Whitepaper

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Defense Readiness: The Role of Additive Manufacturing

This whitepaper gives answers to:

- Where Additive Manufacturing can strengthen European defense readiness and resilience
- How defense organizations can integrate AM into their supply chains today
- Real-world success stories demonstrating the operational impact of AM

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Introduction

In an era defined by geopolitical instability, accelerating technological change and increasingly sophisticated threats, Europe's defense readiness is under unprecedented pressure. The global call for a once-in-a-generation surge in defense investment underscores the need not only for increased spending, but also for smarter, more resilient ways of delivering military capability.

This white paper explores the transformative role of Additive Manufacturing (AM) in strengthening Europe's defense readiness and operational capability. It highlights how AM can empower the industry to innovate and create new products, while addressing long-standing supply chain challenges, such as vulnerability to disruption, long lead times and limited manufacturing capacity.

Through use cases and real-world examples, the paper demonstrates how AM is already delivering operational advantage, from battlefield repair to advanced system design, setting out practical steps to integrate AM into defense procurement, supply chains and industrial strategy.

The European Defense Landscape

Europe faces an acute and evolving threat environment, including active war zones in Eastern Europe and other neighboring territories. Regimes and autocracies have become more assertive around the world, using a range of methods to achieve their nefarious aims including policy, psyops, kinetic warfare and the rising threat of grey zone threats (cyber, disinformation and sabotage for example).

The recent European Commission White Paper for European Defence – Readiness 2030 [1], highlights how "geopolitical rivalries have not only led to a new arms race but have also provoked a global technology race." Ultimately it calls for a once in a generation surge in coordinated European defense investment to ensure readiness by 2030 with a focus on collective defense, deterrence, and resilience.

Core to achieving effective defense across Europe is the need to build a strong and innovative European Technological and Industrial Base – effectively a European market for defense equipment to ensure that land, air and maritime borders are protected.

Effective defense will not only rely on coordination amongst the military organizations of European countries, but a wholesale shift in the way supply chains operate. Moving forward these will need to support defense innovation in several areas from the way contract and procurement processes take place, through to the way in which materials are acquired and products manufactured.

The same report specifically cites a need to support the development of new and innovative industrial processes such as distributed design and manufacturing, additive manufacturing (AM) and the use of artificial intelligence (AI). Crucially, Small and Medium-sized Enterprises, and start-ups are seen as vital contributors to a more agile and competitive defense sector.

The Challenges Facing Defense Manufacturing

AM is already being used in the defense sector at the design, manufacture and maintenance stages of the product lifecycle, and some nations have also identified AM as a strategic technology for logistics. Despite these uses by some innovative companies and nations, and clear benefits, there has not been enough progress to adopt the technology across the sector. Much of the benefit is being gained by individual defense manufacturers and their customers for specific products, rather than part of a European strategy to create a defense market.

Governments that have quantified the benefits of AM include the UK, stating that it believes the application of AM technologies and processes would be cost effective and improve the availability of inventory. A UK report commissioned using Defence Innovation Unit funding, stated that if 15% of the defense inventory were produced with AM, the "net financial benefit to the MOD would be £110M over the next 15 years, with a net value per year thereafter of £35.5M [2]."

The U.S. Department of Defense (DoD) too has highlighted how AM is aligned with its own DoD Additive Manufacturing Strategy (2021), supporting all three aims: the modernization of national defense systems, increasing material readiness, and enhancing warfighter innovation & capability [3]. The same document states that key to the success of AM will be achieving several goals including integration into the wider U.S. defense industrial base, and its external partners, while educating and training the technical and business workforce.

Whilst the White Paper for European Defence - Readiness 2030 concludes that AM is a technology to be supported, it also characterizes specific challenges in defense industrial base as having "structural weaknesses" despite being the home of several global defense companies [1]. It summarizes the current situation as one where the defense industrial base cannot meet the demand for defense systems, is fragmented, and with many national players focusing on serving their own domestic market.

The fragmentation that currently exists extends beyond the defense industrial base to European defense departments. The German Federal Court of Audit recently noted that even the German Armed Forces, one of the largest in Europe, is investing in AM without enabling the supply chain, thereby creating an island solution that does not work properly. It concluded that "the German Armed Forces should take 3D printing into account in their procurement contracts and – where appropriate – acquire design data and manufacturing rights."

These challenges are not unique to Germany, with initiatives to overcome them being discussed at many levels across Europe.

The Evolution Underway

Europe is building a new and stronger EU Defence and Technology Industrial Base (EDTIB), forming a single EU-wide market for defense equipment. This new market will benefit from a harmonized and simplified set of rules and be able to operate at a scale Member States can rely on to meet their equipment needs.

According to the EU, defense spending by Member States has risen by 30% since 2021 to EUR 326bn (1.9% of EU GDP) [4]. As all readers of this paper will be acutely aware, conflicts and political uncertainty have driven debate about the need for spending to rise dramatically. NATO guidelines, for example, have now risen to 5%, split between core military spending (3.5%) and resilience (2%) by 2035.

As the examples cited earlier in this paper show, money alone will not secure an effective defense infrastructure and capability. An evolution is needed in how the industrial base approaches the manufacture of defense equipment, so it is produced more rapidly, flexibly and at a scale that can support every European nation.

Additive Manufacturing at the Center of Mission Readiness

Underinvestment has affected European defense infrastructure in several ways, but probably the two most acutely felt by countries are mission readiness and a stagnation of operational capabilities.

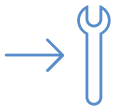
The days of predictable supply chains and comfortable lead times are over. Global defense leaders now operate in a landscape where geopolitical flashpoints, trade restrictions, and raw material shortages have made traditional manufacturing approaches increasingly vulnerable to a range of risks. The COVID-19 pandemic was a compelling example of how fragile supply chains are that rely on traditional manufacturing techniques and logistics. Ultimately, over-reliance on single-source suppliers and extended logistics networks can cripple mission readiness when it is needed most. AM is helping the defense industry overcome these challenges:

Supply chain resilience

AM enhances resilience in the supply in several ways. Firstly, because AM machines rely only on having the secure digital technical data packages and the correct materials, components can be printed anywhere, whether at a supplier, or using a contract manufacturer perhaps to scale-up production. This creates resilience and lowers risk by creating a decentralized supply chain. Machines can also rapidly switch between components to manufacture, with no retooling required, and work 24 hours a day with minimal supervision. Together these benefits bring great agility to defense supply chains, eliminating choke points and single points of failure that bring production to a standstill.

Lead time reduction

Traditional manufacturing methods such as casting can prolong lead times, taking time to tool up. Conversely AM enables the rapid scaling up of production through additional purchased machines, or sub-contract manufacturing. Orders can be fulfilled more quickly, keeping supply chains agile and elastic. Components can also be produced nearer to the location needed, removing the costs and delays associated with long-distance logistics such as container shipping.



Deployable manufacturing

Maintaining and repairing damaged military equipment is one of the most challenging aspects of mission readiness. Which components will be needed when and where can be hard to predict, and in the theatre of war it is essential that hardware can be returned to operational duties quickly without compromising safety. The small footprint required by AM machines makes them ideal for deployment at the rear area of a theatre, or local air or naval base. Using digital technical data packages, a host of components can be printed on demand – even for a single expedient repair – dramatically improving mission readiness in contested environments. This capability transforms the calculus of operational planning, allowing commanders to sustain operations with a smaller logistics footprint.

The *Additive Manufacturing for Logistics Support (ALMS) project* [5], funded by the European Defence Agency, is a great example of where European countries are working together to integrate AM as fundamental technology for the armed forces. This group of 11 countries is cooperating to determine common standards and ensure interoperability between their operations. Started in 2023, the project is looking at a wide range of areas including spare parts production, procurement, quality control and legislation.

Driving Operational Capabilities

The lack of investment in defense is seen by many as primary reason for the stagnation of operational capabilities in the sector, particularly with respect to system design and innovation. As outlined at the start of this paper, huge steps are being taken to address funding, but across history innovation has been driven by need, challenging circumstances and limited resources. Ingenuity and creativity matter too.

Additive Manufacturing has enabled industries from consumer goods to medical, energy, aviation and space to completely reimagine the design of products. Approaches to design that are impossible with traditional manufacturing methods are improving everything from thermal management in electronics to structural integrity in lightweight components. These performance gains often translate directly to higher efficiencies and system reliability.

In pockets, the defense industry is taking advantage of AM, but the UK Ministry of Defence, European Union, NATO and U.S. Department of Defense have all highlighted how important AM will be moving forward. The level of innovation seen in Ukraine developing drone technologies is just one example of how defense is evolving to rapidly design, develop and deploy technologies in timescales and at price points not seen before.

Increasing system performance

Fully digital AM workflows directly improve system design capabilities. Benefits such as rapid iterative prototyping and mass distributed production are improving performance at every step of the product lifecycle, from idea to legacy component provision. The design freedom of AM is enabling engineers to reimagine components with complex geometries, leading to extraordinarily efficient and compact components such as high-performance heat exchangers.

Cost and complexity reduction

AM designs reduce the component and assembly steps to produce final products. Complex geometries can be printed that consolidate components into

a single functionally integrated piece that is more robust, lighter and more reliable. A shortened design process, reduced energy consumption, localized production and a lower material waste can all make AM a more cost-effective production method.

Rapidly supporting new mission profiles

Recent conflicts have clearly demonstrated how quickly mission profiles are evolving. From designing new equipment to refining products based on field feedback, or creating new camera and munition mounts, the digital workflow of AM is shortening the prototype to production lifecycle from months to days, with tool-free production allowing rapid design iterations.

AM is being used in some of the most demanding use cases, such as advanced missile production. Lead times and production costs are being cut, as part consolidation eliminates assembly steps and improves reliability. Finally, new levels of performance have been made possible with AM. Components such as fuel injectors, heat exchangers, control systems and propellant management devices have all been redesigned to take advantage of advanced materials such as Niobium C103, copper alloys and NASA's GRX-810 High Temperature Alloy.

Priority Defense Areas for Additive Manufacturing

EOS is ready to build on its defense industry experience and make a bigger impact on helping Europe meet its defense challenges. Digital workflows and technical data packages mean files can be securely transmitted and produced locally, eliminating vulnerable physical supply chains that cross multiple borders and jurisdictions. In contested environments, this digital-to-physical capability becomes a force multiplier, enabling commanders to maintain equipment readiness regardless of logistical constraints.

The idea of transmitting data files for military hardware naturally raising concerns about how to protect sensitive military designs while enabling the distributed manufacturing that makes AM so valuable in defense contexts. This has prompted investment in secure digital rights management systems, including NATO's RAPiD-e, which are designed for advanced manufacturing workflows and allow securely encrypted files to be shared with trusted partners, protecting intellectual property.

Defense departments and certified supply chain partners, such as contract manufacturers, can start today to look at where they can implement AM into their product lifecycle or different areas of the supply to shorten lead times or scale-up production. Some of the areas EOS believes AM can make an immediate and substantive impact include:

- **Air and missile defense:** AM is already being used to enhance the capabilities of defense systems by improving performance, accelerating development lifecycles and reducing cost.
- **Ammunition and missiles:** Current production methods are struggling to meet the demand for munitions and taking years to scale. AM can be used to address these shortfalls, with large scale production.
- **Drones and counter-drone systems:** AM already plays a crucial role in drones and counter-drone systems. The speed of innovation that has taken place during the Ukraine war has never been seen before – as short as 4-6 weeks. Systems are constantly being updated with new technology. It is an arms race in every sense that conventional manufacturing cannot keep up with.
- **Strategic enablers and critical infrastructure protection:** AM platforms can be containerized for rapid deployment in remote environments, rather than treated as a fixed asset. This enables supply chains to be reinforced, whether at the rear area of a military theatre, within an air base, or to replace part of a compromised supply chain.

Conclusion: Getting Additive Manufacturing Into Your Defense Supply Chain

As a German family-owned company and over 35 years of experience in industrial 3D printing, EOS is a trusted partner to defense organizations worldwide. Our metal and polymer additive manufacturing solutions are designed to deliver mission-critical reliability and have a long-standing track record in defense applications, mitigating risk and enhancing supply chain resilience. More than 10 EOS metal and polymer systems are already supporting in the battlefield. With the largest installed base at qualified contract manufacturers, we enable rapid scalability in times of increased operational demand.

Additive Minds, the consulting division of EOS, empowers defense manufacturers and armed forces to implement AM successfully. With over 100 global experts, Additive Minds provides deep technical expertise, co-engineering services, and targeted training to accelerate AM adoption — ensuring your teams gain both capability and confidence.

Each case study in this paper reflects how EOS technology and expertise have already contributed to advance defense readiness — improving operational capabilities and mission readiness in the defense sector.

Contact the EOS Additive Minds team or visit

to explore how we can help you build a more agile, sovereign, and future-ready defense supply chain.

Gripen case study

Sweden's defense leader Saab, working together with AMEXCI, has proven that AM parts can be used to produce temporary replacement components for Gripen fighter jets. This approach is keeping aircraft operational until the conventional spare parts are available again. The significance isn't just in the part itself, but in what it represents: the ability to rapidly replace battlefield-damaged components with AM and increase operational availability of the equipment.

Figure 1: Source: SAAB

Field-Ready Manufacturing use case

Eliminating logistics risks is a challenge in military planning, particularly when it comes to the repair and servicing of equipment. AM platforms can be containerized for deployment in the field, enabling localized, on-demand production of mission critical parts right where they are needed. Digital workflows and scanning technology mean that physical components can even be reverse engineered, manipulated in design tools to incorporate enhancements and then manufactured on site. Fieldmade is an example of providing such solutions.

Figure 2: Source: Fieldmade

Submarine pump case study

The consolidation of parts through AM has brought significant benefits to a multistage pump used in submarines. Designed to be at sea with limited returns to port, it is critical that components are reliable. Created by OEM pump manufacturer KSB, the new design increased operational reliability, by turning three parts into a single printed component, which also removed the need for several gaskets. Design changes reduced the weight by 50%, and installation space by 5%. The design workflow enabled changes on demand that could be immediately printed, rather protracted manufacturing processes taking weeks. This approach also allowed precision design changes to be made that tailored the natural frequency of the component reducing the acoustic signature of the submarine, lowering the chances of detection.

Figure 3: Source: KSB | EOS

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Florian began his professional career with a master's degree in industrial engineering & economics from TU Berlin. With around 11 years of experience in Additive Manufacturing (AM), Florian has held several roles at EOS, progressing from technical consulting within Additive Minds to positions in Business Development. Currently, as Industry & Key Account Management, Florian can leverage both his technical insight and strategic expertise to drive impactful business outcomes.

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