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Additive Manufacturing and the Future of European Defence

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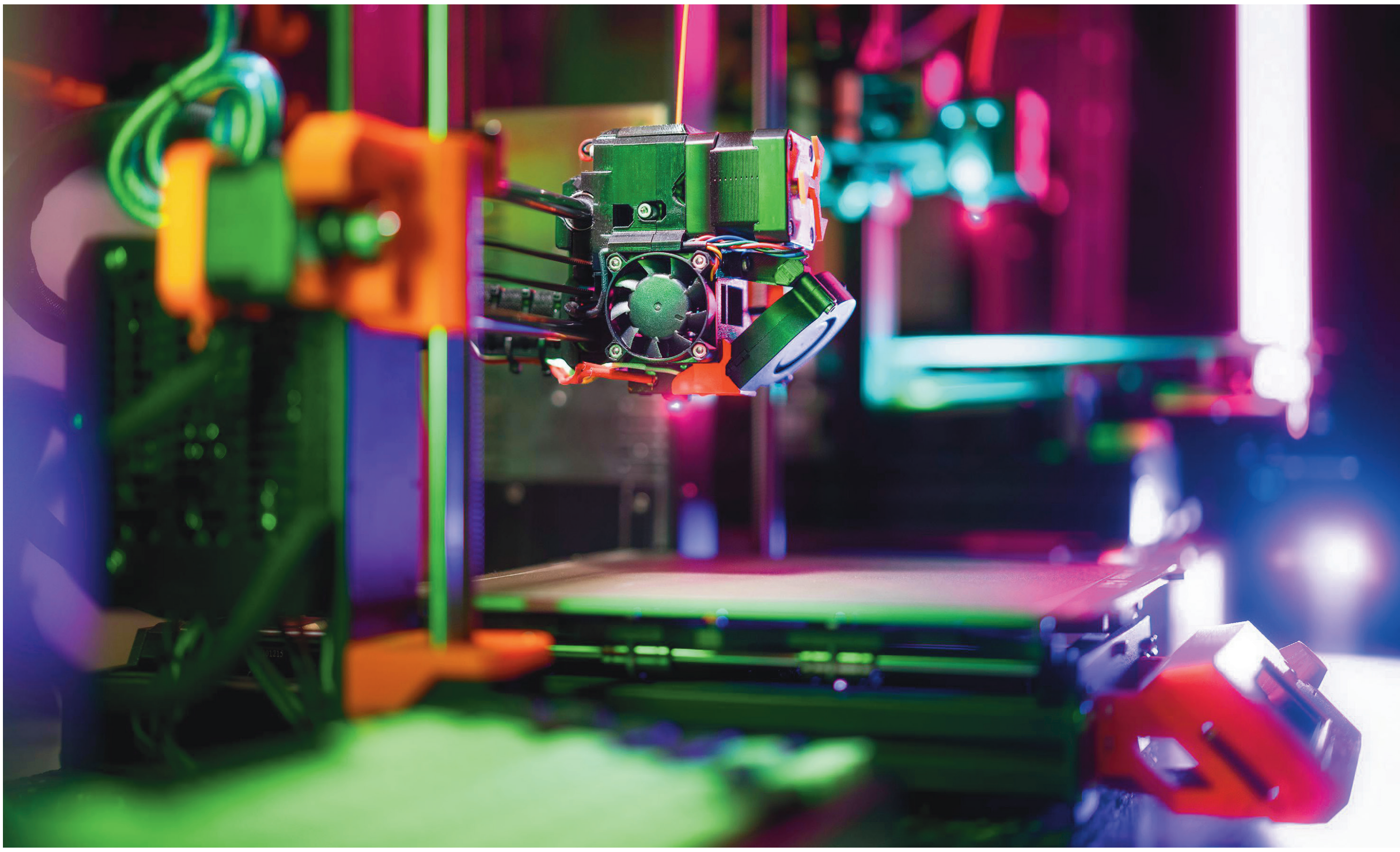

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Executive summary

Additive manufacturing is rapidly becoming central to how Europe supplies, repairs, and sustains its armed forces, giving it an edge over adversaries like Russia who are struggling with sanctions and supply chain constraints. This policy paper explores how AM is reshaping logistics, strengthening strategic autonomy, and recommends steps European leaders must take to maximize this advantage.

To transform AM from a tactical novelty to a strategic capability, Europe and NATO must act decisively in six areas:

1. **Standardize and certify.** Finalize one set of interoperable AM standards via EDA and NATO Standards Agreements (STANAGs), aligning material properties, testing, and digital workflows.

2. **Build secure digital infrastructure.** Develop federated digital part libraries compatible with NATO's RAPID–e system and protect them within cyber-secure IP frameworks.

3. **Reform procurement.** Shift defence acquisitions to value AM's lifecycle benefits and not just unit cost. Enable flexible contracting for digital files and fieldable AM printers.

4. **Accelerate joint R&D and training.** Expand EDF and DIANA-supported AM projects; launch a European AM Centre of Excellence for training, best practice exchange, and field trials.

5. **Reduce external dependencies.** Invest in European-controlled software platforms, advanced materials R&D, and open-access design libraries to reduce reliance on US-held intellectual property and supply chains. Prioritize the development of sovereign feedstocks, firmware, and precision AM systems tailored to EU operational and certification needs.

6. **Invest in industry and skills development.** Support SMEs and academic partners to scale AM capacity. Establish EU-wide training pathways to build a qualified military-industrial AM workforce.

1. Introduction

Europe's security environment is entering a period of prolonged uncertainty. Russia's sustained aggression in Ukraine, mounting pressure on global supply chains, and renewed transatlantic volatility during Trump's second term have all underscored a hard truth: Europe must strengthen its capacity to sustain defence operations independently. Amid these converging pressures, additive manufacturing (AM), often called 3D printing, is quietly emerging as one of the most consequential tools in Europe's strategic toolkit.

Europe must strengthen its capacity to sustain defence operations independently.

AM now enables armed forces to make mission-critical components near the point of use, reducing downtime, minimizing logistical exposure, and increasing battlefield agility. In an era when traditional supply lines can be disrupted or deliberately targeted, AM offers a sovereign and decentralized alternative to reinforce Europe's readiness.[1]

AM's promise lies not only in new manufacturing methods but in transforming Europe's entire approach to defence readiness. From rapid prototyping to digital part libraries, AM redefines logistics, resilience, and interoperability. As the EU seeks to bolster its ability to defend itself, AM must be treated not just as a technical novelty, but as a sovereign capability essential to deterrence and crisis response. Europe's rapid progress in this area already places it well ahead of Russia, which remains constrained by sanctions and limited operational AM capacity.[2]

2. Revolution under way

Across Europe, national initiatives have begun embedding additive manufacturing into defence operations. The UK's Project TAMPA, a £5 million accelerator, has demonstrated rapid prototyping of vehicle parts, including projects that have halved their production time and weight.[3] In 2025, the UK also extended AM support to Ukraine, providing digital part files and training to enable frontline 3D printing of essential components.[4]

France has pioneered AM integration through Naval Group, whose certified wire-arc manufactured (WAAM) propeller for the minehunter Andromède cut both cost and lead time dramatically.[5]

Germany, once viewed as a laggard in defence-related additive manufacturing due to fragmentation and limited IP access, has made significant progress by mid-2025.[6,7] The Bundeswehr's Planning Office now leads a national roadmap, highlighted at the 2025 European Military AM Symposium in Bonn. New initiatives from the MOD's scientific arm (WIWeB) and Bundeswehr logisticians are aligning AM capabilities with operational needs. Germany is also emerging as a regional hub for standardization and NATO interoperability.[8]

Meanwhile, Spain's Ministry of Defence co-funded a new €82.6 million centre military AM (CEDAEC), for deployable spare parts (Duran, 2025).[9] Italy's MBDA is using AM to produce lighter and more compact missile subcomponents at lower cost.[10]

Multiple other European countries are innovating with AM. Greece has fielded 3D-printed drone systems for its army, Sweden is advancing electron-beam printing for high-performance components, while Finland, Norway, and the Baltics are testing AM for naval, cold-weather, and frontline repair applications.[11] Together, these efforts point to a broadening pan-European ecosystem of defence innovation.

These efforts are supported at the EU level by the European Defence Agency (EDA) and the European Defence Fund (EDF), which backs multinational projects like DISCMAM to develop secure digital supply chains.[12,13] Together, all these actors form a growing ecosystem for AM innovation, deployment, and sustainment.

AM is delivering measurable readiness gains across all operational domains. In aerospace, AM enables companies like Rolls-Royce and Safran to produce high-performance components that improve efficiency while reducing weight.[14] Saab's Gripen fighter has flown with a 3D-printed parts, and the UK's Tempest air demonstrator will feature structural AM parts post-processed via hot isostatic pressing.[15,16]

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The Royal Netherlands Navy operates shipboard polymer printers to generate spare parts on demand while the UK's Babcock International has printed submarine parts, halving both cost and production time.[17]

The technology has already been tested in field conditions. Cold-spray AM printers were deployed during NATO's Exercise Steadfast Defender, fabricating Land Rover parts in hours.[18] Looking to the future, Rheinmetall estimates that up to 38 percent of tank components could eventually be 3D-printed.[19]

In Ukraine, volunteer groups are using consumer-grade 3D printers to produce drone parts under battlefield conditions, prompting NATO to integrate drone printing into training exercises.[20]

3. Transforming Military Logistics

Additive manufacturing is reshaping military logistics from a 'push' model of stockpiling spares to a 'pull' paradigm of manufacturing on demand. Deployable AM labs can make mission-critical parts within hours, enabling rapid repairs and increasing operational availability at forward locations.[21] Rather than transporting and securing heavy crates of spares, militaries can now store digital inventories (design files accessed securely in theatre), dramatically reducing the size and scope of their logistics tail, making them easier to defend in the process.[22]

France's AM advances demonstrated this potential during Operation Barkhane in remote areas of Mali, where the technology bridged gaps that traditional supply chains couldn't reach.[23, 24] Meanwhile, additive electronics are also emerging. The European Space Agency printed high-frequency antennas with lightweight internal structures for satellites, a design approach applicable to secure military communications.[25] Experiments in portable printed circuit board (PCB) printing and field-made enclosures hint at a new wave of tactical electronics production.[26]

Beyond battlefield logistics, additive manufacturing also holds promise for strengthening civil preparedness and societal resilience. In times of systemic shocks like natural disasters, infrastructure failures, or hybrid attacks, AM enables decentralised, rapid production of critical supplies such as medical gear, water purification parts, energy grid components, and temporary shelters. Its ability to localise production reduces dependency on fragile global supply chains and accelerates response times when conventional logistics falter. Civil-military interoperability around AM, including the use of dual-use facilities and shared digital libraries, can bolster whole-of-society readiness.

4. The Technology Landscape: From Catalogues to Capabilities

Europe's defence sector employs AM processes tailored to different needs. For precision applications like aerospace and UAVs, Laser Powder Bed Fusion (LPBF) and selective laser sintering (SLS) deliver high-resolution, high-performance parts.[27, 28] For large-scale or field use, WAAM, cold spray technology, and binder jetting are preferred for their speed and scalability.[29, 30]

Emerging technologies include hybrid printers that combine additive and subtractive steps for tight tolerances, as well as multi-material systems capable of embedding sensors or circuitry mid-print. Automated print farms (robot-supervised clusters of AM machines) could one day also support surge manufacturing during conflict or crisis.

The strength of Europe's AM ecosystem lies in its cross-sectoral partnerships. Defence primes such as Airbus, BAE Systems, Naval Group, and MBDA are already driving in-house adoption. Agile SMEs like SPEE3D, AddUp, and Markforged have also developed develop bespoke machines and materials. Research institutions including Fraunhofer, Cranfield, TNO, and AMRC continue to advance core science, certification, and workforce training to support the broader adoption of AM.

Governments are also driving this evolution. The UK MOD, France's DGA, Germany's BMVg, and Spain's MoD are funding AM pilot projects and formulating strategy. At the EU level, the EDA and European Commission promote interoperability and joint R&D via the EDF. During COVID-19, this ecosystem pivoted to produce medical gear, illustrating AM's dual-use agility.[31] Trials of NATO's RAPID–e system for digital part sharing validated its use among allies, pointing to broader logistics and resilience applications.[32]

The strength of Europe's AM ecosystem lies in its cross-sectoral partnerships.

5. Global State of Play

Europe holds a clear strategic and operational advantage over Russia in AM, particularly in the defence sector. Moscow is significantly constrained by international sanctions that limit access to advanced materials, high-precision machine tools, and industrial software required for modern AM production.

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While Russian research institutions, such as Bauman Moscow State Technical University, continue to explore AM concepts, there is no verified evidence of operational deployment within the Russian military at scale.[33] Europe's success during the COVID-19 pandemic in rapidly converting military and civilian AM infrastructure to produce medical supplies further demonstrates the resilience and dual-use potential of its AM ecosystem.

China, by contrast, is investing heavily in AM under its civil-military fusion strategy. Industrial giants such as BLT, Farsoon, and Xi'an Bright Laser are producing metal AM systems, some of which are reportedly in use by the People's Liberation Army (PLA) for aerospace components and repair logistics.[34, 35] However, China still faces constraints in ultra-high precision and material quality control, particularly for critical parts.[36] Europe retains an edge in certification transparency, aerospace safety regimes, and NATO-aligned interoperability, though it lags behind China in centralized scaling and procurement speed.[37]

The United States remains the global leader in defence-focused additive manufacturing. Through decades of early investment from DARPA and the Department of Defense, AM is now embedded in US military logistics, aerospace platforms, and naval repair operations. US forces have also tested deployable AM labs for field logistics, supported by strong public-private partnerships and advanced R&D environments.[38] While Europe is rapidly advancing, particularly in dual-use and multinational frameworks, it continues to trail the US in industrial scale, integration speed, and end-to-end logistics adoption.

While Europe's defence AM capabilities are advancing rapidly, full strategic independence from the United States has remained elusive. European firms and EU-backed programs like the EDF and DISCMAM are strengthening indigenous production, certification, and logistics. However, many AM systems still rely on US-developed software, patented technologies, and high-performance feedstocks, particularly for aerospace and naval components.[39] Reducing these dependencies will require targeted investment in European materials science, IP development, and industrial scaling to match US depth and flexibility.

6. Toward a Nimbler European Defence Industrial and Logistics Base

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Additive manufacturing is already changing how Europe repairs, supplies, and sustains its defence forces. As global competition intensifies and logistics grow more vulnerable to attack, AM offers a resilient and sovereign solution. But realising its full potential will require coordination, certification, and bold procurement reform.

In the future, readiness will not be defined by what we can stockpile but by what we can make when and where it's needed most. AM is the bridge from industrial legacy to modern operational agility. This is a bridge Europe must cross decisively to deter future aggression on its own.

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