the intercorrelation of parameters and effects on overall builds.

Once your system is installed, regular maintenance ensures optimal performance and prolongs the equipment lifetime. Perform maintenance according to the designated schedule and safety guidelines outlined for your machine.

The Studio System requires only light maintenance, mostly cleaning and purging as needed or when material changes occur. Similarly the Desktop Metal furnace requires cleaning and top offs of consumables like pump oil and filters as needed. Several maintenance operations are initiated from the touchscreen displays.

As mentioned above, the printhead is the workhorse of binder jetting machines like the Shop System. To help maintain the life of the printhead, the Shop System printer automatically performs maintenance cycles and manual steps, such as ensuring water is supplied to the humidifier and keeping the printer door closed when idle, help keep the printhead hydrated. To determine the health of the printhead, a test page can be printed and evaluated for defects.

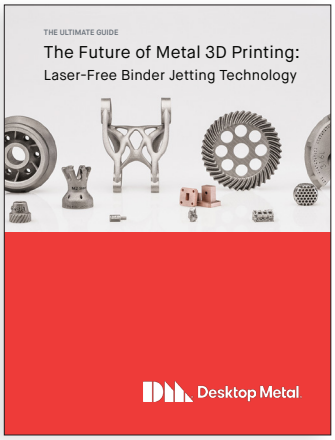
Service packages offer seamless support options beyond your equipment's original warranty. Services like annual preventative maintenance and deep cleanings ensure systems are cleansed and wear parts like filters and seals are replaced. **DM Care** packages include email and phone support from our expert Customer Service team.

Conclusion

Adopting metal 3D printing can offer a range of benefits for manufacturers, from increased design freedom and efficiency to reduced material waste and cost. However, successfully integrating this technology requires careful evaluation of your facility needs, including space, power supply, ventilation, and safety requirements. It is important to work with experienced professionals to help you navigate the process. The team at Desktop Metal, from our component-optimizing Applications Engineers to our support-driven Customer Service team, is available to customers at every stage of metal 3D printing adoption.

Learn More

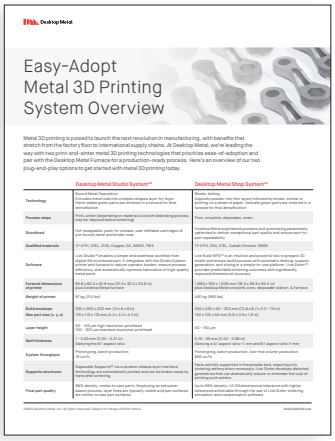
Metal 3D Printing Resources



Ultimate Guide to Metal Binder Jetting

Take a deep dive into this transformative 3D printing process with the global leaders in binder jetting technology. Our guide contains a comprehensive overview of what makes high-speed binder jetting truly special and an advantageous approach in the metal 3D printing marketspace.

TeamDM.com/BinderJetGuide



Studio System vs Shop System Overview

Looking for more information on easy-to-adopt metal 3D printing systems? Download this quick guide for an overview comparison of the Bound Metal Deposition technology of the Desktop Metal Studio System and binder jetting with the Desktop Metal Shop System.

TeamDM.com/StudioVsShop

Additive Manufacturing 2.0

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Printer platforms

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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 DesktopMetal.com