Additive Manufacturing in Military Contracting: 2025 Predictions

Introduction

Additive manufacturing (AM), also known as 3D printing, has emerged as a transformative technology with the potential to revolutionize the manufacturing landscape across various sectors, including the military. AM involves building three-dimensional objects layer by layer from a digital design, offering unparalleled flexibility and customization compared to traditional manufacturing methods. This report delves into the predictions for the additive manufacturing market in military contracting for 2025, examining key trends, drivers, challenges, and the impact on both large-scale and small-scale contractors.

Market Size and Growth

The additive manufacturing market in aerospace and defense is experiencing significant growth. In 2022, the global market was valued at $2.76 billion and is projected to reach $17.89 billion by 2032, growing at a compound annual growth rate (CAGR) of 20.48% during the forecast period [1].

In the United States, direct Department of Defense (DoD) spending on AM is estimated to reach $800 million in 2024, a significant increase from $300 million in 2023 [2]. This growth is expected to continue, with the market for military AM exceeding $2.6 billion by 2030 [2]. This growth is driven by the increasing adoption of AM for various military applications, including prototyping, tooling, jigs and fixtures, and end-use parts [3].

Drivers of AM Adoption in Military Contracting

Several factors are driving the adoption of AM in military contracting:

- **Customization and Rapid Prototyping:** AM enables the production of customized parts without the need for expensive tooling or dyes, facilitating rapid prototyping and testing of new weapons systems [4]. This significantly reduces development cycles and time-to-market, allowing defense manufacturers to respond quickly to evolving needs. For example, Sig Sauer, a leading DoD supplier, has embraced AM during the development of its pistols, rifles, and silencers. AM enables silencers to be printed in one piece, using advanced materials to reduce weight and improve sound suppression [4].

- **On-Site Repairs:** With 3D printers, defense contractors can produce parts closer to the point of need, whether in a remote base or in the field [4]. This reduces downtime and improves operational readiness, crucial in critical military operations. The U.S. Navy, for instance, uses AM on its USS Bataan to produce ship parts like water filters at sea, cutting costs by up to 98% and reducing wait times for supplies [4].

- **Supply Chain Resilience:** AM allows for localized production of parts, reducing reliance on global supply chains and mitigating risks from geopolitical or pandemic-related disruptions [4]. This is particularly important for the defense sector, where supply chain vulnerabilities can have significant national security implications. The U.S. Army has deployed Markforged composite printers at base locations to manufacture vehicle parts, tools, and personal protective equipment (PPE), ensuring a steady supply of critical items [4].

- **Lightweight and Durable Parts:** AM enables the production of lightweight, durable parts with complex geometries, crucial for modern defense applications such as unmanned aerial vehicles (UAVs), missiles, and advanced combat aircraft [5]. This improves operational efficiency and adaptability in defense strategies.

- **Reduced Lead Times and Costs:** AM can reduce lead times and costs associated with traditional manufacturing processes, especially for low-volume production of complex parts [6]. This is particularly beneficial for the military, which often requires specialized parts in limited quantities. For example, in 2020, the U.S. Army needed hatch plugs for combat vehicles. The original vendor had discontinued the part, and replacements would have required a three-month lead time and cost $10,000 to produce. Using AM, the Army 3D printed two versions of the part in a few days at a fraction of the cost [7].

- **Enhanced Sustainment and Readiness:** AM plays a crucial role in improving sustainment and readiness by enabling on-demand production of spare parts, reducing reliance on traditional supply chains, and facilitating rapid repairs in the field [4]. This capability is essential for maintaining the operational effectiveness of military equipment and ensuring mission success. The ability to produce parts on demand eliminates time, costs, and infrastructure while contributing significantly to readiness levels [6].

- **Boosting Domestic Production:** The AM Forward initiative, launched by the Biden administration in May 2022, aims to leverage AM to boost domestic production and enhance supply chain readiness [8]. This initiative encourages the adoption of AM on shop floors across the country, thereby strengthening the domestic manufacturing base and reducing reliance on foreign suppliers.

Challenges to AM Adoption in Military Contracting

Despite the numerous advantages, several challenges hinder the widespread adoption of AM in military contracting:

- **High Initial Investment and Operational Costs:** The initial investment in AM equipment and the ongoing operational costs can be high, particularly for metal AM processes [9]. This can be a barrier for smaller contractors with limited resources.

- **Lack of Skills and Knowledge:** There is a shortage of skilled personnel with expertise in AM technologies and processes [9]. This can limit the ability of defense contractors to effectively implement and utilize AM.

- **Quality Control and Standardization:** Ensuring consistent quality and standardization of AM-produced parts remains a challenge [10]. This is crucial for critical military applications where part failure can have serious consequences.

- **Limited Production Speed and Scalability:** AM processes can be slower than traditional manufacturing methods, particularly for large-scale production [9]. This can limit the applicability of AM for certain military applications.

- **Intellectual Property Protection:** Protecting the intellectual property associated with AM designs and processes is a concern [11]. This is particularly important for the defense sector, where sensitive technologies need to be safeguarded.

Types of AM Technologies Used in the Military

The military utilizes a variety of AM technologies to meet its diverse needs. These technologies can be broadly categorized based on the materials they process and the underlying printing processes.

Material Categories:

- **Polymers:** Polymers are widely used in AM due to their versatility, ease of processing, and relatively low cost. They are used for applications such as prototyping, tooling, and non-structural components.

- **Metals:** Metal AM is gaining traction in the military for producing high-performance parts with complex geometries. Titanium and titanium alloys are of particular interest due to their lightweight and high strength-to-weight ratio [12].

- **Ceramics:** Ceramics offer high-temperature resistance and wear resistance, making them suitable for applications such as engine components and protective coatings.

- **Composites:** Composite materials combine the properties of different materials to achieve enhanced performance. Hybrid ceramic tile/polymer-matrix composites are being explored for military applications [12].

AM Processes:

- **Vat Polymerization:** This process uses a vat of liquid photopolymer resin that is selectively cured by a UV light source. Stereolithography (SLA) is a common vat polymerization technique.

- **Powder Bed Fusion:** This process uses a high-energy laser or electron beam to selectively melt and fuse powdered material. Selective laser sintering (SLS) and direct metal laser sintering (DMLS) are examples of powder bed fusion technologies.

- **Material Extrusion:** This process involves extruding molten thermoplastic material through a nozzle to build the object layer by layer. Fused deposition modeling (FDM) is the most common material extrusion technique.

- **Binder Jetting:** This process uses a liquid binding agent to selectively join powdered material. It is suitable for producing complex shapes with intricate details.

- **Directed Energy Deposition:** This process uses a focused energy source, such as a laser or electron beam, to melt material as it is deposited. It is often used for repairing or adding features to existing parts.

- **Sheet Lamination:** This process involves bonding thin sheets of material together to create the object. It is suitable for producing large parts with complex internal structures.

The selection of the appropriate AM technology depends on the specific application requirements, material properties, and production volume.

Recent Developments and Trends

The DoD has been actively promoting the adoption of AM through various initiatives. In 2021, the DoD published the Additive Manufacturing Strategy and DoD Instruction 5000.93 Use of Additive Manufacturing, outlining a comprehensive strategy for implementing AM in the defense industry [13]. This strategy aims to integrate AM into DoD operations, modernize national defense systems, increase materiel readiness, and empower warfighters with innovative solutions [14].

The DoD has also been investing in research and development to advance AM technologies and applications. For example, the Army Research Laboratory is exploring the use of lightweight metals such as titanium and titanium alloys for 3D printing vehicle parts [12]. The Navy has installed a metal 3D printer aboard one of its ships, enabling on-demand production of parts at sea [8].

Some notable recent developments and trends include:

- **Expansion of AM to the Tactical Edge:** The Army is increasingly focused on developing the ability to do 3D printing on the battlefield, bringing AM capabilities to the "tactical edge" [15]. This involves deploying 3D printers and skilled personnel to forward operating bases and potentially even to individual soldiers in the field. This initiative aims to enhance operational readiness and self-sufficiency by enabling on-demand production of critical parts and equipment in remote locations.

- **Jointless Hull Project:** The Jointless Hull project aims to use additive technology to print single, seamless combat hulls, eliminating weaknesses in vehicle bodies [8]. This innovative application of AM has the potential to significantly improve the survivability of ground vehicles by eliminating vulnerable joints and increasing structural integrity.

- **Production of Obsolete Parts:** AM is being used to manufacture obsolete parts for legacy aircraft, such as the B-52, C-5M Super Galaxy, and B-2 Stealth Bomber [16]. This capability is crucial for maintaining the operational readiness of aging aircraft fleets and extending their service life.

- **Lightweight Brackets and Mounts:** The US Army has been using AM to create lightweight brackets and mounts for handheld launch components [17]. This demonstrates the design flexibility and lightweighting capabilities of AM, which are essential for improving the performance and portability of military equipment.

Impact of AM on Military Equipment and Operations:

AM is transforming the design, production, and maintenance of various types of military equipment. For example:

- **UAVs:** AM enables the production of lightweight and complex UAV components, improving their performance and efficiency [5].
- **Ground Vehicles:** AM is used to produce customized parts for ground vehicles, such as hatch plugs and brackets, reducing lead times and costs [7].
- **Naval Vessels:** The Navy's use of AM on the USS Bataan demonstrates the potential for on-demand production of parts at sea, enhancing self-sufficiency and reducing reliance on external suppliers [8].

Specific Deals and Contracts

Several recent deals and contracts highlight the growing importance of AM in military contracting:

- The US Naval Surface Warfare Center has issued six contracts to vendors for developing prototype projects using 3D printing technology to protect military technologies [18].
- The US Air Force has awarded a $975 million contract to 67 companies, including MELD Manufacturing, 3D Systems, and Authentise, to support the Rapid Sustainment Office in optimizing the operational readiness of deployed assets [19].
- The Defense Logistics Agency (DLA) has awarded its first competitive contract for an additively manufactured part that prevents structural damage to F-15 aircraft [20]. This reinforces DLA's commitment to collaborating with the military services on 3D printing procurement strategies.

Competitive Landscape

Both large-scale and small-scale contractors are impacted by the growth of AM in military contracting.

Large-scale contractors like Lockheed Martin are investing heavily in AM infrastructure and expertise [21]. They are leveraging AM to enhance product design, reduce development time, and improve production efficiency. Lockheed Martin recently expanded its AM facility in Grand Prairie, Texas, with state-of-the-art equipment, including large-format, multi-laser machines [21].

Small-scale contractors can also benefit from AM by offering specialized AM services, such as design, prototyping, and low-volume production of customized parts. The DLA is actively working with small businesses to help them access technical data and participate in AM

procurement opportunities [20].

The competitive landscape in the AM market for military contracting is characterized by:

- **Increasing Competition:** The market is becoming increasingly competitive, with both established players and new entrants vying for a share of the growing pie.
- **Collaboration and Partnerships:** There is a growing trend of collaboration and partnerships between large and small contractors, with large companies often leveraging the specialized expertise of smaller firms.
- **Focus on Innovation:** Companies are investing in research and development to develop new AM technologies, materials, and processes to gain a competitive edge.
- **Emphasis on Cybersecurity:** With the increasing importance of AM in the defense sector, cybersecurity is becoming a key focus area for companies to protect their intellectual property and prevent counterfeiting.

Company	Key Products and Services	Deals and Contracts
3D Systems, Inc.	3D printers, materials, software, and services for various applications.	Awarded a contract by the US Air Force to support the Rapid Sustainment Office[19].
Aerojet Rocketdyne Holdings Inc.	Aerospace and defense products, including rocket engines and missile defense systems.	Major player in the aerospace and defense AM market[22].
Airbus SE	Commercial aircraft, helicopters, defense and space systems.	Partnered with Stratasys to supply 3D printed parts for Airbus aircraft[23].
Applied Science & Technology Research Organization (ASTRO)	Advanced manufacturing solutions, including large-scale metal 3D printing.	Selected by the US Army to develop the world's largest metal 3D printer for vehicles[23].
Autodesk Inc.	Software solutions for design, engineering, and manufacturing, including CAD, CAM, and CAE software.	Leading company profiled in the military 3D printing market[3].

Company	Key Products and Services	Deals and Contracts
BAE Systems	Defense, aerospace, and security products, including combat vehicles, aircraft, and cybersecurity solutions.	Major player in the aerospace and defense AM market[5].
BeAM Machines Inc.	Directed energy deposition (DED) metal AM systems for aerospace, defense, and energy applications.	Major player in the aerospace and defense AM market[22].
The Boeing Company	Commercial aircraft, defense, space, and security systems, including fighter jets, helicopters, and satellites.	Major player in the aerospace and defense AM market[5].
Carpenter Technology Corporation	Specialty alloys and high-performance materials for aerospace, defense, and energy applications.	Major player in the aerospace and defense AM market[22].
CRP Technology SRL	Professional 3D printing and rapid prototyping services, specializing in high-performance polymers and composites.	Major player in the aerospace and defense AM market[22].
Dassault Systèmes	3D design software, 3D digital mock-up, and product lifecycle management (PLM) solutions for various industries.	Leading company profiled in the military 3D printing market[3].
Desktop Metal Inc.	Metal AM systems for mass production, including binder jetting and bound metal deposition technologies.	Major player in the aerospace and defense AM market[22].

Company	Key Products and Services	Deals and Contracts
EOS GmbH	Industrial 3D printing solutions for polymers and metals, including laser sintering and direct metal laser melting technologies.	Major player in the aerospace and defense AM market[5].
ExOne	Industrial 3D printing systems, including binder jetting and sand printing technologies.	Developed a portable 3D printing factory in a shipping container for the DoD[3].
Fracktal Works Private Limited	Metal AM solutions, including metal 3D printers and software.	Leading company profiled in the military 3D printing market[3].
GE Additive (General Electric Company)	AM technologies, materials, and services for aerospace, defense, healthcare, and other industries.	Major player in the aerospace and defense AM market[5].
GKN Aerospace	Aerospace systems and components, including aerostructures, engine systems, and landing gear.	Major player in the aerospace and defense AM market[5].
Honeywell Aerospace	Aerospace products and services, including aircraft engines, avionics, and environmental control systems.	Major player in the aerospace and defense AM market[5].
Lockheed Martin Corporation	Aerospace and defense systems, including fighter jets, missiles, and space systems.	Invested in AM expansion at its Grand Prairie, Texas facility[21].
Markforged	Industrial 3D printers and materials, including composite and metal 3D	Awarded a contract by the US Air Force to support the Rapid Sustainment

Company	Key Products and Services	Deals and Contracts
	printers.	Office[19].
Materialise NV	3D printing software and services, including medical, industrial, and software solutions.	Major player in the aerospace and defense AM market[22].
MELD Manufacturing	Friction stir welding-based AM solutions for large-scale metal parts.	Awarded a contract by the US Air Force to support the Rapid Sustainment Office[19].
Moog Inc.	Precision motion control components and systems for aerospace, defense, and industrial applications.	Major player in the aerospace and defense AM market[22].
Northrop Grumman Corporation	Aerospace and defense systems, including autonomous systems, cybersecurity, and space systems.	Major player in the aerospace and defense AM market[5].
OC Oerlikon Corporation AG	Surface solutions, polymer processing, and additive manufacturing for various industries.	Major player in the aerospace and defense AM market[22].
Optomec Inc.	Additive manufacturing solutions for 3D printed electronics and metals, including aerosol jet printing and LENS technology.	Major player in the aerospace and defense AM market[22].
Optisys LLC	Antennas and radio frequency (RF) systems for aerospace, defense, and commercial applications.	Major player in the aerospace and defense AM market[22].

Company	Key Products and Services	Deals and Contracts
Proto Labs Inc.	Rapid prototyping and on-demand manufacturing services, including injection molding, CNC machining, and 3D printing.	Leading company profiled in the military 3D printing market[3].
Raytheon Technologies Corporation	Aerospace and defense systems, including missiles, radars, and intelligence systems.	Major player in the aerospace and defense AM market[5].
Renishaw PLC	Metrology and healthcare technologies, including coordinate measuring machines (CMMs) and Raman spectroscopy systems.	Major player in the aerospace and defense AM market[22].
Rolls-Royce Holdings	Aero engines and power systems for civil aerospace, defense, and power systems.	Major player in the aerospace and defense AM market[5].
Safran SA	Aircraft engines, rocket engines, and aerospace components, including landing gear and nacelles.	Major player in the aerospace and defense AM market[5].
Siemens Digital Industries Software	Software solutions for product lifecycle management (PLM), including CAD, CAM, CAE, and simulation software.	Major player in the aerospace and defense AM market[5].
Sintavia	AM services for aerospace and defense applications, specializing in metal AM using laser powder bed fusion technology.	Launched a proprietary copper 3D printing technology for rocket thrust chamber assemblies[23].

Company	Key Products and Services	Deals and Contracts
SLM Solutions Group AG	Metal-based AM systems, including selective laser melting (SLM) technology for high-performance metal parts.	Major player in the aerospace and defense AM market[22].
Stratasys Ltd.	Polymer 3D printing solutions, including FDM and PolyJet technologies.	Partnered with Airbus to supply 3D printed parts for Airbus aircraft[23].
Ultimaker BV	Desktop 3D printers and software for professionals and educators.	Leading company profiled in the military 3D printing market[3].

Predictions for 2025

Based on the current trends and developments, the following predictions can be made for the additive manufacturing market in military contracting for 2025:

- **Continued Market Growth:** The market for AM in military contracting will continue to grow in 2025, driven by increased DoD spending and wider adoption of AM across different military branches.
- **Increased Focus on Standardization and Qualification:** There will be a greater emphasis on developing industry standards and qualification processes for AM-produced parts to ensure quality and reliability for critical military applications.
- **Expansion of AM Applications:** AM will be used for a wider range of military applications, including the production of complex components, customized tooling, and on-demand spare parts.
- **Greater Integration with Digital Engineering:** AM will be further integrated with digital engineering workflows, enabling seamless transition from design to production and facilitating rapid iteration and optimization.
- **Growing Importance of Cybersecurity:** Cybersecurity will become increasingly important in AM, as the defense sector needs to protect sensitive designs and prevent counterfeiting of critical parts.

Conclusion

Additive manufacturing is poised to play a significant role in the future of military contracting. The technology offers numerous advantages, including customization, rapid prototyping, on-site repairs, and supply chain resilience. While challenges remain, ongoing advancements in AM technologies, coupled with supportive government initiatives, are paving the way for wider adoption and greater impact in the defense sector. Both large-scale and small-scale contractors

have opportunities to leverage AM to enhance their capabilities and competitiveness in the evolving landscape of military manufacturing.

The key predictions for 2025 suggest a future where AM is deeply integrated into military operations, enabling greater agility, responsiveness, and self-sufficiency. The increased focus on standardization, qualification, and cybersecurity will ensure that AM-produced parts meet the stringent requirements of military applications. As AM technologies continue to mature and evolve, the defense sector can expect to reap even greater benefits in terms of enhanced performance, reduced costs, and improved readiness.

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