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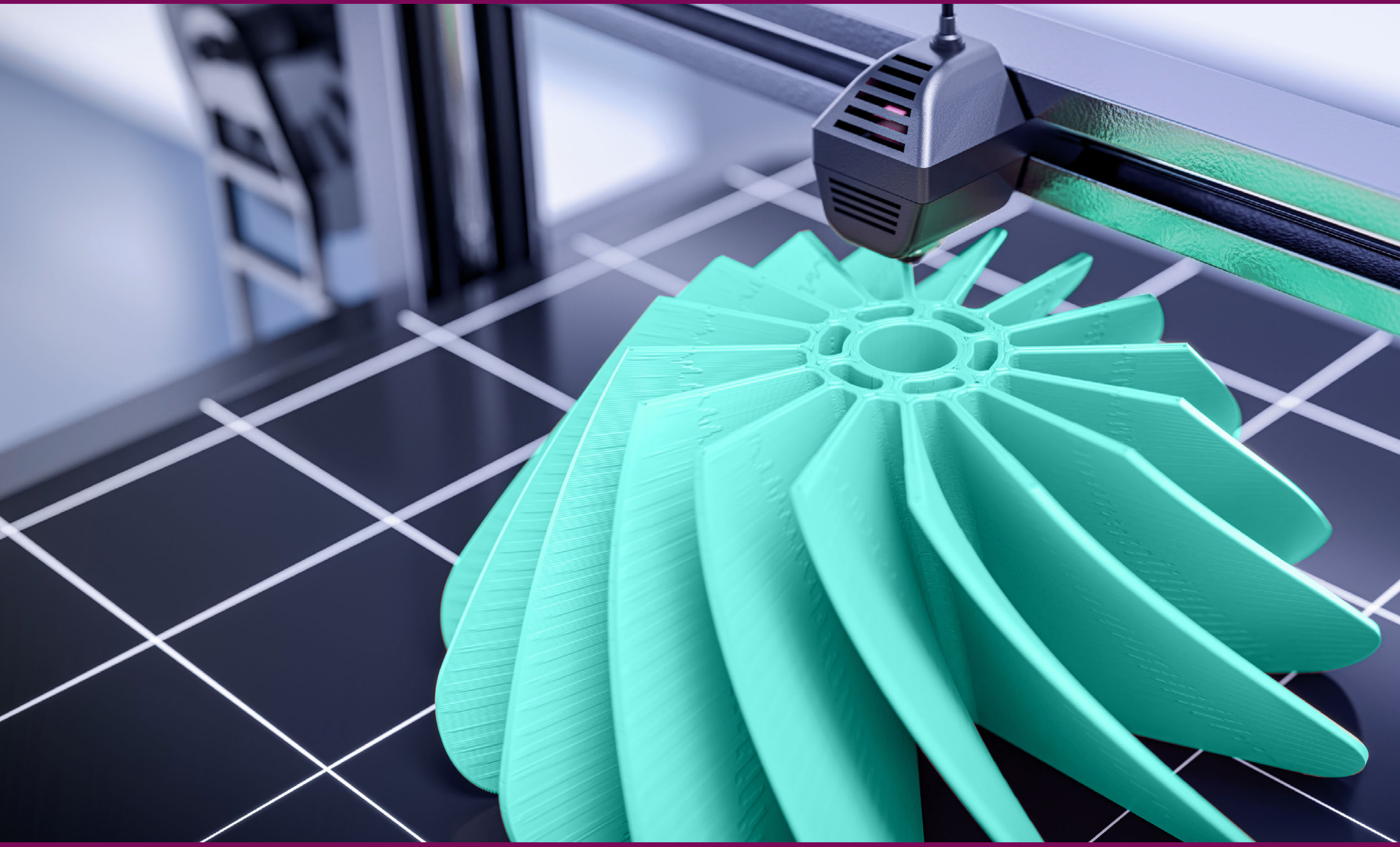
WHITE PAPER

Can 3D Printing Ease OEMs' Aftermarket Inventory Challenges?



Where Vision Takes Shape.

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Executive Summary

Original equipment manufacturers (OEMs) in aerospace, heavy equipment, automotive, and commercial computing carry long-term obligations to support products with lifespans measured in decades. This obligation requires maintaining large, globally distributed inventories of aftermarket parts. For many OEMs, these inventories are not merely cost centers — they also support profitable aftermarket service lines. Yet the portion of inventory held solely to ensure long-term support, particularly slow-moving parts, can impose high carrying costs, tie up working capital, and expose OEMs to material risk when suppliers discontinue critical components.

While OEMs have long used additive manufacturing (AM), or 3D printing, to prototype parts, most OEMs have not yet adopted AM at a meaningful scale for aftermarket parts. The reasons are structural: qualification cycles, material requirements, volume uncertainty, complex ROI modeling, and difficulty identifying which parts are genuinely viable for AM.

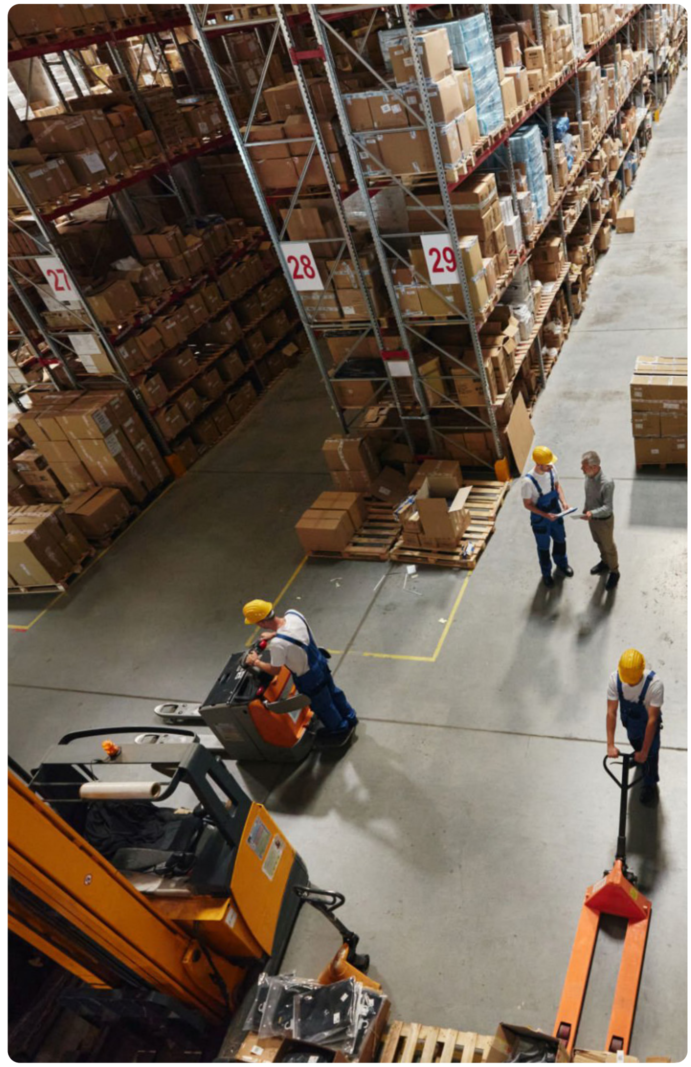
This paper presents a balanced, financially grounded view of where AM offers real and measurable value and where traditional sourcing remains superior. It establishes a case not to replace existing sourcing models but to augment them with advanced decision intelligence that unlocks targeted savings, reduces inventory risk, and strengthens supply resilience. When applied in this way, AM's impact on aftermarket supply chains translates into material business impact for large OEMs.

The Aftermarket Inventory Imperative

OEMs supporting long-lived equipment operate under a long tail of obligation. Assets like aircraft, power systems, heavy machinery, and servers require dependable spares availability for 10 to 40 years. Customer expectations for uptime are absolute: Unavailability of a $12 connector can ground a jet, disable a fire truck, or halt a 5MW industrial generator.

OEMs often maintain readiness in the following ways:

- **Carry buffer stock of slow-moving items**
- **Purchase lifetime buys when suppliers discontinue parts**
- **Pay for tooling and minimum order quantities (MOQs) far above demand**
- **Manage global logistics, warehousing, and distribution networks**
- **Forecast uncertain demand for aging fleets**



Many OEMs monetize aftermarket parts, making spares a profit center. However, the subset of inventory held solely to preserve operational support — especially slow movers with long lifespans — can become financially burdensome and strategically risky.

Hidden Costs of Traditional Aftermarket Inventory

The full cost of aftermarket inventory is rarely visible in financial statements but is well understood by procurement and supply chain executives. Key cost drivers include:

1. **Tooling and MOQ Exposure**
A supplier may require a 3,000-unit MOQ even if the OEM forecasts only 300 units of demand over five years. Tooling may cost $10k–$250k, depending on materials and complexity.

2. **Annual Carrying Costs**
Carrying cost typically ranges from 20% to 35% of inventory value per year, including:
   - Cost of capital
   - Warehouse space
   - Insurance
   - Handling
   - Obsolescence and depreciation

3. **Long-Term Storage and Logistics**
OEMs maintain multi-node distribution networks, regional depots, and compliance-driven export/import processes. These layers add cost even when demand is sparse.

4. **Stockout Risk and Emergency Procurement**
A stockout of a $20 sensor can trigger a six-figure AOG (aircraft-on-ground) event or a thousand-dollar field-service expense.

5. **Supplier Discontinuation (DMSMS)**
Rapid technology cycles, supplier consolidation, and geopolitical constraints increase the frequency of discontinuation (known as “diminishing manufacturing sources and material shortages” or DMSMS by the U.S. Department of Defense), forcing OEMs into last-time buys or expensive requalification efforts.

These cost layers detail how parts obsolescence and DMSMS can force OEMs into high-cost mitigation strategies for aftermarket inventory. While such costs can and do have material impact on OEMs’ margins and earnings, they’re rarely cited as factors in corporate reports and analyst coverage. Yet if an OEM achieves significant cost savings over traditional aftermarket inventory practices, the results — whether heralded on the next earnings call or not — will translate into improved profitability, which is an outcome any C-suite, board of directors, and investor will appreciate.

DOD as a Proxy for OEM Challenges

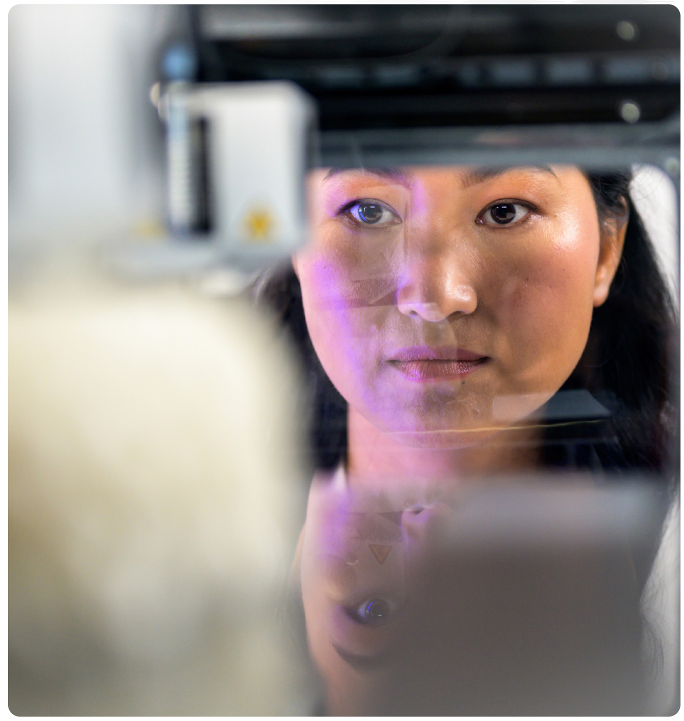
The U.S. Department of Defense provides a highly visible example of aftermarket constraints. With fleets expected to remain operational for 30 to 70 years, the DoD monitors thousands of suppliers for DMSMS. Examples like the C-5 toilet seat cover, which was previously $10,000 each but reduced to ~$300 with AM, illustrate the potential value of avoiding tooling and MOQ constraints.

However, many DoD achievements rely on engineering teams with deep AM expertise, secure qualification pathways, and flexible acquisition authorities. Most OEMs lack these structural advantages, making AM adoption far more challenging without decision-support automation.

3D Printing vs. Traditional Sourcing: A Clear-Eyed Comparison

AM offers compelling advantages, but only in specific, constrained scenarios. Procurement teams often struggle with identifying printable parts, matching materials and technologies, navigating qualification and certification, and quantifying full-cycle ROI.

The illustrative cost model below compares the major cost elements of CNC/MOQ sourcing versus AM for a typical heavy-equipment aftermarket part.



Illustrative Cost Model

Comparing Traditional CNC with 3D Printing

Traditional CNC with Minimum Order Quantity (MOQ)	3D Printing
Base unit cost: ~$10	Per-unit cost: higher ($35–$75 typical)
Tooling: $10k–$50k amortized	No tooling
MOQ exposure: purchase 5×–10× forecast	No MOQ exposure
Annual carrying costs: 20–30%	Minimal carrying cost
Warehousing: required (multi-node)	Localized or distributed print-on-demand
Global logistics: multi-leg	-----
Lead time: 6–12 weeks	Lead time: 48–96 hours
Total landed cost (10-year horizon): HIGH	Total landed cost (10-year horizon): LOWER for slow-movers; HIGHER for mid/high-volume parts

This comparison makes clear that AM does not universally lower costs. Its advantage emerges in the long tail of slow-moving, risk-prone parts.

Where Additive Manufacturing Is Not the Right Fit

As promising as additive manufacturing can be, procurement and engineering leaders are right to scrutinize applicable use cases. AM is not a universal substitute for traditional production. There are several situations where established manufacturing methods are clearly superior.

For example, **parts with high and predictable annual demand** are typically produced more economically through conventional processes, where economies of scale drive down unit costs. Likewise, components that rely on **specialized alloys, coatings, or surface treatments** — especially those not yet supported in current AM platforms — are often better sourced through traditional machining or molding.

In industries where safety and compliance are paramount, **safety-critical parts** can pose significant hurdles. The lengthy qualification cycles required to certify AM versions of these components may outweigh any potential operational benefit.

Long-standing supplier relationships also matter. When an OEM has **mature contracts with guaranteed service levels**, the stability and predictability of those arrangements can offer more value than the flexibility of AM. In some cases, the economics are straightforward: If **retooling or a minor redesign** provides a cheaper and faster path to continued production, AM is unlikely to be the optimal choice.

Where 3D Printing Delivers Clear Value

However, there are use cases that are clearly more cost-efficient and sensible for applying additive manufacturing, beckoning a hybrid strategy.

Additive manufacturing should be applied to aftermarket inventory procurement where the technology offers the most benefit — targeted, low-volume, high-impact scenarios in the aftermarket rather than where legacy processes remain the better business decision.

Key markers that make AM a likely cash-positive solutions include:

- **Annual demand for relevant parts is low or uncertain**
- **Parts are at risk of discontinuation**
- **MOQ/tooling costs exceed expected revenue from spares sales**
- **Storage and logistics dominate full-cycle cost**
- **Customers' fleet mix is highly variable**
- **Traditional suppliers are geographically constrained**
- **Reducing lead times has high business value (e.g., AOG avoidance)**

In these scenarios, AM enables procurement teams to eliminate tooling investments, MOQ exposure, long-term carrying costs, global logistics layers, and storage and insurance costs.

Industry Readiness Segmentation

Industry	Readiness Summary
Aerospace	Most advanced. Strong qualification frameworks; highest part criticality; AM already approved for many non-critical components.
Heavy Equipment	High potential due to long equipment lifespans, fragmented global supplier base, and significant volumes of slow-moving inventory.
Automotive	Mixed readiness. High-volume programs rarely benefit, but legacy vehicles and specialty programs are strong candidates for AM
IT & Commercial Electronics	Rapid technology cycles create ongoing DMSMS issues; AM typically viable for mechanical components, brackets, and housings.
Life Sciences	Heavily regulated with long qualification cycles. Adoption is increasing, but use cases remain highly selective.

Mini Case Vignettes

Aerospace

- A Tier-1 aerospace OEM required **180 units/year** of a specialized bracket.
- Supplier MOQs were **2,500 units with $40k tooling.**
- AM increased per-unit cost from $12 to $48 but **eliminated more than $120k** in overbuys and carrying costs, producing

10-year net savings of $310k.

Heavy Equipment

- A global tractor OEM **faced discontinuation** of a hydraulic manifold part needed at only **60 units/year**.
- AM avoided a **$75k retool and a 1,200-unit MOQ** and cut lead times from 14 weeks to 4 days, enabling faster service revenue recognition and

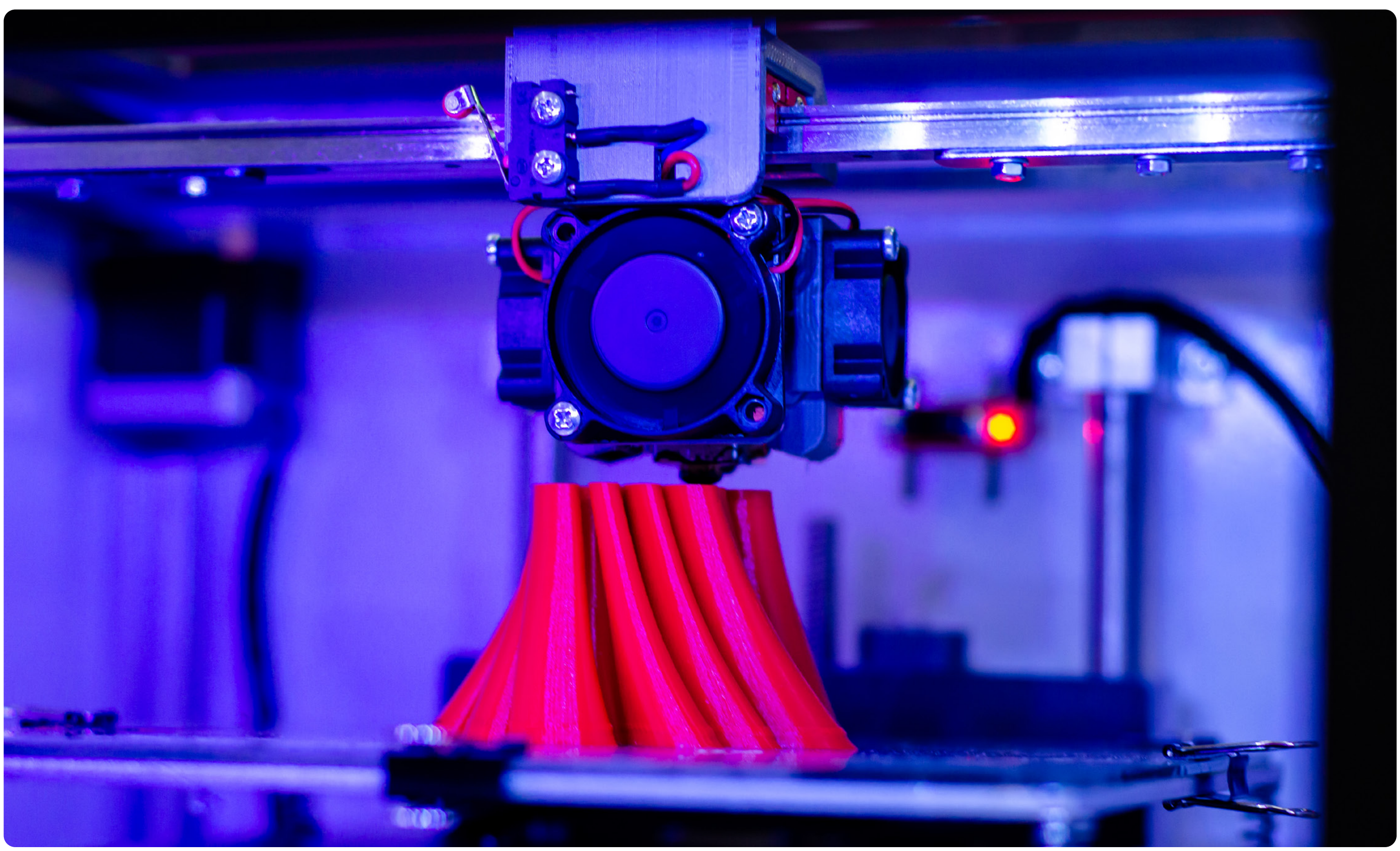
Reducing inventory by 90%.

Why OEM Procurement Teams Struggle to Adopt AM

Despite clear benefits, AM adoption lags. There are many reasons.

- **Difficulty identifying which parts are printable**
- **Lack of internal AM engineering expertise**
- **Fragmented vendor landscape**
- **Technology complexity (powder bed fusion vs. MJF vs. DMLS, etc.)**
- **Uncertain ROI modeling**
- **Long qualification cycles**

Procurement teams often know AM can help streamline their aftermarket inventory management. However, as AM's technological evolution accelerates, challenges multiply and prove too complex for human procurement professionals to master. Fortunately, new solutions are resolving these challenges, enabling greater use and adoption of AM techniques.



AI Capabilities to Scale Additive Manufacturing for Aftermarket Parts

Just as AI helps OEMs improve the speed and precision of their overall procurement and supply chain operations, AI solutions are emerging that enable firms with long-tail inventory obligations to utilize 3D printing more effectively.

These solutions include six Key features:

1. **Printability Assessment**
Determining whether AM can be used to produce a legacy or service part is a time-consuming task requiring deep materials science and manufacturing expertise. Modern AI systems can automate much of this evaluation, analyzing part geometry, tolerances, material characteristics, historical performance, and functional requirements to quickly identify which components are suitable for AM and which should remain in conventional production.

2. **Intelligent Materials and Process Matching**
Additive manufacturing encompasses dozens of machines, processes, and material families. Each have different strengths, limitations, and cost profiles. AI tools help OEMs navigate this complexity by mapping each part's engineering requirements to the most appropriate AM technology.

3. **Vendor Discovery and Sourcing Support**
Because the AM vendor landscape evolves rapidly, AI solutions are needed to continuously update knowledge bases of AM providers' capabilities, certifications, materials, and pricing patterns. By creating short lists of qualified vendors for specific parts and drafting RFQs, AI significantly reduces the manual effort required to engage appropriate AM suppliers.

4. **Full-Cycle ROI Modeling and Scenario Analysis**
One of the most challenging aspects of evaluating AM is comparing its unit costs to the complex, multi-year costs of tooling, MOQ exposure, carrying costs, logistics, and other costs associated with traditional procurement of aftermarket parts. AI-driven cost models can incorporate these full-cycle dynamics, enabling OEMs to compare scenarios over multi-year horizons.

5. **Streamlined Contracting, Logistics, and Transaction Management**
AI can also automate downstream procurement activities, including generating contract templates and validating pricing structures, selecting logistics routes, and coordinating shipment details. By simplifying the administrative load associated with sourcing small batches of AM parts, these tools make it easier for OEM procurement teams to integrate additive manufacturing into their existing supply chain workflows.

6. **Support for Qualification and Compliance Review**
Industries like aerospace, defense, life sciences, and energy require strict verification before contracting with new supply sources. AI can organize vendor documentation, facilitate analysis of sample-part tests, and reference regulatory or industry-specific requirements. With this kind of assistance, engineering and quality teams can quickly evaluate AM suppliers to ensure they meet safety-critical product standards.

Conclusion

AM is not a replacement for traditional sourcing. It is a powerful, targeted lever for reducing aftermarket inventory risk, eliminating unnecessary carrying costs, and strengthening supply-chain resilience. Emerging AI solutions can give OEM procurement leaders the decision intelligence they need to identify where AM truly delivers ROI and to act on those insights quickly, safely, and at scale.

AM's positive impact on supply chains is significant not just for procurement and operations teams but for their CXOs, boards, and investors, as well as sell-side analysts following their firms. If these teams manage their large and complex structures more cost-effectively with AM, the fiscal relief they generate translates to real material business impact — earnings, growth, and even market capitalization.

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