

THE ***ADDITIVE*** ***MANUFACTURING*** REPORT

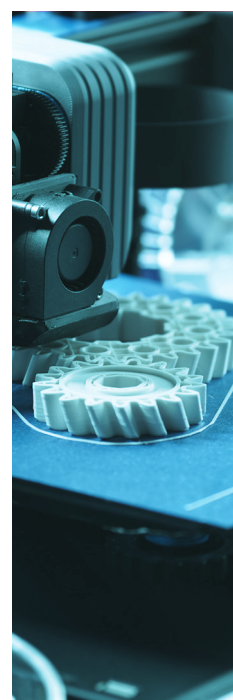
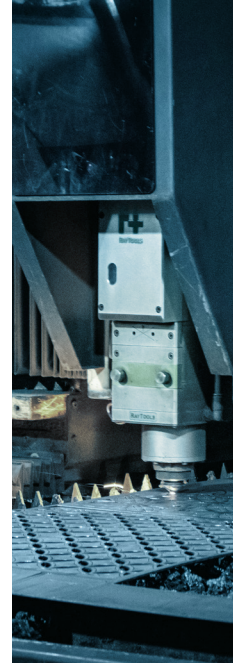
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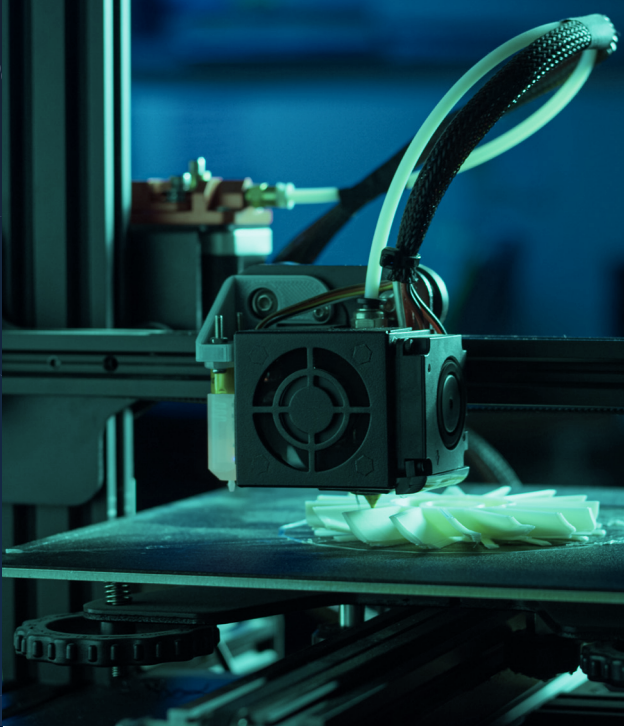
Part of *The State of
Manufacturing Pillar Reports*
by AMT – The Association For
Manufacturing Technology

THE ASSOCIATION FOR
 **MANUFACTURING
TECHNOLOGY**

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Introduction

Additive manufacturing (AM) has been part of the industrial conversation for decades – often framed as a next-generation technology poised to replace traditional manufacturing. That outcome has clearly not materialized. Traditional processes such as machining, casting, and molding remain the backbone of industrial production and will likely remain so for the foreseeable future.

Yet interest in AM has not disappeared. In fact, it is growing again – this time driven less by technological optimism and more by practical manufacturing pressures. Supply chain disruptions, reshoring initiatives, workforce shortages, and increasing demand for production flexibility are forcing companies to reevaluate how and where things are made. In many of these situations, AM offers capabilities that traditional processes cannot easily match.

Like any manufacturing process, AM is best suited to particular applications. Applying it in the wrong situations can create economic and operational inefficiencies, much like trying to drive a screw with a hammer. Recognizing where additive manufacturing can provide the most value is therefore critical to justifying its use, even if it ultimately serves only as a supplementary capability.

Use the scorecard below as a quick check to determine whether additive manufacturing may be relevant to your operation.

AM Evaluation Scorecard			
Category	0	1	2
Supply Instability	None	Occasional	Chronic
Tooling Burden	Amortized	Aging	Obsolete
Quality Issues	Stable	Moderate Defects	Chronic Defects
Design Constraints	None	Minor	Significant
Inventory Burden	Stable	Moderate	High
8+ Points → AM feasibility review recommended			

If your score is **8 or higher**, AM may warrant further evaluation. Even if your score is lower, the following sections provide the context and tools needed to determine whether AM could play a useful role in your production strategy.

This report will address:

- ◆ Why interest in additive manufacturing is increasing in today's industrial environment
- ◆ The conditions under which additive manufacturing can provide meaningful value
- ◆ Where traditional manufacturing continues to hold clear advantages
- ◆ The operational and economic factors organizations should evaluate before adopting additive manufacturing

Why Additive Manufacturing Is More Important Than Ever

The manufacturing environment is changing. Supply chain disruptions, geopolitical uncertainty, and increasing demand for production flexibility are forcing companies to rethink how and where parts are produced. At the same time, the U.S. government is investing heavily in advanced manufacturing capabilities to strengthen domestic production and industrial resilience.

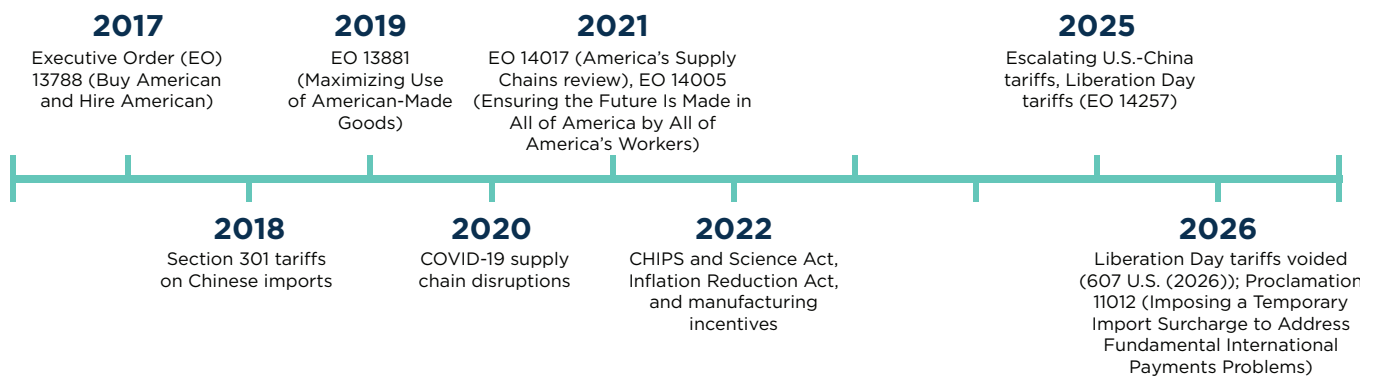
Together, these pressures are prompting organizations to reassess their manufacturing strategies and reconsider additive manufacturing.

Reshoring and Supply Chain Resilience

For decades, U.S. manufacturing supply chains were shaped by globalization and cost optimization. Many industries shifted production overseas to take advantage of lower labor costs and large-scale manufacturing ecosystems abroad. While this approach reduced costs and increased production efficiency, it also led to a gradual erosion of domestic manufacturing capacity in certain sectors and increased reliance on complex global supply networks.

Recent disruptions have exposed the vulnerabilities of these systems. Events such as the COVID-19 pandemic, shipping bottlenecks, geopolitical tensions, and trade disputes highlighted how quickly global supply chains can become constrained. In response, policymakers, industrial leaders, and manufacturers across the United States have begun placing greater emphasis on supply chain resilience and domestic production capability.

This shift has resulted in a growing number of U.S. policy initiatives and industrial investments aimed at strengthening domestic manufacturing capacity and reducing dependence on overseas suppliers.¹⁻⁹



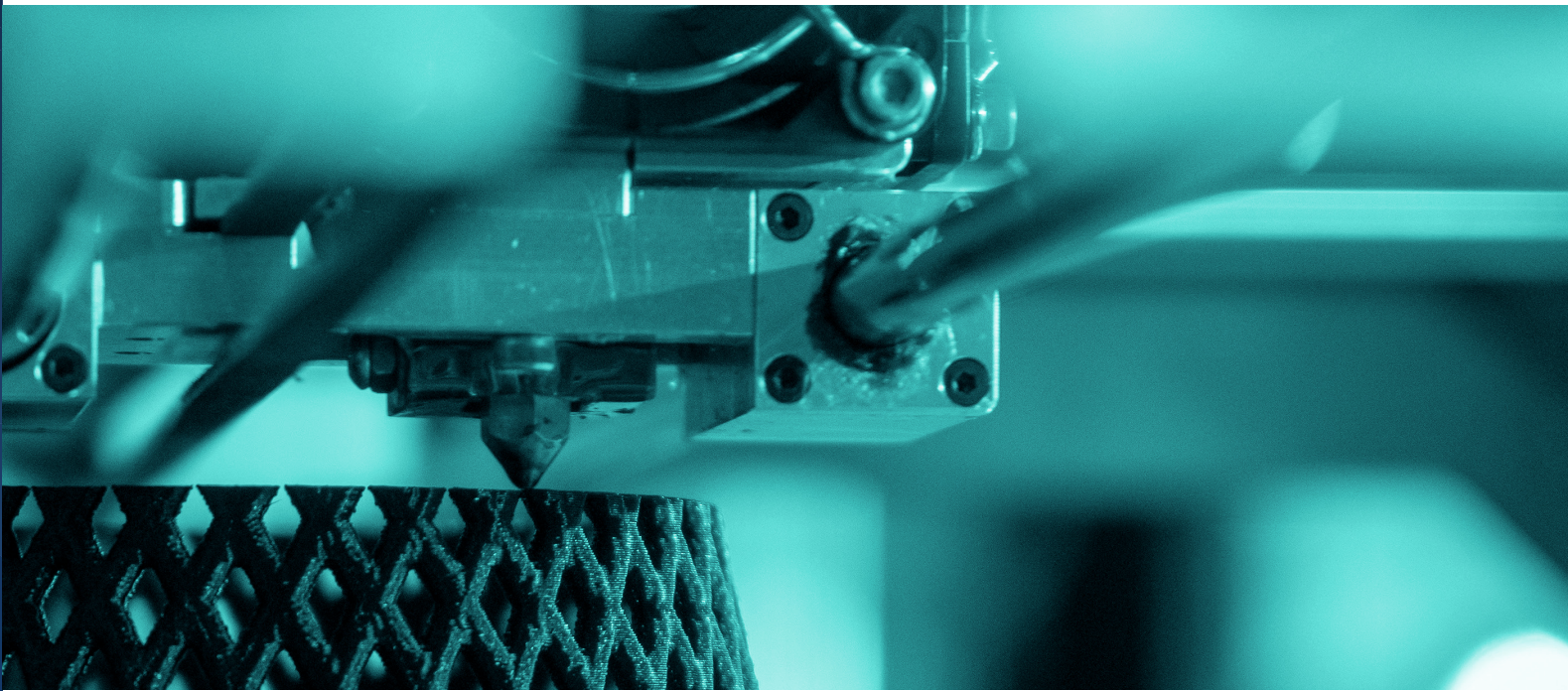
Over the past several years, federal policies – such as tariffs on strategic imports, supply chain executive orders, and legislation like the CHIPS and Science Act – have sought to encourage domestic production in critical industries.⁹ These initiatives reflect a broader recognition that manufacturing capacity is also a strategic one tied to national security, economic stability, and technological leadership.

At the same time, decades of offshoring have left gaps in parts of the U.S. manufacturing ecosystem.¹⁰ In some sectors, key suppliers, specialized tooling capabilities, and production capacity have migrated overseas. For example, the number of U.S. metal casting facilities has declined by 72% since 1955, from 6,150 to 1,725.¹¹

As manufacturers attempt to reshore production, they often encounter limited domestic capacity and workforce shortages, which contribute to longer lead times and supplier bottlenecks. Rebuilding this industrial base will require significant time and investment.

Parts can be produced directly from digital designs without the need for dedicated tooling, allowing production to be deployed more quickly and in a wider range of locations, including closer to the point of need. This reduces reliance on specialized tooling infrastructure and enables manufacturers to establish production with relatively limited up-front setup.

While AM rarely replaces large-scale traditional production, it can provide organizations with greater flexibility to produce certain parts domestically, reduce dependence on long and fragile supply chains, and respond more quickly to disruptions.



Key Takeaway

Efforts to rebuild domestic manufacturing capacity are increasing interest in production technologies, such as additive manufacturing, that can operate with less tooling infrastructure and greater geographic flexibility.

Defense Investment and Industrial Base Modernization

In addition to broader reshoring efforts, the U.S. Department of Defense (DOD) has been actively investing in advanced manufacturing technologies, including additive manufacturing, as part of a broader effort to strengthen the defense industrial base. These investments are intended to address long-standing supply chain vulnerabilities, modernize production capabilities, and ensure reliable access to critical components. The DOD's Additive Manufacturing Strategy specifically identifies AM as a technology that can improve materiel readiness, modernize defense systems, and strengthen the defense industrial base.¹²

Many defense systems remain in service for decades and rely on specialized parts produced by small or highly specialized suppliers. Over time, as suppliers go out of business, key employees retire, and original tooling goes missing, portions of the defense supply chain develop bottlenecks. Additionally, addressing supply needs at the point of need in a timely manner, such as during a military operation, becomes even more infeasible.

In response, the DOD has begun supporting AM by both creating demand and addressing systemic barriers.

Creating Demand Through Capital Investment and Procurement

Federal investment is playing a significant role in accelerating additive manufacturing adoption within the defense industrial base. Government contracts have been awarded for applications leveraging AM, including propulsion systems, unmanned aircraft, satellites, supply chain capacity, and research infrastructure.¹³⁻¹⁷

Programs such as the AM Forward initiative and the Critical Technologies SBIC fund are designed to expand the supplier base and encourage adoption among small and mid-sized manufacturers.^{18,19} By combining government procurement demand with private investment, these programs aim to strengthen domestic manufacturing capacity and accelerate the commercialization of AM technologies.



Lowering Barriers to Adoption

Despite its potential, AM adoption has historically been slowed by several structural challenges, particularly in regulated industries, such as aerospace and defense. Issues like material qualification, part certification, and secure management of digital technical data require coordinated standards, testing infrastructure, and validation processes that are difficult for individual manufacturers to develop independently.

The Department of Defense is uniquely positioned to help address these barriers through collaborative programs and public-private partnerships designed to establish qualification pathways, develop shared testing infrastructure, and standardize best practices for AM across the defense industrial base.

Key initiatives include coordinating AM activity across military branches, developing standardized qualification frameworks for AM components, and accelerating the testing and certification of advanced materials. Programs such as the Joint Additive Manufacturing Working Group (JAMWG) focus on developing consistent qualification approaches, while partnerships like the FAST (Future Alloy Study & Testing) Center support rapid alloy development and material validation.^{20,21}

In parallel, organizations such as America Makes and ASTRO America help expand the broader industrial ecosystem by supporting research, workforce development, and collaboration between government, industry, and academia.^{22,23}

Together, these efforts aim to reduce technical and regulatory uncertainty, making it easier for manufacturers to integrate AM into defense and, in turn, commercial supply chains.

Key Takeaway

Defense investment is helping accelerate additive manufacturing adoption by both creating demand and reducing systemic barriers such as qualification standards and testing infrastructure.

Section Takeaway

Reshoring pressures and supply chain disruptions are exposing gaps in U.S. manufacturing capacity. At the same time, the Department of Defense is accelerating AM through investment, procurement, and standards development. Together, these forces are increasing interest in AM as a practical tool for improving supply chain resilience and domestic production flexibility.

Additive Manufacturing Processes Overview

For organizations grounded in casting, machining, molding, stamping, or welding, additive manufacturing can sound like a single category of equipment, a different kind of machine tool.

It is not.

AM is a family of fundamentally different process technologies. AMT – The Association For Manufacturing Technology recognizes 16 distinct additive manufacturing processes, as well as hybrid systems that combine AM with traditional production technologies. These processes vary in:

- ◆ The form in which material is introduced
- ◆ How material is consolidated or bonded
- ◆ The amount and type of energy applied
- ◆ The thermal environment
- ◆ The resulting microstructure and material properties
- ◆ The level of post-processing required

In many cases, AM processes differ from one another almost as much as casting differs from CNC machining. Selecting “additive manufacturing” is not the decision. Selecting the appropriate process family and understanding its implications is.

Traditional process families such as casting, machining, molding, and welding represent decades, often centuries, of industrial maturity. In AM, process development is still evolving, and new variations continue to emerge. Two systems that both fall under “metal AM” may operate in entirely different thermal conditions, require different facility controls, and produce different microstructures.

For organizations evaluating AM, recognizing this internal diversity is essential. A successful implementation depends less on adopting “additive” broadly and more on aligning a specific process physics with a specific application.

The purpose of this section is to provide a structured way to understand how they differ and why those differences matter. For a detailed overview of all AMT-recognized categories, please reach out to AMT Research Services at research@AMTonline.org.

Bridging Traditional Manufacturing and Additive Manufacturing

Before examining additive process families more closely, it is helpful to clarify how additive manufacturing differs structurally from traditional manufacturing.

Traditional Manufacturing	Additive Manufacturing
Most traditional processes are: ◆ Tooling-driven ◆ Constrained by tool access, mold geometry, or forming capability ◆ Built from bulk material (billet, casting, molding feedstock) ◆ Dependent on material properties established before shaping ◆ Highly repeatable once tooled and dialed in ◆ Cost-efficient at scale ◆ Expensive to modify when geometry changes Risk is typically concentrated in tooling investment and setup. Once validated, the process produces consistent results with limited parameter variability.	In contrast, AM is: ◆ Design- and process-driven ◆ Built layer by layer ◆ Dependent on how material is deposited and consolidated ◆ Sensitive to process parameters ◆ Flexible for geometry changes ◆ More complex in qualification and repeatability ◆ Its geometry is defined by a digital file, not tooling AM shifts complexity away from tooling and toward process control, software, and material behavior during consolidation. Properties are influenced not only by material chemistry but by build orientation, scan strategy, energy input, and thermal management.

The shift also changes where risk resides:

- ◆ Traditional manufacturing concentrates risk in tooling and upfront capital.
- ◆ AM concentrates risk in process stability, parameter control, and qualification effort.

The relevant question is not whether AM can produce a given geometry, but whether your organization can manage the associated variability, validation requirements, and integration complexity that comes with it. These considerations become clearer when examining AM at the process level, where each technology offers distinct strengths and production constraints.

Additive Manufacturing Processes Overview

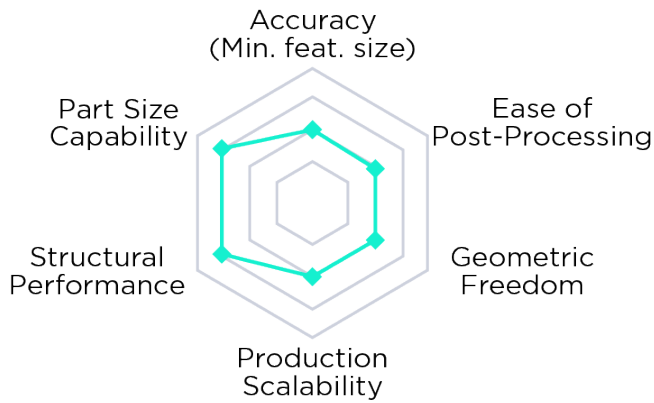
Process	Material Class/State	Support Requirement	Post-Processing Burden	Industrial Context/Deployment	Additive Processes in Traditional Manufacturing Terms
Alternate Sinter-Based (SINT)	• Metal • Powder + Mold	Mold-supported	◆◆◆◆◆	Emerging production approach that combines additive patterning with powder metallurgy sintering. Primarily targeted at metal component production where shrinkage can be managed through design compensation.	Resembles: Powder metallurgy Consolidation occurs primarily during sintering rather than full melting during build.
Binder Jetting (BJ)	• Metal, Ceramic • Powder	Powder-supported	◆◆◆◆◆	Increasingly adopted for batch metal production where sintering furnaces provide final consolidation. Often compared to metal injection molding without the mold tooling.	Resembles: Metal injection molding (MIM) without the mold Produces a green part that requires debinding and sintering. Final properties are achieved in the furnace, and shrinkage must be managed during design.
Cold Spray (CS)	• Metal • Powder	Minimal	◆◆	Primarily used for repair, coating, and structural buildup rather than complex geometry creation. Common in aerospace maintenance and industrial restoration.	Resembles: Thermal spray coating (without melting) High-velocity particles bond without full melting, enabling repair and buildup applications.
Digital Light Processing (DLP)	• Photopolymer • Liquid Resin	Required structures	◆◆	Widely used for high-resolution polymer parts in prototyping, dental, and small component production. Known for excellent surface finish and fine feature resolution.	Resembles: Tool-less molding chemistry Liquid photopolymers are cured into solid form through light exposure.
Directed Energy Deposition (DED)	• Metal • Wire/Powder	Process-dependent	◆◆◆◆	Common for repair, remanufacturing, and large near-net-shape metal components. Often integrated with CNC systems to enable hybrid manufacturing workflows.	Resembles: Robotic welding + CNC machining Material is deposited and melted using focused energy, often building near-net shapes that require finishing.
Electrodeposition (ED)	• Metal • Electrolyte	None	◆◆	Emerging electrochemical additive method used for specialized applications requiring precise metal deposition. Still largely limited to research and niche industrial use.	Resembles: Electroplating Material is deposited through electrochemical processes.
Electron Beam Powder Bed Fusion (EBPBF)	• Metal • Powder	Required structures	◆◆◆◆	Used for high-performance metal components, particularly titanium alloys in aerospace and medical implants. Vacuum processing enables stable metallurgy for reactive materials.	Resembles: Vacuum casting + powder metallurgy Fully melts powder in a vacuum environment, combining high-temperature metallurgical processing with post-build machining.
Electrophotographic Deposition (EPD)	• Thermoplastic • Powder	None	◆◆	Adapts laser-printing style electrostatic powder imaging to AM. Designed for scalable polymer part production in industrial environments.	Resembles: Laser printing + thermoplastic powder fusion Powder is selectively patterned using electrostatic imaging, similar to two-dimensional laser printing, and then fused into solid layers.
Friction Energy Deposition (FED)	• Metal • Solid Feedstock	Minimal	◆◆	Solid-state metal deposition technology derived from friction welding principles. Used for structural buildup and repair where melting is undesirable.	Resembles: Friction welding or friction stir processing Material bonding occurs through frictional energy rather than full melting.
High-Speed Sintering (HSS)	• Thermoplastic • Powder	Powder-supported	◆◆	Industrial polymer production technology capable of producing thousands of parts in batch powder bed systems. Often compared to injection molding for moderate production volumes.	Resembles: Thermoplastic powder processing Polymer powders are thermally fused, producing functional thermoplastic components.
Hybrid Process (Hybrid)	• Metal, Polymer • Wire/Powder + CNC	Process-dependent	◆◆	Combines additive deposition with subtractive machining within a single machine platform. Enables near-net-shape fabrication with in-process finishing.	Resembles: Multi-axis machining center with integrated deposition Combines additive deposition and subtractive finishing within a single system.
Laser Powder Bed Fusion (LPBF)	• Metal • Powder	Required structures	◆◆◆◆	Widely used for high-performance metal components in aerospace, medical, and energy sectors. Produces dense parts with excellent mechanical properties but requires significant post-processing.	Resembles: Powder metallurgy + controlled-atmosphere processing + CNC finishing Operates with fine metal powders and selective melting. Like powder metallurgy, material behavior is central; unlike PM, geometry is created without compaction tooling and typically requires stress relief and machining.
Material Extrusion (ME – Bound Metal)	• Metal • Bound Metal	Required structures	◆◆◆◆◆	Uses metal powder embedded in a polymer binder that is later removed through debinding and sintering. Similar to metal injection molding but without tooling.	Resembles: Automated extrusion adapted for geometry creation Material is extruded through a nozzle and deposited layer by layer.
Material Extrusion (ME – Polymer)	• Thermoplastic • Filament/Pellet	Required structures	◆	One of the most widely deployed AM technologies for prototyping, tooling, and large polymer components. Systems range from desktop printers to large-format industrial machines.	Resembles: Automated extrusion adapted for geometry creation Material is extruded through a nozzle and deposited layer by layer.
Material Jetting (MJ)	• Photopolymer • Liquid Droplets	Required structures	◆◆	Produces high-resolution polymer parts with smooth surface finishes and multi-material capability. Primarily used in design validation and visual prototyping.	Resembles: Inkjet printing combined with polymer curing Droplets are deposited and cured with high precision.
Selective Laser Sintering (SLS)	• Thermoplastic • Powder	Powder-supported	◆◆	Mature polymer powder bed process used for functional prototyping and short-run production of thermoplastic components.	Resembles: Thermoplastic powder processing Polymer powders are thermally fused, producing functional thermoplastic components.
Sheet Lamination (SL)	• Metal, Composite • Sheet	None	◆◆	Bonds stacked sheets of material using ultrasonic welding or adhesives. Useful for embedding sensors or creating multi-material laminated structures.	Resembles: Laminated fabrication Layers of sheet material are bonded and shaped to create geometry.
Stereolithography (SLA)	• Photopolymer • Liquid Resin	Required structures	◆◆	One of the earliest AM processes and still widely used for high-accuracy prototypes and tooling masters requiring fine surface finish.	Resembles: Tool-less molding chemistry Liquid photopolymers are cured into solid form through light exposure.

Additive Manufacturing Processes Overview (Continued)

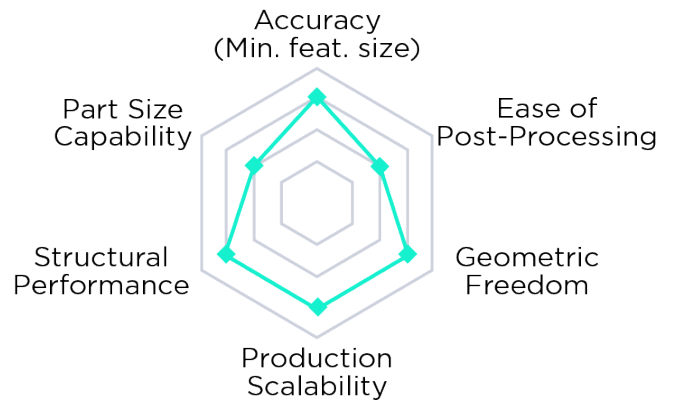
Design	Prototyping/ Engineering	Manufacturing Aid	Low Volume Production	Mid Volume Production	High Volume Production
					Alternate Sinter-Based
					Binder Jetting
					Cold Spray
					Digital Light Processing
					Directed Energy Deposition
					Electrodeposition
					Electron Beam Powder Bed Fusion
					Electrophotographic Deposition
					Friction Energy Deposition
					High-Speed Sintering
					Hybrid Systems
					Laser Powder Bed Fusion
					Material Extrusion (Bound Metal)
					Material Extrusion (Polymer)
					Material Jetting
					Selective Laser Sintering
					Sheet Lamination
					Stereolithography

Additive Manufacturing Processes Overview (Continued)

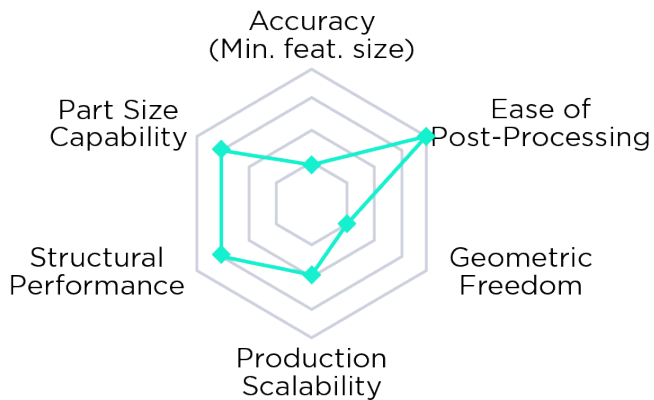
Alternate Sinter-Based (SINT)



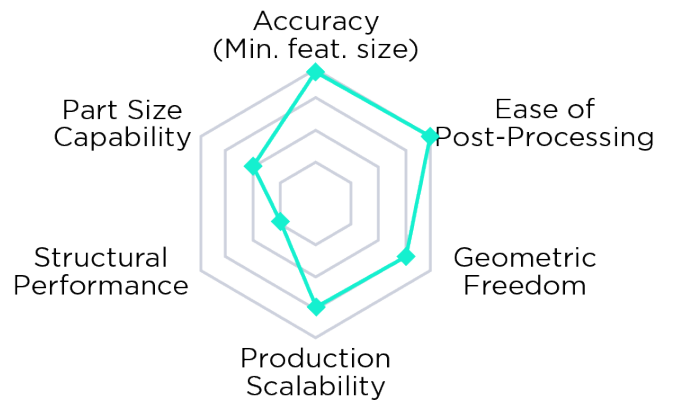
Binder Jetting (BJ)



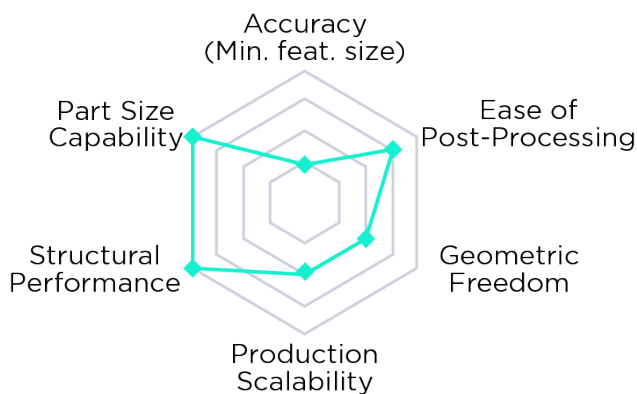
Cold Spray (CS)



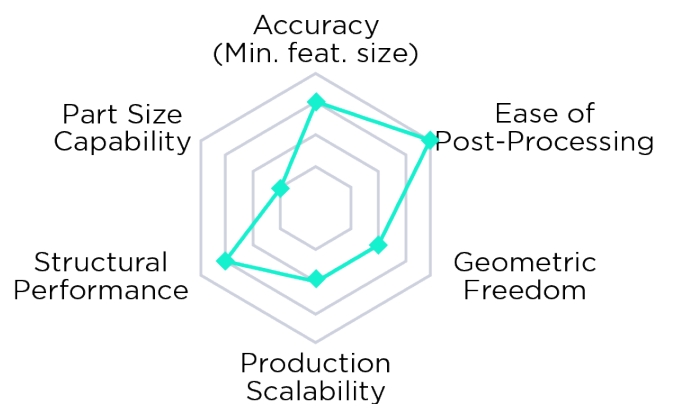
Digital Light Processing (DLP)



Directed Energy Deposition (DED)

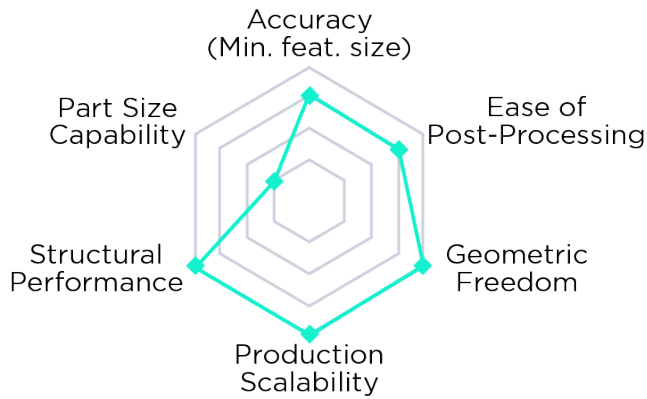


Electrodeposition (ED)

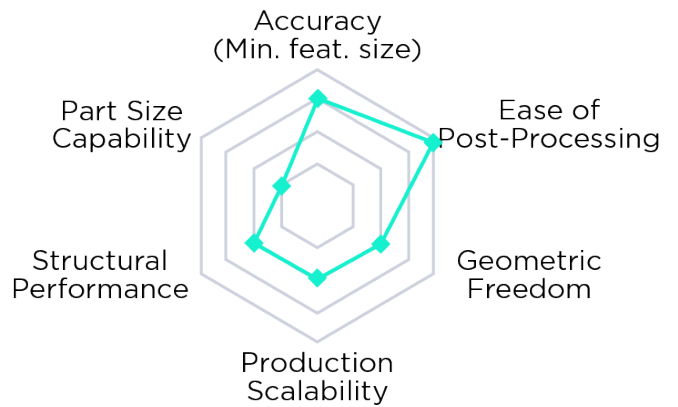


Additive Manufacturing Processes Overview (Continued)

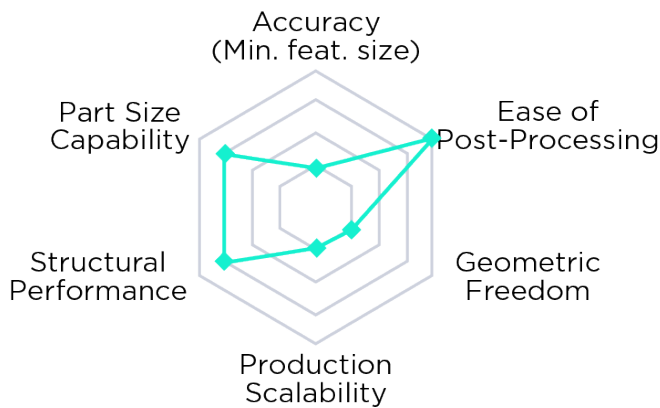
Electron Beam PBF (EBPBF)



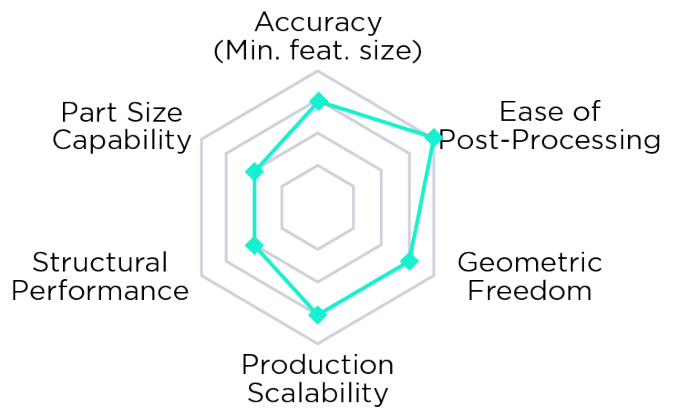
Electrophotographic Deposition (EPD)



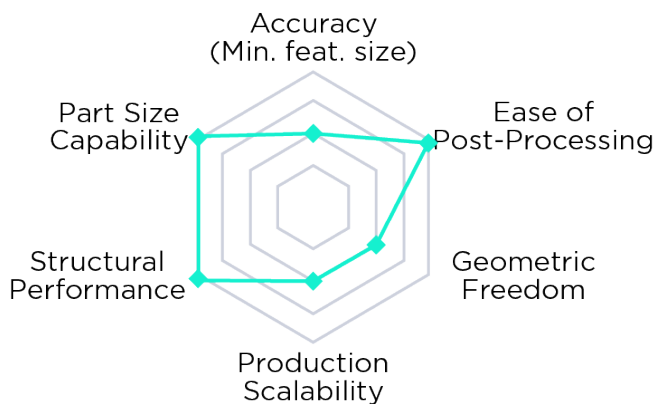
Friction Energy Deposition (FED)



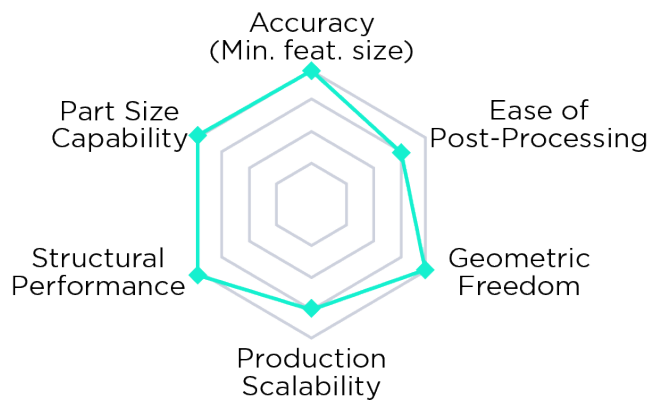
High Speed Sintering (HSS)



Hybrid Process

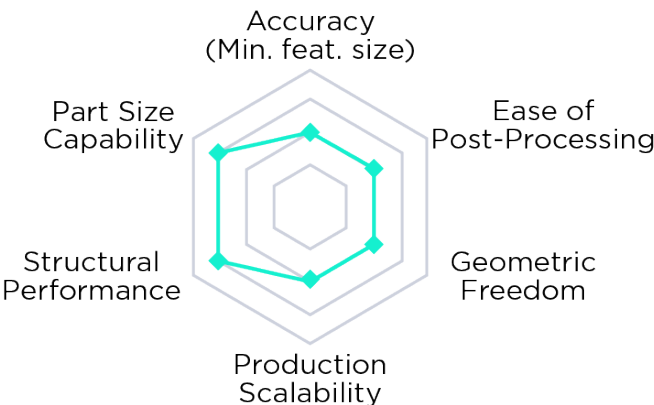


Laser Powder Bed Fusion (LPBF)

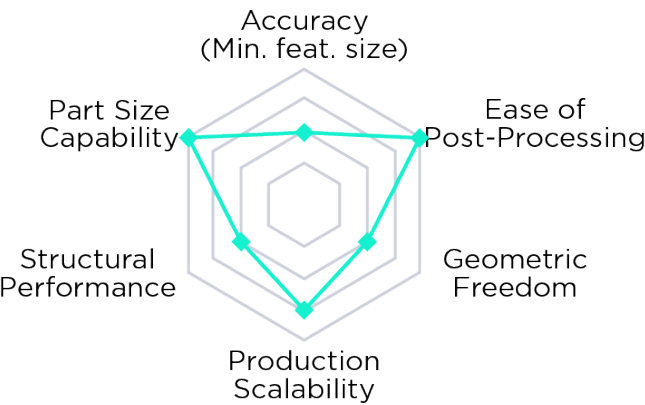


Additive Manufacturing Processes Overview (Continued)

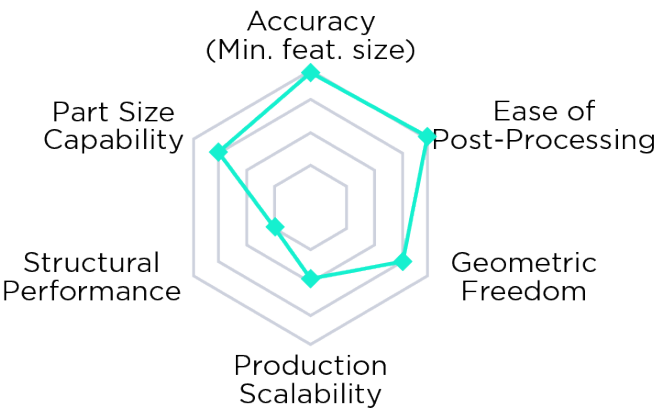
Material Extrusion (Bound Metal)



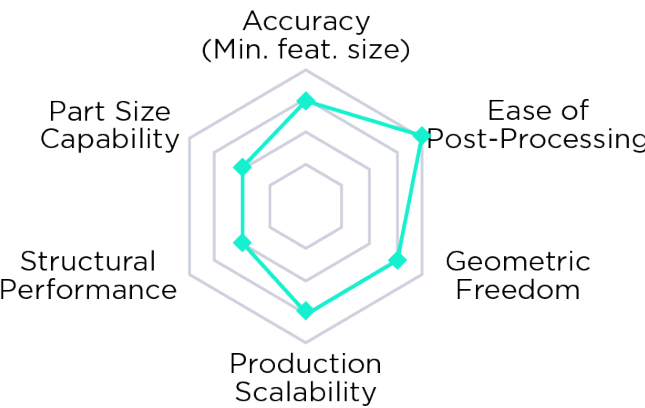
Material Extrusion (Polymer)



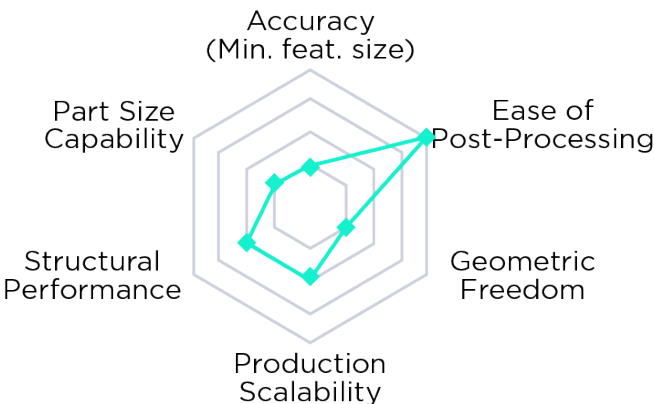
Material Jetting (MJ)



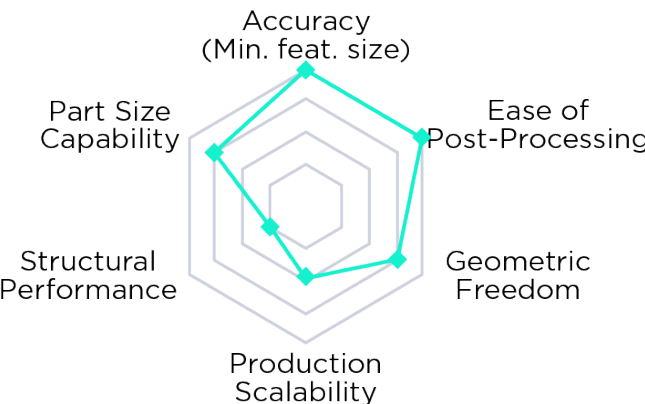
Selective Lasering Sintering (SLS)



Sheet Lamination (SL)



Stereolithography (SLA)



Additive Manufacturing Processes Overview (Continued)

Hybrid Processes

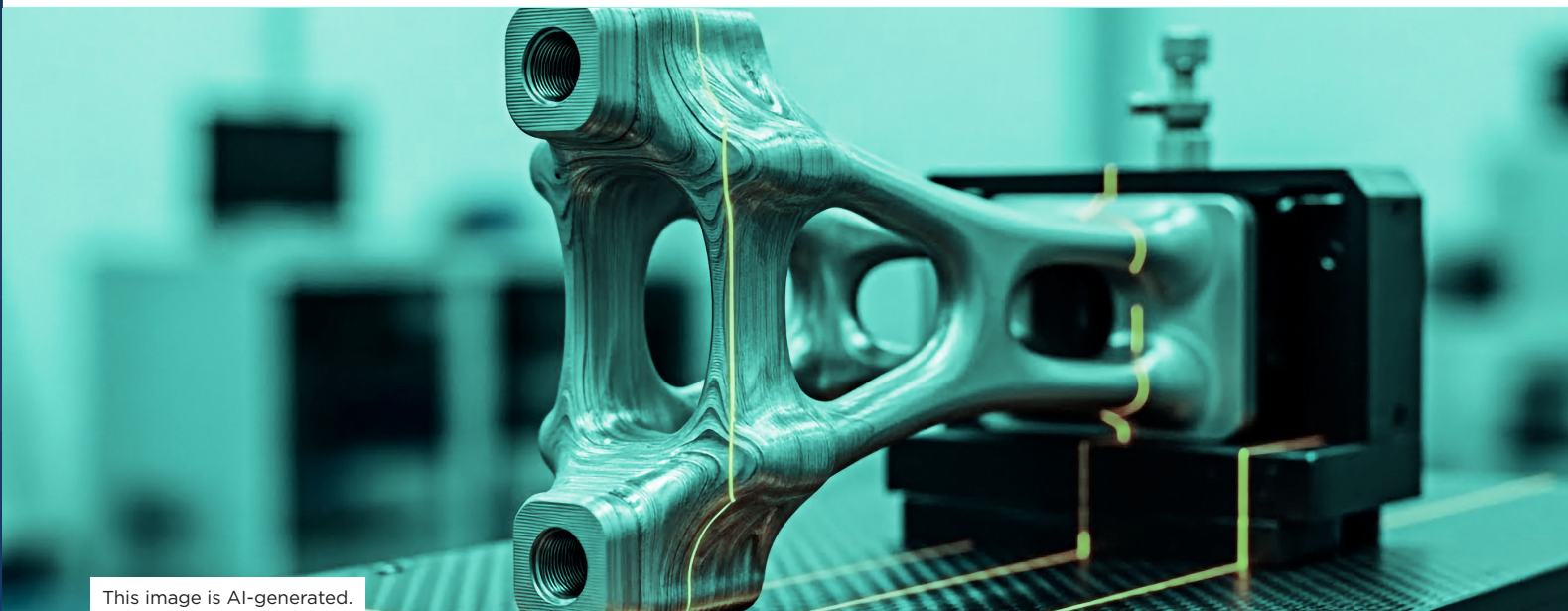
In practice, AM is often used in combination with traditional manufacturing processes rather than as a standalone production method. These integrated approaches are commonly referred to as hybrid manufacturing: a near-net-shape geometry is produced with AM; conventional processes – such as machining, grinding, or heat treatment – then finish critical features.

For example, a component may be printed with internal channels or complex geometry that would be difficult to machine and then returned to a CNC machine to finish precision surfaces, bores, or interfaces.

Hybrid approaches are also widely used for repair and remanufacturing. The worn areas of a part are rebuilt using additive deposition and then machined back to final dimensions.

Some machine tool builders have also begun integrating additive deposition capabilities directly into CNC machines, allowing material to be deposited and machined within the same system. These hybrid machines are often based on directed energy deposition (DED) or material extrusion (ME) combined with multi-axis machining.

Combining additive and machining into a single machine can reduce floor space requirements and material handling, since parts do not need to move between multiple systems. However, this configuration introduces trade-offs. Additive processes often run for extended periods, meaning that while the machine is performing deposition, it cannot be used for conventional machining operations. In high-utilization shops, this can limit the practical value of fully integrated hybrid machines compared with using separate additive and machining equipment.



Key Takeaway

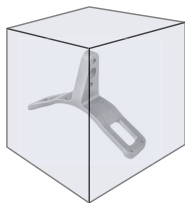
Selecting the right additive manufacturing process requires understanding how each technology's strengths and constraints align with a given application. While these differences guide process selection, they also introduce new design considerations and shift complexity toward process control, material properties, and qualification requirements.

Additional Considerations for Additive Manufacturing Integration

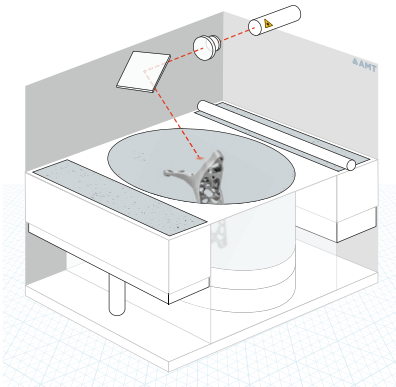
Tooling-Driven vs. Function-Driven Design

Most traditional manufacturing processes are tooling-driven. Parts must be designed around the limitations of cutting tools, mold geometry, or forming capability. In these systems, much of the engineering effort is concentrated in tooling development and process setup. Once the tooling and setup are validated, production tends to be stable and predictable.

Additive manufacturing approaches are function-driven, allowing engineers to focus more directly on functional requirements rather than tooling constraints. This design flexibility can enable geometries that would be difficult or impossible to produce using conventional manufacturing methods.



Subtractive Manufacturing



Additive Manufacturing



Part reproduced with permission from Materialise.³⁴

Process-Dependent Material Properties

In traditional manufacturing, material properties are mostly defined by the material itself. Engineers choose a material with known characteristics (strength, fatigue, hardness), and manufacturing processes shape that material into the final geometry. Once the material and processing steps are defined, part behavior is generally predictable and well understood.

AM introduces a closer interaction between material, design, and process. In many AM processes, the final properties of a part depend not only on the material but also on how the part is printed.

Factors that influence AM material properties include:

- ◆ Build orientation
- ◆ Scan strategy and toolpath
- ◆ Energy input (laser/electron beam parameters)
- ◆ Thermal gradients during the build
- ◆ Support structures and heat dissipation

These variables can affect microstructure, strength, fatigue performance, and anisotropy. As a result, two parts made from the same material may exhibit different properties if printed under different conditions.

This shifts where complexity and risk occur in production:

Traditional Manufacturing

Risk concentrated in tooling and setup

vs.

Additive Manufacturing

Risk concentrated in process control

Material behavior largely predetermined

vs.

Properties influenced by build parameters

Stable once tooling is established

vs.

Requires monitoring, validation, and qualification

For this reason, AM often requires additional process control, validation, and qualification, especially in regulated industries such as aerospace and defense.

Key Takeaway

In additive manufacturing, design is driven more by functional requirements than by tooling limitations. However, this flexibility shifts complexity toward ensuring consistent quality and reliable material properties, as part performance depends on both design and process conditions. These differences extend beyond engineering considerations, influencing the economics of production and how manufacturing systems are structured and evaluated.

Section Takeaway

Unlike traditional manufacturing, which concentrates risk in tooling and setup, AM introduces a fundamentally different production model, where geometry is digitally defined and part performance is influenced by process conditions. Successful adoption depends on selecting the right process for a given application, rather than treating “additive manufacturing” as a single solution.



The Real Economics of Additive Manufacturing

Additive manufacturing is often evaluated using the same metric as traditional manufacturing: cost per part. While useful, this measure rarely captures the full economic picture of producing and supporting a component.

In practice, manufacturing economics extends well beyond the cost of making a single part. Factors such as tooling investment, assembly labor, inventory management, supply chain risk, and production lead times all influence the true cost of delivering a product.

While AM can reduce or remove several major cost drivers, it introduces new operational requirements that are often overlooked during early evaluation.

Typical AM production workflows may include:

- ◆ Post-processing and finishing operations
- ◆ Material preparation and handling
- ◆ Inspection and process monitoring requirements
- ◆ Part qualification and certification

As a result, understanding the economics of AM requires examining both sides of the equation: the costs AM can remove and the new costs it introduces across the broader production system.

Cost Per Part Isn't the Whole Story

Traditional Cost Driver

How AM Can Address It

Tooling Investment	✓ Eliminates molds, dies, and patterns
Assembly Labor	✓ Part consolidation reduces assembly steps
Shipping & Logistics	✓ Enables localized or on-demand production
Inventory Carrying Costs	✓ Digital inventory reduces spare-part stock
Lead Time	✓ Production begins directly from digital design

Traditional manufacturing processes often appear less expensive on a per-part basis because the cost of molds, dies, tooling, and production setup can be spread across large production volumes. Once those systems are optimized, processes such as casting, molding, and machining can produce parts at extremely low unit cost.

However, the lowest cost per part does not always translate to the lowest overall manufacturing cost, even when production volumes justify the large upfront tooling investments. Additional economic factors throughout the production and distribution supply chains influence the final landed costs.

These can include:

- ◆ Tooling investment for molds, dies, and patterns
- ◆ Assembly labor required to combine multiple components
- ◆ Shipping and logistics costs for globally sourced parts
- ◆ Inventory carrying costs for spare or low-demand components
- ◆ Lead-time delays that slow product launches or production schedules

AM can alter these dynamics in several ways. Because parts are produced directly from digital designs without dedicated tooling, AM can eliminate mold fabrication and reduce the delays associated with tooling development. The ability to consolidate multiple components into a single printed part can also reduce assembly labor and simplify production workflows.

In some cases, AM also enables parts to be produced closer to the point of use, reducing shipping distances and lowering inventory requirements by enabling on-demand production rather than long-term stockpiling.

For these reasons, a printed component may have a higher direct manufacturing cost but can still improve the overall economics of the product.

Key Takeaway

The lowest cost per part does not always mean the lowest total cost. By eliminating tooling, reducing assembly, and enabling localized or on-demand production, additive manufacturing can improve overall economics even when the printed part itself costs more to produce.

The Hidden Costs of Additive Manufacturing

While additive manufacturing can eliminate certain traditional cost drivers, it also introduces new operational requirements that are often overlooked during early evaluations. In many cases, the infrastructure, equipment, and expertise required to support additive production can represent a significant portion of the total implementation cost.

Post-Processing and Finishing Operations

Few additive parts exit the machine ready for deployment. Depending on the process and application, printed parts often require additional processing before they are usable in production.

In many industrial applications, AM functions as a near-net-shape process. The printed part forms the base geometry, while conventional manufacturing methods complete critical surfaces, tolerances, and material properties. As a result, AM often becomes one step within a larger production workflow rather than a stand-alone manufacturing solution.

Typical post-processing operations may include:

- ◆ Build plate separation using wire EDM, band saws, or similar cutting tools
- ◆ Support removal and powder evacuation, often performed using depowdering systems or manual finishing processes
- ◆ Thermal processing, such as stress relief, heat treatment, debinding, or sintering using industrial furnaces
- ◆ Densification processes, such as hot isostatic pressing (HIP), for certain metal components
- ◆ Machining operations to achieve final tolerances and critical surfaces using CNC equipment
- ◆ Surface finishing or coating processes, such as blasting, polishing, or protective coatings

These steps extend the overall production workflow beyond the build itself and may introduce additional capital equipment requirements. For organizations that already maintain machining and finishing infrastructure, these processes may integrate naturally. For others, AM can trigger secondary equipment investments that rival or exceed the cost of the printer itself.



Material Preparation and Handling

AM materials often require more controlled handling than conventional manufacturing feedstock. This is especially true for powder-based processes, where material handling, contamination, and reuse all affect part quality and process stability. At the same time, handling fine powders introduces additional safety considerations that must be addressed in day-to-day operations.

Powder-based systems typically introduce additional infrastructure for managing feedstock throughout the production workflow. This may include:

- ◆ Depowdering stations to remove loose powder from completed builds
- ◆ Powder recovery and recycling systems
- ◆ Sieving equipment to maintain particle size consistency
- ◆ Controlled storage environments for humidity and contamination management
- ◆ Dust control and safety systems for handling fine metal powders

These systems help maintain material quality while enabling unused powder to be recovered and reused where appropriate.

While wire- and filament-based systems reduce some of the handling complexity associated with powders, they introduce their own material management considerations related to feedstock storage, quality control, and process consistency.

As a result, the cost of AM materials is not only determined by the price of the feedstock itself, but also by the infrastructure and operational procedures required to store, handle, recycle, and maintain that material within the production environment.

Inspection and Process Monitoring Requirements

AM often requires inspection methods that differ from those used in many conventional manufacturing workflows. For AM, the resulting components often contain complex internal features, intricate geometries, and process-dependent material properties that are not always visible or measurable using traditional inspection tools.

As a result, evaluating AM parts often requires inspection approaches that go beyond the dimensional measurement methods commonly used for machined or cast components. This may include:

- ◆ **Computed tomography (CT) scanning** to evaluate internal geometry, porosity, and defects
- ◆ **Advanced metrology systems** capable of capturing complex freeform surfaces
- ◆ **Non-destructive testing (NDT)** methods, such as ultrasonic or radiographic inspection

In addition to evaluating finished parts, many AM workflows also incorporate in-process monitoring, using sensors and data systems to track build conditions and detect anomalies during production. Organizations may need to invest in additional inspection infrastructure or rely on specialized external service providers.

Part Qualification and Certification

In regulated industries such as aerospace and defense, qualification and certification requirements can significantly affect both the timeline and cost of deploying AM in production. Parts used in safety-critical systems must undergo rigorous validation to demonstrate reliable performance.

Traditional certification frameworks were developed around conventional manufacturing processes, where material properties are relatively consistent and well-documented. AM introduces a more complex relationship between process parameters, material behavior, and final part performance, which existing qualification methods were not originally designed to address.

Conventional processes also benefit from decades of established standards, material databases, and certification history that AM is still developing.

Challenges for AM qualification include:

- ◆ Process-dependent material properties
- ◆ Limited historical material data
- ◆ Certification frameworks built around traditional processes
- ◆ Costly test coupons and validation builds
- ◆ Additional inspection and process documentation

As a result, some manufacturers continue using traditional production methods simply to avoid the complexity of qualifying an additive process, even when AM could offer technical advantages.

Government agencies, industry consortia, and standards organizations are actively working to develop clearer qualification pathways. However, many certification frameworks are still evolving. Broader adoption often depends on clearly established standards, yet the development of those standards typically requires sustained industrial use and validation. As a result, qualification and certification can represent a significant hidden cost when evaluating AM in regulated sectors.

Section Takeaway

The economics of additive manufacturing extend beyond cost per part. While AM can reduce tooling, simplify assembly, and improve supply chain flexibility, it also introduces a unique set of operational requirements. Post-processing, material handling, inspection, and qualification requirements can significantly impact the total cost. Evaluating AM effectively requires considering the full production life-cycle prior to adoption.

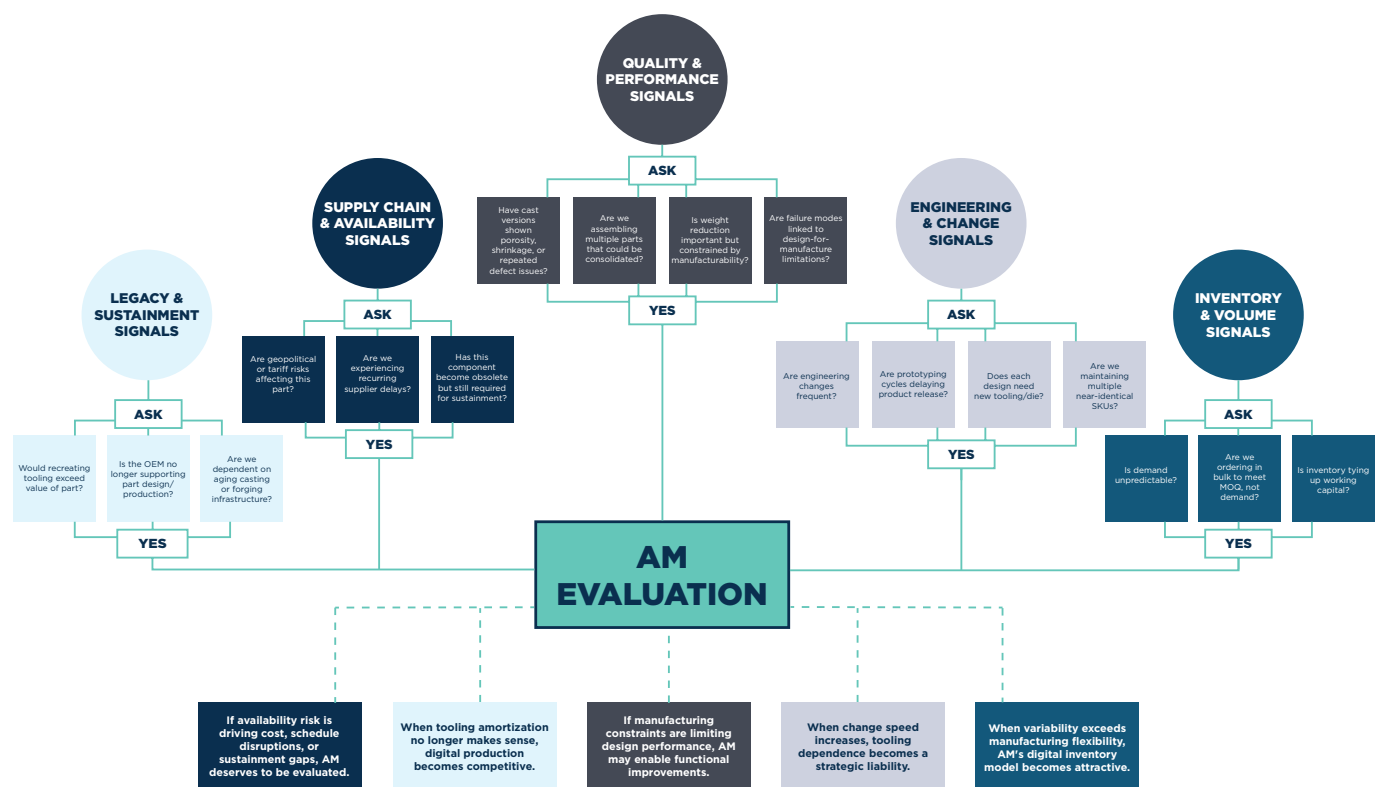
When Additive Manufacturing Becomes the Right Tool

Additive manufacturing becomes relevant when existing production methods begin to create operational or economic strain. In many cases, manufacturers do not evaluate AM because of broader market trends, but because current processes are becoming harder to justify for certain parts or programs. Rising tooling costs, supplier instability, long lead times, frequent engineering changes, and increasing product complexity can all signal that conventional production methods are no longer the best fit in every situation.

The key question is not whether AM is growing as a technology category. The more important question is whether your organization is encountering the kinds of constraints that make AM worth evaluating.

This section focuses on those decision signals. It outlines the conditions that often trigger serious AM evaluation, the types of parts most likely to benefit, and how priorities tend to change as organizations move from early exploration to broader adoption.

Organizational Triggers for Additive Manufacturing Evaluation



Rising Tooling and Mold Costs

Injection molding and casting remain integral manufacturing processes, especially for high-volume production. However, both rely on up-front tooling investment and predictable payoff schedules.

AM becomes relevant when:

- ◆ Tooling costs increase faster than part volumes
- ◆ Low-volume programs cannot justify new mold or die investments
- ◆ Engineering changes require repeated retooling
- ◆ Mold fabrication lead times delay product updates

AM does not eliminate tooling-based production but may reduce dependence on repeated tooling cycles for bridge production, spare parts, or variant-heavy programs.

Organizations facing uncertain demand may choose to initially evaluate AM through qualified service providers. Contract manufacturing partners can validate part suitability, material performance, and production economics before internal capital investment is considered. This approach enables manufacturers to test AM without requiring immediate infrastructure changes.

SKU Proliferation and Variant Complexity

Customization and product differentiation continue to expand across aerospace, defense, medical, energy, and industrial equipment sectors.

Indicators include:

- ◆ Expanding part families with minor geometric changes
- ◆ Increased low-volume production runs
- ◆ Higher inventory carrying costs
- ◆ Changeover inefficiencies in traditional manufacturing operations

Traditional molding and casting processes are optimized for volume consistency, but when variability increases, AM's ability to produce without geometry-specific tooling becomes economically relevant, especially for unique and complex parts.

Engineering Change Frequency

Digital design tools have accelerated iteration cycles across product development workflows, but tooling-based production can limit overall time reduction.

Indicators include:

- ◆ Engineering updates delayed due to tooling modification timelines
- ◆ Repeated mold revisions and iterations
- ◆ Extended prototype-to-production cycles

AM enables quicker design iterations without requiring additional capital investment. For applications with frequent design iterations, this flexibility can outweigh higher direct manufacturing costs.

Supplier Instability and Lead Time Constraints

Foundries and mold-making suppliers represent specialized segments of the manufacturing industry that have experienced notable structural changes in recent years. Annual and quarterly federal reporting data, including Federal Reserve Economic Data (FRED), point to continued industry consolidation and workforce challenges.²⁴

Supply chain instability may present as:

- ◆ Single-source suppliers and foundry capacity limitations
- ◆ Extended lead times, especially for legacy parts
- ◆ Obsolescence of tooling or casting dies
- ◆ Increased repeat-scrap rates from recurring defects (i.e., porosity, shrinkage, warping)

Workforce data from the U.S. Bureau of Labor Statistics indicates sustained employment shortages in skilled manufacturing trades, including mold-making and metalworking occupations.^{25,26} These shortages contribute to longer production cycles and higher remediation costs for defects.

With these constraints, AM is increasingly being evaluated as a risk mitigation strategy rather than solely as a cost-reduction tool.

Evaluating Individual Parts

Common indicators that a part may be a good candidate for additive manufacturing include:

- ◆ **Complex geometry**, such as internal channels, lattice structures, or organic shapes that are difficult to machine or cast
- ◆ **Part consolidation opportunities**, where multiple components can be integrated into a single, printed part
- ◆ **Low or variable production volumes**, where tooling investment is difficult to justify
- ◆ **Long supplier lead times** or supply chain risk for critical components
- ◆ **Performance-driven redesign opportunities**, such as improved thermal management, weight reduction, or system integration

Conversely, AM is typically less competitive for simple parts produced at very high volumes, especially when those components are already manufactured through mature, highly optimized processes such as injection molding, high-volume machining, or casting.

For this reason, most organizations adopt AM incrementally. Early adoption typically focuses on targeted applications where the advantages are clear, allowing manufacturers to gain operational experience before expanding AM into broader production workflows.

Key Takeaway

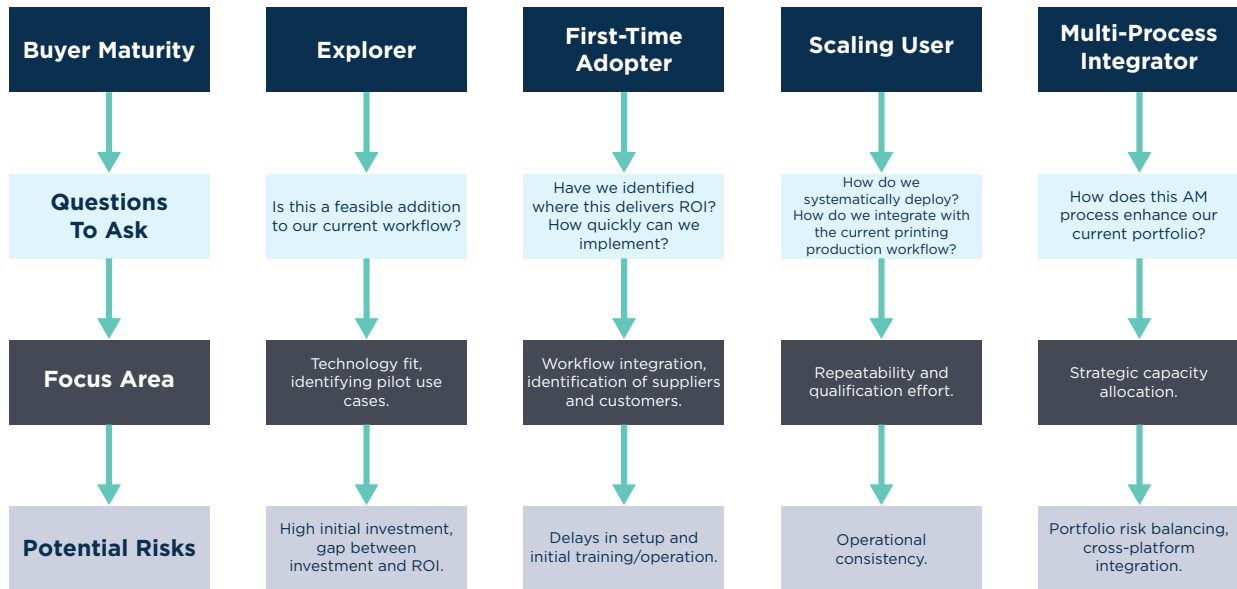
Early indicators that additive manufacturing could be a useful solution include rising tooling costs, increasing product variability, frequent design changes, and unstable supplier lead times.

Key Takeaway

The best parts for additive manufacturing often combine complexity, low or variable volumes, supply chain risk, or opportunities for performance improvement.

Stages of Additive Manufacturing Adoption

Additive manufacturing evaluation varies by organizational experience and integration level.



Explorer

Organizations that are assessing relevance but not yet purchasing AM systems.

Focus:

- ◆ Identify parts with high tooling burden or supply instability
- ◆ Evaluate fit relative to current manufacturing constraints
- ◆ Develop internal literacy around additive capabilities

At the Explorer stage, organizations should avoid overemphasizing direct machine comparisons and broad transformation narratives. The focus should be on identifying niche applications where AM offers a solution to current manufacturing challenges. One way to help determine whether internal equipment investment is warranted is to engage AM contract manufacturing service providers to assess its feasibility and build internal familiarity with the process.

First-Time Adopter

Organizations deploying AM for a defined application, such as a tooling avoidance, bridge production, or spare/legacy parts.

Focus:

- ◆ Controlled production entry
- ◆ Clear ROI boundaries
- ◆ Risk management

The primary considerations at the First-Time Adopter stage should be reducing retooling cycles, avoiding mold investments, and reducing lead times. Some First-Time Adopters choose to combine limited internal capability with external service providers. This allows manufacturers to scale gradually, stabilize demand patterns, and refine workflow integration before expanding AM capabilities internally.

Scaling User

Organizations expanding AM use cases across multiple parts or production areas.

Focus:

- ◆ Workflow integration
- ◆ Quality documentation and repeatability
- ◆ Post-processing optimization
- ◆ Cross-functional coordination

The primary risk at the Scaling User stage is underutilization or stalled utilization due to insufficient integration rather than machine limitations.

Multi-process AM Integrator

Organizations integrating multiple AM processes alongside machining, molding, casting, and automation systems.

Focus:

- ◆ Portfolio-level capital allocation
- ◆ Hybrid production strategies
- ◆ Design-for-additive integration in development cycles
- ◆ Long-term manufacturing optimization

At the Multi-process AM Integrator stage, AM competes for capital allocation against all other equipment options. Demonstrating application-specific advantages for AM is critical at this stage.

Key Takeaway

Organizations typically adopt additive manufacturing in stages, beginning with targeted applications, then expanding as experience, workflow integration, and internal capabilities mature.

Section Takeaway

AM becomes worth evaluating when traditional production systems begin to struggle with tooling costs, design complexity, supply chain risk, or production flexibility. Successful adoption typically starts with targeted parts, where AM clearly solves a problem and expands gradually as organizations build experience and integrate the technology into broader manufacturing workflows.

Operational Readiness: Facilities, Workforce, and Workflow Requirements

For organizations that identify promising applications for additive manufacturing, the next step is evaluating operational readiness. Successfully deploying AM requires more than purchasing a machine. Facilities, workforce capabilities, and production workflows must support the full AM process, including material handling, post-processing, and quality assurance.

In many cases, manufacturers begin this process by working with external AM service providers before investing in internal equipment.

Facility Readiness Checklist					
Process	Average Power Requirements Range (kW)	Electrical Requirements	HVAC Requirements	Machine Footprint Range (sq. ft.)	Workforce Investment
Directed Energy Deposition (DED)	25 – 120+	3-phase required, 80-200A typical, depending on laser and motion platform	Fume extraction system localized shielding gas, power-fed systems require dust collection	18 – 16,000+	Very High – Laser safety, CNC cross training, metallurgy knowledge, inert gas handling, process parameter development
Laser Powder Bed Fusion (LPBF)	20 – 100+ (metal)	3-phase typically required, 60-150A depending on system size High-capacity single-phase possible for mid-size systems	Temperature and humidity stability, inert gas supply, dedicated power handling ventilation, HEPA filtration	20 – 5,000+	High – Laser safety, combustible dust training, proper powder handling training, inert gas safety, QA/inspection standards
Selective Laser Sintering (SLS)	10 – 40+	3-phase preferred, some mid-size systems configurable for high-capacity single-phase	Temperature and humidity stability, powder ventilation, moderate filtration system	5 – 500+	Moderate – Powder handling and refresh ratio management training, QA standards, PPE protocols
Hybrid (AM + CNC)	40 – 150+	3-phase industrial service often required, 150-300A typical depending on laser and motion platform	CNC coolant management, AM ventilation, inert gas supply for laser deposition	35 – 4,500+	Very High – Laser safety, CNC cross training, metallurgy knowledge, QA integration
Industrial Material Extrusion (ME)	5 – 25	Single-phase for smaller industrial and desktop systems; 3-phase for large-format systems	Temperature stability, limited ventilation requirements unless working with high-temperature materials, no inert gas required	0.5 – 2,000+	Moderate – Material handling training, process parameter development, limited hazards compared to other processes
Stereolithography (SLA)	5 – 20	Single-phase or 3-phase, depending on system size	Narrow temperature stability, humidity control, resin storage requirements, solvent ventilation	4 – 600+	Moderate – Resin handling, chemical PPE, UV exposure protocols, VOC management from cleaning solvents

Evaluating Additive Manufacturing Through Service Providers

Before committing to capital investment, many organizations choose to pilot additive manufacturing through certified service providers. Contract manufacturers specializing in AM can produce parts, support design optimization, and provide insight into real-world workflow requirements.

Working with service providers can help organizations:

- ◆ Validate part suitability and material performance
- ◆ Optimize design for AM
- ◆ Understand post-processing and finishing requirements
- ◆ Evaluate production economics before purchasing equipment
- ◆ Develop internal familiarity with AM workflows

This approach allows manufacturers to gain practical experience with AM while reducing risk during early adoption.

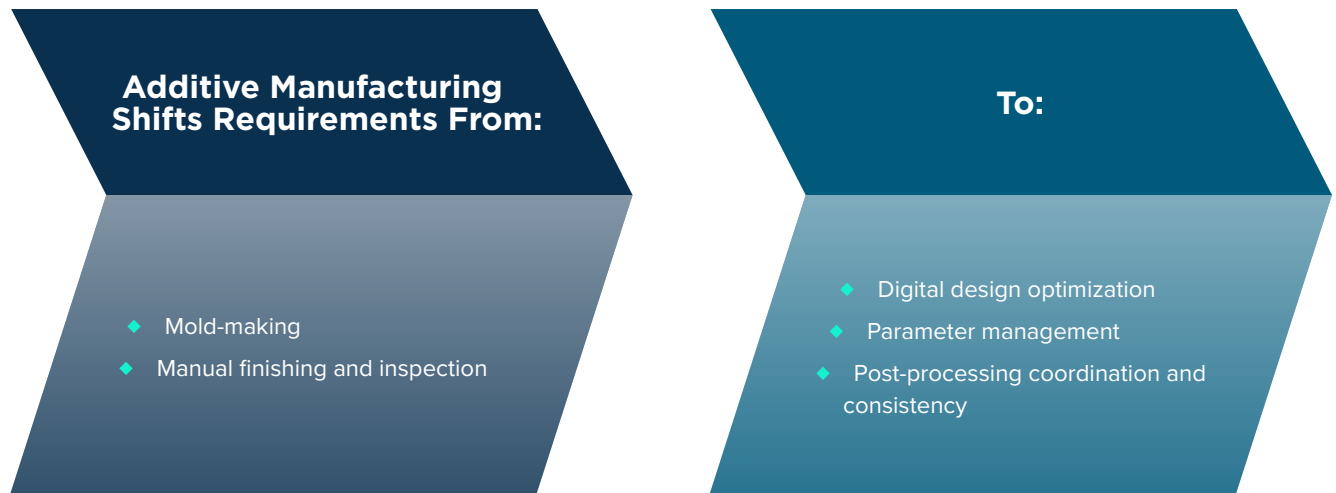
Facility and Infrastructure Requirements

Requirements vary by process type but fall within the following ranges:

- ◆ Power Requirements (based on published OEM system specifications)
Polymer systems: ~5 – 30+ kW
Industrial metal systems: ~20 – 80+ kW
- ◆ Floor Space
Industrial systems range from 100 – 500+ square feet per system, in addition to post-processing equipment space.
- ◆ Environmental Controls
Stable temperature and humidity; inert gas handling required for many metal powder systems.
- ◆ Safety Requirements
Powder handling procedures, laser safety training, ventilation, and PPE in accordance with OSHA guidelines.^{27–32}
- ◆ Post-Processing Space
Heat treatment, support removal, machining, finishing, and inspection areas

These requirements are generally comparable to other manufacturing equipment but often differ in workflow structure.

Workforce and Training Considerations



Occupational training typically includes:

- ◆ Machine operation training and certification
- ◆ Powder safety training
- ◆ Quality inspection standard operating procedures

Workforce trends across manufacturing occupations indicate continued labor shortages in skilled trades.^{32,33} Additive manufacturing does not eliminate labor requirements; rather, it redistributes them across digital, operational, and post-processing stages, shifting the required skill set and creating new career opportunities in manufacturing.

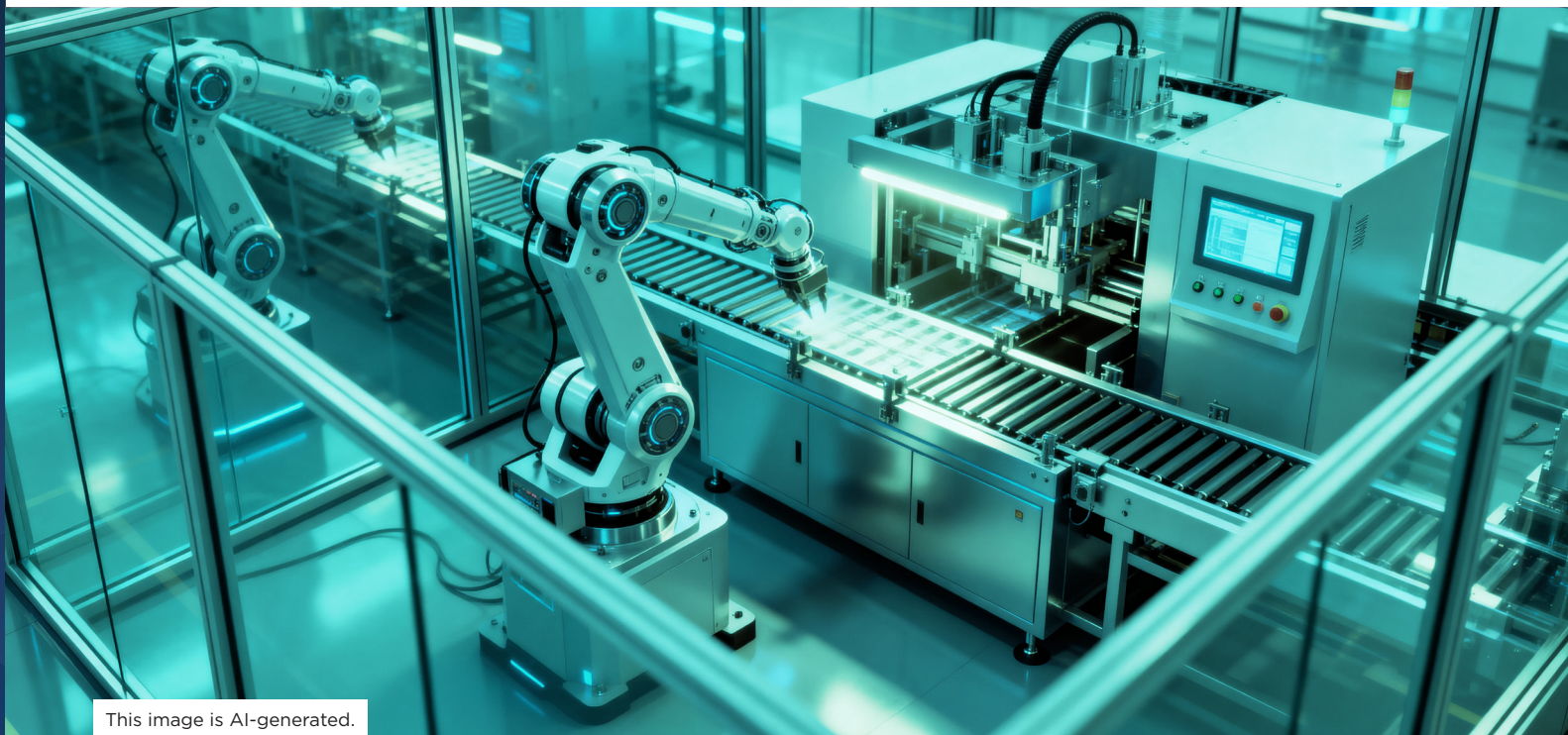
Workflow Integration

Successful AM adoption requires integration with existing manufacturing systems. Additive manufacturing rarely operates as a standalone process and typically becomes one step within a broader production chain.

Integration considerations may include:

- ◆ CAD and digital part design systems
- ◆ CNC machining for the hybrid production of parts
- ◆ Quality management systems
- ◆ ERP and MES platforms

Organizations that integrate AM into broader production systems tend to scale more effectively than those that operate it as a siloed capability.



This image is AI-generated.

Section Takeaway

Successfully deploying additive manufacturing requires more than installing a printer. Facilities, workforce skills, post-processing capabilities, and workflow integration must support the full production chain. As a result, many organizations begin by piloting AM through service providers before investing in internal equipment.

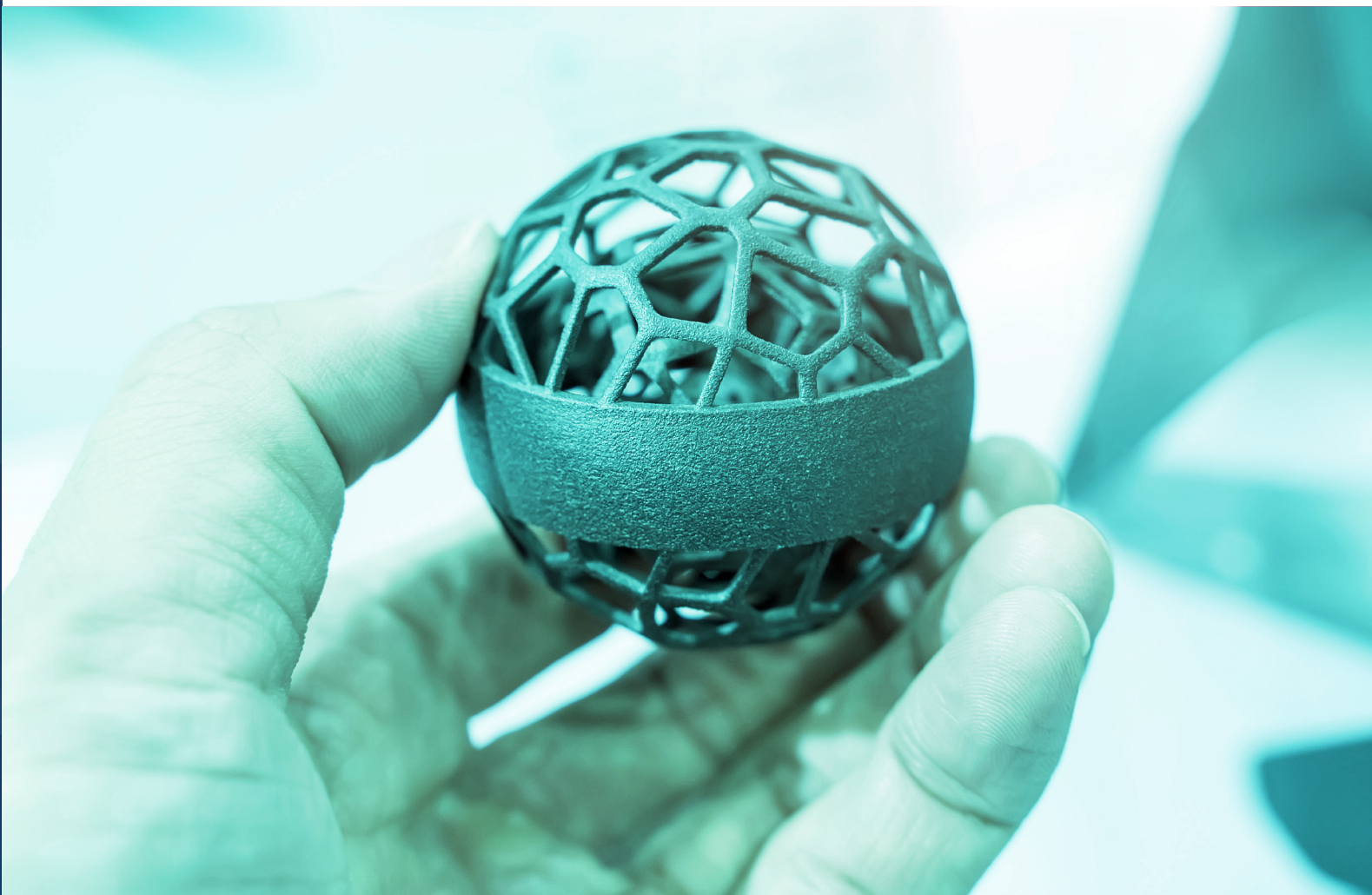
Where Additive Manufacturing Is Already Delivering Value

While additive manufacturing is not the right solution for every application, it is already delivering measurable value across a range of industrial use cases. In many cases, adoption has occurred in situations where AM provides capabilities that conventional processes cannot easily replicate, or where it meaningfully improves production responsiveness and supply chain flexibility.

These successful applications generally fall into two broad categories:

- ◆ **Design-driven applications**, where AM enables geometries, integrated features, or system-level designs that are difficult or inefficient to achieve with conventional manufacturing
- ◆ **Responsiveness-driven applications**, where AM reduces lead times, avoids tooling delays, or improves access to low-volume or hard-to-source parts

The following application areas illustrate where AM is already seeing meaningful industrial adoption and delivering practical value. These examples illustrate how manufacturers are using AM today to improve performance, simplify production, and address supply chain challenges.



Internal Channels for Thermal Management



Leap-71 and Fraunhofer IGC's multimaterial heat exchanger.

Traditional Manufacturing Limitation

- ◆ Restricted to straight-drilled channels or tool-accessible geometries, traditional cooling systems are often designed around manufacturing constraints rather than thermal performance.

What AM Changes

- ◆ Enables complex internal channels that can curve, branch, and follow the geometry of a part.
- ◆ These flow paths can be integrated directly into the part during the build process.
- ◆ Allows engineers to design cooling channels that closely follow heat-generating surfaces and maintain consistent spacing – improving fluid flow and heat transfer efficiency.

Why It Matters

- ◆ Thermal management is often a limiting factor in high-performance systems. Improving cooling performance can enable higher power density, improved efficiency, and more reliable operation.

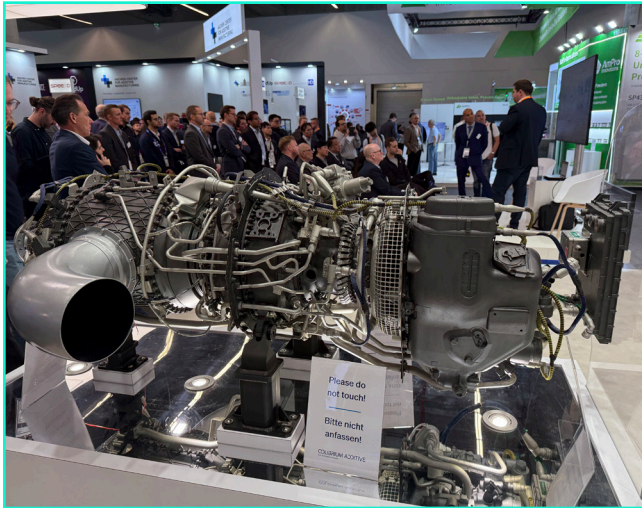
Key Applications and Industries

- ◆ **Conformal cooling in injection molds**, where cooling channels follow the shape of a mold cavity to remove heat more evenly and reduce cycle times.
- ◆ **Advanced heat exchangers**, where complex internal geometries improve heat transfer efficiency and reduce weight in aerospace, energy, and automotive systems.
- ◆ **Cooling plates and thermal management components for high-density computing and power electronics**, a rapidly growing application driven by the expansion of AI infrastructure and data centers.

Key Takeaway

Additive manufacturing transforms internal cooling from simple, drilled passages into fully optimized three-dimensional thermal management systems, allowing engineers to design for heat removal performance first rather than tooling constraints.

Part Consolidation



GE Aerospace's Catalyst, an advanced turboprop engine.



TUM.Additive's model turbine.

Traditional Manufacturing Limitation

- ◆ Complex products are often split into multiple parts and subassemblies due to tooling access, machining constraints, or casting geometry.
- ◆ Components must then be joined with fasteners, welds, adhesives, or mechanical interfaces.
- ◆ More parts create assembly labor, tolerance stack-up, inventory complexity, and additional failure points.

What AM Changes

- ◆ AM builds parts layer by layer without tooling constraints.
- ◆ Enables multiple components, features, and internal structures to be integrated into one part.
- ◆ Engineers can design systems as unified components rather than manufacturable subassemblies.

Why It Matters

- ◆ Reduces assembly time and labor
- ◆ Eliminates fasteners and joint-related failures
- ◆ Simplifies supply chains and inventory
- ◆ Often reduces weight and system complexity

Key Applications and Industries

- ◆ **Aerospace components** with combined brackets, ducts, and mounting features
- ◆ **Suppressors**
- ◆ **Industrial tooling and fixtures** with integrated mounting and flow channels
- ◆ **Medical implants** with integrated lattice structures and fixation features
- ◆ **Energy and fluid systems** with combined housings, flow paths, and mounting geometry

Key Takeaway

Additive manufacturing can consolidate multipart assemblies into single integrated components, reducing assembly effort, lowering weight, simplifying supply chains, and eliminating common failure points.

Maintenance, Repair, and Overhaul (MRO)



Assembling and replacing engine parts of the plane after repair. A specialist mechanic controls the crane of an airplane. Concept maintenance of aircraft.

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Traditional Manufacturing Limitation

- ◆ Replacement parts may require long lead times, legacy tooling, or large minimum-order quantities
- ◆ Suppliers exit the market or discontinue low-volume components
- ◆ High-value assemblies are scrapped due to localized wear or damage
- ◆ Inventory costs for rarely used spare parts

What AM Changes

- ◆ Enables repair of worn areas through directed energy deposition and similar processes
- ◆ Allows legacy parts to be reproduced from digital scans or archived designs
- ◆ Supports low-volume or one-off replacement parts without tooling
- ◆ Enables design improvements when reproducing components

Why It Matters

- ◆ Downtime can cost far more than the part itself
- ◆ Many systems operate for decades, outliving original supply chains
- ◆ AM enables localized repair and on-demand production, reducing dependence on legacy suppliers and long lead times

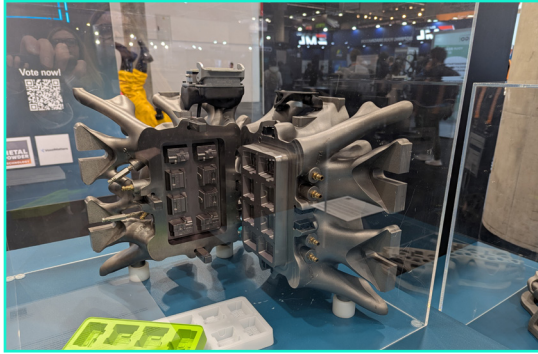
Key Applications and Industries

- ◆ **Rail:** On-demand production of obsolete train components
- ◆ **Defense:** Sustainment of aging aircraft, vehicles, and naval systems
- ◆ **Energy:** Repair of turbine and power generation components
- ◆ **Industrial equipment:** Replacement parts for legacy machinery

Key Takeaway

Additive manufacturing enables the repair, reproduction, and on-demand replacement of critical components, reducing downtime, extending equipment life, and maintaining systems even after original supply chains disappear.

Casting, Forging, and Mold Tooling Alternatives



Erofi's 3D printed mold.



Formlabs' 3D printed bottle blow molds.

Traditional Manufacturing Limitation

- ◆ Tooling required: molds, dies, patterns, and fixtures
- ◆ Long lead times for tooling development and supplier queues
- ◆ Limited domestic capacity in foundries and forge shops
- ◆ Minimum order quantities make low-volume runs uneconomical

What AM Changes

- ◆ Produces parts directly from digital designs – no tooling required
- ◆ Production can begin immediately after design finalization
- ◆ Design changes require no tooling rework
- ◆ Batch sizes match demand, from one part to small production runs

Why It Matters

- ◆ Long lead times can delay production schedules or product launches
- ◆ Reshoring efforts are exposing domestic capacity constraints
- ◆ AM enables bridge production, low-volume runs, and rapid replacement parts

Key Applications and Industries

- ◆ **Bridge manufacturing** while waiting for cast or forged components
- ◆ **Low- to mid-volume production** where tooling costs are unjustified
- ◆ **Aftermarket and legacy parts** with limited supplier availability
- ◆ **Reshoring programs** that need faster domestic production capability

Key Takeaway

Additive manufacturing reduces dependence on constrained casting and forging capacity by eliminating tooling and enabling faster production.

Section Takeaway

AM offers a practical alternative when tooling lead times, supply constraints, or design limitations limit traditional production. Across applications, a consistent pattern emerges: AM delivers the most value when applied to specific challenges where conventional processes start to face constraints.

Additive Manufacturing as a Strategy, Not Just a Trend

Additive manufacturing adoption is no longer a question of hype or inevitability. It's a question of fit.

Manufacturers today are dealing with unstable supply chains and limited domestic capacity, made worse by reshoring efforts. These pressures are exposing gaps in traditional production systems. AM stands out because it can address some of those gaps in ways conventional processes were never designed to.

The most successful manufacturers won't ask whether AM can replace what they already do well. Instead, they focus on where their systems start to break down – where tooling slows progress, lead times create risk, or design limits performance – and apply AM in those situations.

This is where AM delivers value. Not as a universal solution, but as a targeted capability that expands what's possible within a broader production system.

For some manufacturers, AM will remain a targeted solution for legacy and bridge production. For others, it will become integrated into capital planning and new product development workflows. And for others still, it simply won't fit their needs. The determining factor is alignment between operational pressures and technology deployment.

Connecting Insight to Action: Explore Additive Manufacturing at IMTS 2026

At IMTS – The International Manufacturing Technology Show, attendees discover advanced manufacturing solutions that include innovations in CNC machining, automation, robotics, additive manufacturing, software, AI, and transformative digital technologies. IMTS is the largest trade event for manufacturing technology in the Western Hemisphere, with more than 1.2 million square feet of exhibit space and 90,000 attendees. For manufacturers ready to move from evaluating AM to adoption, IMTS 2026 provides an opportunity to explore technologies across the entire manufacturing ecosystem.

Attendees can explore:

- ◆ Metal AM systems
- ◆ Polymer AM systems
- ◆ Hybrid AM + CNC platforms
- ◆ Post-processing technologies
- ◆ Automation and workflow integration systems
- ◆ AM service providers and contract manufacturers

Explore additive solutions at IMTS.com/additive, and a full list of exhibitors is available at director.IMTS.com.

Final Takeaway

Additive manufacturing delivers value when manufacturers understand both its capabilities and limits, applying it selectively to the right problems as a targeted capability that improves flexibility, resilience, and performance.

References

- (1) *Advanced Manufacturing Production Credit* | Internal Revenue Service. <https://www.irs.gov/credits-deductions/advanced-manufacturing-production-credit> (accessed 2026-03-22).
- (2) *Executive Order 14257 - Regulating Imports With a Reciprocal Tariff To Rectify Trade Practices That Contribute to Large and Persistent Annual United States Goods Trade Deficits*. <https://www.federalregister.gov/documents/2025/04/07/2025-06063/regulating-imports-with-a-reciprocal-tariff-to-rectify-trade-practices-that-contribute-to-large-and> (accessed 2026-03-22).
- (3) *Executive Order 14005 - Ensuring the Future Is Made in All of America by All of America's Workers*. <https://www.federalregister.gov/documents/2021/01/28/2021-02038/ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers> (accessed 2026-03-22).
- (4) *Executive Order 14017 - America's Supply Chains*. <https://www.federalregister.gov/documents/2021/03/01/2021-04280/americas-supply-chains> (accessed 2026-03-22).
- (5) Egan, T. 2020: *How did the Pandemic Change the Manufacturing Industry?* <https://www.amtonline.org/article/2020-how-did-the-pandemic-change-the-manufacturing-industry> (accessed 2026-03-22).
- (6) *Executive Order 13881 - Maximizing Use of American-Made Goods, Products, and Materials*. <https://www.federalregister.gov/documents/2019/07/18/2019-15449/maximizing-use-of-american-made-goods-products-and-materials> (accessed 2026-03-22).
- (7) *Notice of Modification of Section 301 Action: China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation*. <https://www.federalregister.gov/documents/2018/09/21/2018-20610/notice-of-modification-of-section-301-action-chinas-acts-policies-and-practices-related-to> (accessed 2026-03-22).
- (8) *Executive Order 13788 - Buy American and Hire American*. <https://www.federalregister.gov/documents/2017/04/21/2017-08311/buy-american-and-hire-american> (accessed 2026-03-22).
- (9) The Reshoring Institute. *Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China*. <https://reshoringinstitute.org/chips-act/> (accessed 2026-03-02).
- (10) Moser, H. *Rebuilding and Reshoring: How Did Offshoring Get so Strong?* <https://www.AMOnline.org/article/rebuilding-and-reshoring-how-did-offshoring-get-so-strong> (accessed 2026-02-26).
- (11) *Market Research Study - Domestic Casting Industry; 2022*. www.dawnbreaker.com (accessed 2026-03-02).
- (12) Joint Defense Manufacturing Council. *Department of Defense Additive Manufacturing Strategy*; Washington, D.C., 2021.
- (13) *Materials Resources LLC (MRL) Secures \$25.2 Million Department of War Award to Revolutionize Solid Rocket Motor Manufacturing*. <https://www.icmrl.net/mrl-srm-manufacturing-award> (accessed 2026-03-22).
- (14) *Firestorm Labs Awarded \$100 Million IDIQ Contract by U.S. Air Force to Accelerate UAS Development and Integration*. <https://www.prnewswire.com/news-releases/firestorm-labs-awarded-100-million-idiq-contract-by-us-air-force-to-accelerate-uas-development-and-integration-302358178.html> (accessed 2026-03-22).

- (15) *3D Printing Savvy Rocket Lab Lands \$515M Space Force Defense Contract - 3DPrint.com | Additive Manufacturing Business.* <https://3dprint.com/306335/3d-printing-savvy-rocket-lab-lands-515m-space-force-defense-contract/> (accessed 2026-03-22).
- (16) *Pentagon picks 24 companies for 3D printing and additive manufacturing of military replacement parts.* <https://www.militaryaerospace.com/computers/article/55362414/pentagon-picks-24-companies-for-3d-printing-and-additive-manufacturing-of-military-replacement-parts> (accessed 2026-03-22).
- (17) *University of Illinois Launches AM Research Center with \$8M DoD Backing.* <https://3dprint.com/317966/university-of-illinois-launches-am-research-center-with-8m-dod-backing/> (accessed 2026-03-22).
- (18) *AM Forward Network - ASTRO America.* <https://astroa.org/project/am-forward/> (accessed 2026-03-22).
- (19) U.S. Department of War Office of Strategic Capital. *Investment Fund Financing.* <https://www.cto.mil/osc/sbicct-initiative/> (accessed 2026-03-22).
- (20) *Joint Additive Manufacturing Working Group.* <https://www.dodmantech.mil/Manufacturing-Collaborations/Joint-Additive-Manufacturing-Working-Group/> (accessed 2026-03-22).
- (21) *Future Alloy Study and Testing (FAST) Center.* <https://www.scotforge.com/fast> (accessed 2026-03-22).
- (22) *America Makes.* <https://www.americamakes.us/> (accessed 2026-03-22).
- (23) *ASTRO America - The Applied Science and Technology Research Organization of America.* <https://astroa.org/> (accessed 2026-03-22).
- (24) Employment for Manufacturing: Foundries (NAICS 3315) in the United States. 2025.
- (25) *Machinists and Tool and Die Makers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics.* <https://www.bls.gov/ooh/production/machinists-and-tool-and-die-makers.htm> (accessed 2026-03-22).
- (26) *Metal and Plastic Machine Workers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics.* <https://www.bls.gov/ooh/production/metal-and-plastic-machine-workers.htm#tab-6> (accessed 2026-03-22).
- (27) Brusak, E. D.; Bowers, L. N.; Friend, S.; Barnes, C.; Qi, C.; Stefaniak, A. B. *Evaluation of Metals Exposure in a Metal Powder Additive Manufacturing Facility*; 2025. <https://www.cdc.gov/niosh/hhe/reports/pdfs/2023-0034-3409.pdf>. (accessed 2026-03-22).
- (28) *Combustible Dust: An Explosion Hazard - OSHA Standards | Occupational Safety and Health Administration.* <https://www.osha.gov/combustible-dust/standards> (accessed 2026-03-22).
- (29) *1926.55 - Gases, vapors, fumes, dusts, and mists. | Occupational Safety and Health Administration.* <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.55> (accessed 2026-03-22).
- (30) *1910.1450 - Occupational exposure to hazardous chemicals in laboratories. | Occupational Safety and Health Administration.* <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1450> (accessed 2026-03-22).
- (31) *Laser Hazards - Standards | Occupational Safety and Health Administration.* <https://www.osha.gov/laser-hazards/standards> (accessed 2026-03-22).

- (32) *Production Occupations : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics*. <https://www.bls.gov/ooh/production/home.htm> (accessed 2026-03-22).
- (33) *BEA Interactive Data Application*. https://apps.bea.gov/iTable/?reqid=19&step=2&isuri=1&1921=survey&_gl=1*h59in6*_ga*MjY3NTkyNjAxLjE3NzI0NjAxMDA.*_ga_J4698JNNFT*czE3NzM2ODMxNzQkbzMkZzEkd-DE3NzM2ODMxODMkajUxJGwwJGgw#eyJhcHBpZCI6MTksInN0ZXBzljpbMSwyLDNdLCJkYXRhIjpbWyJDYXRIZ29yaWVzIiwU3VydmlV5II0sWyJOSVBBX1RhYmxiX0xpc3QiLCIxOTMiXV19 (accessed 2026-03-22).
- (34) *Materialise*. <https://www.materialise.com/en/inspiration/articles/certifying-metal-3d-printed-parts-aerospace> (accessed 2026-04-03).

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