



SECRETARY OF THE ARMY
WASHINGTON

18 SEP 2019

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Army Directive 2019-29 (Enabling Readiness and Modernization Through Advanced Manufacturing)

1. References. See enclosure 1.
2. Glossary. See enclosure 2.
3. Purpose. This directive establishes policy and assigns responsibilities for the employment of advanced manufacturing methods and materials in all capability areas where the Army has an interest.
4. Applicability. This directive applies to the Regular Army, Army National Guard/Army National Guard of the United States, U.S. Army Reserve, and Department of the Army Civilians.
5. Background. Advanced manufacturing refers to new ways to manufacture existing products and the manufacture of new products resulting from advances in technology. Advanced manufacturing depends on use and coordination of information, automation, computation, software, sensing, and networking, and making use of cutting-edge materials and emerging capabilities enabled by the physical and biological sciences. Advanced manufacturing includes, but is not limited to, additive manufacturing (also known as three-dimensional (3D) printing), artificial intelligence, robotics, and advanced composite materials.
6. Objective. Advanced manufacturing will fundamentally change the way the Army designs, delivers, produces, and sustains materiel capabilities. It will enable the Army to modernize systems while simultaneously enhancing readiness.
 - a. Advanced manufacturing decreases design limitations traditional manufacturing methods impose, allowing for the production of complex parts that cannot be manufactured using traditional processes. These optimized designs, coupled with lighter and stronger advanced materials, can result in improved system performance. Additionally, advanced manufacturing will allow the Army to innovate with unparalleled speed because it enables rapid production of prototypes, leading to decreased development time and faster iterations, and also enables production scalability. Using advanced methods, the Army can quickly establish a production line and increase throughput of systems, subsystems, and parts. As such, advanced methods can

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reduce the time to fielding, ensuring that warfighters receive critical capabilities when needed.

b. In addition to using new methods and materials to modernize and deliver capabilities more quickly, advanced manufacturing will transform industrial operations. By combining artificial intelligence, robotics, sensors, and a digital network on the factory floor, we will enable the connection between machines, products, and people, leading to efficiencies like improved quality control, predictive maintenance, and automatic ordering of supplies.

c. The Army can also use advanced manufacturing to address the readiness challenges posed by parts obsolescence, diminishing sources of supply, and sustained operations in austere environments. If employed to the maximum extent, advanced manufacturing could transform battlefield logistics through on-demand fabrication of parts close to the point of need, thus reducing the large number of parts stored and transported around the world.

d. Achievement of this objective requires that we consider and incorporate advanced manufacturing in all aspects of a system's life cycle, from early design and development through sustainment. Organizations across the Army, including requirements, research and development, acquisition, sustainment, and contracting activities, must continue to invest in and embrace advanced manufacturing.

7. Policy

a. Advanced manufacturing methods and materials will have the largest effect when they are incorporated early in a system's design. The following will occur when the Army develops a new materiel capability or system:

(1) Capability developers, with input from technical subject matter experts, will write performance and readiness capability requirements to account for gains that can be made using advanced methods and materials.

(2) Materiel developers will use digital engineering throughout all phases of the acquisition lifecycle to the maximum extent practical.

(3) Materiel developers will incorporate advanced methods and materials into system design, development, production, and sustainment when analysis indicates they offer the best value to the Government.

(4) When materiel developers incorporate advanced methods into a system, subsystem, or part during materiel design and development, the appropriate

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engineering analyses, tests and evaluation, certifications, and qualifications will be performed as part of the normal acquisition process.

(5) Materiel developers must plan for manufacturability and sustainment early in system development and ensure sustainment factors are addressed in design specifications, contracts, and source selection criteria.

(6) Consistent with paragraph 7d(2), materiel developers will take appropriate action to collaborate with industry and encourage investment in advanced manufacturing for the development, production, and sustainment of systems when analysis indicates it offers the best value to the Government.

(7) Materiel developers will address advanced methods and materials required to support design, development, production, fielding, and sustainment in program acquisition and planning documentation. This includes, but is not limited to, the acquisition strategy, systems engineering plan, life-cycle sustainment plan, and intellectual property (IP) strategy.

(8) Materiel developers must incorporate advanced materials, processes, and technology into specifications, standards, and technical data packages when advanced manufacturing is part of the production, fielding, or sustainment strategy, consistent with the process used for traditional manufacturing methods.

b. Advanced methods and materials will be incorporated into fielded systems when analysis indicates they offer the best value to the Government. The following will occur when the Army incorporates advanced methods into fielded systems:

(1) Life-cycle managers must consider using advanced methods when shortfalls exist in the ability of the supply chain to support mission readiness. Valid needs must be supported with analysis of materiel availability, backorder status, and order volume. Advanced manufacturing will supplement—not supplant—the supply chain.

(2) When changing the method of manufacture (for example, subtractive to additive method or additive to extrusion method) for a fielded system, subsystem, or part when the basic material properties could be altered, the Current Design Activity (CDA) must certify and qualify the system, subsystem, or part, and the life-cycle/configuration manager must approve the change.

(3) Life-cycle/configuration managers will collaborate with U.S. Army Materiel Command (AMC) and U.S. Army Futures Command (AFC) to fund and expedite the test and evaluation, qualification, certification, inspection, and acceptance of advanced manufactured parts, materials, and equipment.

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(4) Systems, subsystems, and parts produced using advanced methods that were certified and qualified by the CDA and approved by the life-cycle/configuration manager are equivalent to original equipment manufacturer parts.

c. For immediate operational requirements (such as battle damage assessment and repair), a commander may temporarily use systems, subsystems, or parts the CDA has not certified and qualified and the life-cycle/configuration manager has not approved if the commander deems the risk acceptable. The system, subsystem, or part must be replaced by a part from the supply system as soon as possible. Exceptions are listed in paragraphs 7e(2) and 7e(3).

d. To fully realize the benefits of advanced manufacturing, investments must be made to mature advanced methods and materials, and digital engineering. As such, Army policy is that:

(1) the Army will develop a threat-based strategy for the application of, investment in, and protection of advanced manufacturing to achieve modernization of weapons capabilities and the Army's industrial base. Army entities will plan and program for resources to mature advanced manufacturing methods and materials, digital engineering, and a digital thread, as appropriate.

(2) materiel developers will take appropriate action to collaborate with industry and encourage investment in advanced manufacturing and digital engineering. They can do so through a number of mechanisms, including but not limited to:

(a) using source selection evaluation factors that favor performance and readiness gains, cost reductions, and schedule reductions that can be achieved using advanced manufacturing.

(b) using digital prototypes before physical prototypes are produced, when appropriate (for example, when downselecting).

(c) requiring delivery of technical data in 3D architecture models instead of two-dimensional drawings, when appropriate.

(d) adopting industry standards (for example, standards related to qualification, certification, test, and evaluation of systems, subsystems, and parts produced using advanced manufacturing).

(3) the Army will collaborate with industry and standards development organizations to develop new standards and expedite their approval for parts that do not have industry standards.

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e. The following must be considered before using advanced methods and materials:

(1) While advanced manufacturing can improve performance and readiness, risk may be involved and it is not appropriate in all situations. Readiness and performance benefits must be balanced with cost, program protection, and safety.

(2) Aviation systems, subsystems, and parts must always be certified by the appropriate authority, including for immediate operational requirements.

(3) Only organizations that are authorized and professionally trained and equipped for explosive ordnance disposal, demolitions, or breaching missions may fabricate or modify energetics, propellants, explosives, and pyrotechnics, including for immediate mission requirements.

(4) For property accountability, items manufactured or fabricated using additive manufacturing will be treated the same as other items made for the same purpose.

(5) The use of IP must comply with all applicable laws, regulations, and policies, including Army Directive 2018-26 (Enabling Modernization Through the Management of Intellectual Property) (reference i).

(a) For new systems, materiel developers will negotiate early in the acquisition process for the appropriate licenses to the IP required to support advanced manufacturing, if it is part of the acquisition, fielding, or sustainment strategy. Do not seek rights to more extensive IP than is necessary.

(b) When incorporating advanced manufacturing into a previously fielded system, negotiate for the necessary IP and the appropriate rights to use it. When the IP does not exist, create it and the appropriate rights to use the information, consistent with Army Directive 2018-26.

(c) When negotiating with industry for license rights to IP, consider alternative license models that benefit both the Government and industry, such as a fee-based agreement under which a negotiated price is paid to the entity that created the IP each time a part is 3D-printed.

(d) All licensed IP must be stored and managed on Army- or Department of Defense (DoD)-approved networks and devices.

(e) Proper precautions will be taken so that only authorized personnel have access to the IP.

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(f) Consult legal counsel for detailed advice on IP and rights.

8. Responsibilities

a. The Assistant Secretary of the Army (Acquisition, Logistics and Technology) (ASA (ALT)) will:

(1) establish and maintain policy related to advanced manufacturing.

(2) coordinate with the Commander, AMC and Commander, AFC to establish and manage modernization investments in advanced manufacturing technologies and associated processes.

(3) develop and publish, in coordination with the Commander, AMC and Commander, AFC, an advanced manufacturing implementation plan.

(4) contribute to drafting a threat-based strategy for the application of, investment in, and protection of advanced manufacturing to achieve modernization of weapons capabilities and the Army's industrial base. The Commander, AFC will develop and publish the strategy.

(5) develop a digital engineering implementation plan that aligns with DoD's digital engineering strategy.

(6) work with the Commander, AMC and Commander, AFC to write requirements for a digital thread to support system development from concept through production and sustainment, which will be developed using the Business Capability Acquisition Cycle (BCAC) process and DoD Instruction 5000.75 (Business Systems Requirements and Acquisitions) (reference f).

(7) assign an office of primary responsibility for the digital thread problem statement(s).

(8) enable integration of advanced manufacturing capabilities into enterprise architecture and supporting business systems and processes.

(9) participate in joint-DoD advanced manufacturing collaborative activities.

(10) establish, in coordination with the Commander, AMC and Commander, AFC, relationships with other DoD and Federal activities to leverage and integrate advanced manufacturing and digital engineering efforts.

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(11) ensure the digital and cyber infrastructure and internal guidance supports advanced manufacturing for all operations and is capable of securing data to prevent unauthorized changes and ensure the integrity of design data.

b. The Commander, U.S. Army Training and Doctrine Command (TRADOC) will:

(1) explore, in coordination with the Commander, AMC; Commander, AFC; and Deputy Chief of Staff (DCS), G-4, uses of advanced manufacturing at the tactical level to reduce the logistics footprint.

(2) establish operational doctrine and training requirements for military personnel requiring mastery of skills in advanced manufacturing to perform their duties.

c. The Commander, AMC will:

(1) establish an advanced manufacturing center of excellence within the organic industrial base to provide an organic capability and serve as the Army's focal point for the application of advanced manufacturing in matters related to sustainment.

(2) work with the ASA (ALT) and Commander, AFC to write requirements for a digital thread to support system development from concept through production and sustainment, which will be developed using the BCAC process and DoD Instruction 5000.75.

(3) contribute to drafting an advanced manufacturing implementation plan. The ASA (ALT) will develop and publish the plan.

(4) contribute to drafting a threat-based strategy for the application of, investment in, and protection of advanced manufacturing to achieve modernization of weapons capabilities and the Army's industrial base. The Commander, AFC will develop and publish the strategy.

(5) participate in joint-DoD advanced manufacturing collaborative activities.

(6) establish, in coordination with the ASA (ALT) and Commander, AFC, relationships with other DoD and Federal activities to leverage and integrate advanced manufacturing and digital engineering efforts.

(7) establish and maintain a capital improvement plan for advanced manufacturing to enable the organic industrial base to address supply chain interruptions affecting readiness.

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(8) plan rollouts of advanced manufacturing-related capabilities and technologies based on supply chain needs.

(9) establish annual advanced manufacturing production goals based on readiness drivers and diminishing sources of supply.

(10) establish metrics, with support from the ASA (ALT); Commander, TRADOC; and Commander, AFC, to track the progress of additive manufacturing implementation and its effect on readiness.

(11) assist with lessons learned and recommendations for procuring advanced manufacturing equipment and services.

(12) establish and maintain collaborations within the defense industrial base, DoD engineering laboratories and centers, academia, and industry to ensure the integration of best practices in manufacturing.

(13) integrate advanced manufacturing into appropriate supply chain processes and ensure demand feedback is systematically provided to appropriate DoD supply organizations.

(14) explore, in coordination with the Commander, TRADOC; Commander, AFC; and DCS, G-4, uses of advanced manufacturing methods at the tactical level to reduce the logistics footprint.

(15) coordinate workforce education and training in advanced manufacturing for the organic industrial base. This must include training on materials and equipment.

d. The Commander, AFC will:

(1) serve as the focal point for the application of advanced manufacturing to achieve Army modernization objectives.

(2) establish and manage, in coordination with the ASA (ALT) and Commander, AMC, modernization investments in advanced manufacturing technologies and associated processes.

(3) develop and publish, in coordination with ASA (ALT); Commander, AMC; and DCS, G-2, a threat-based strategy for the application of, investment in, and protection of advanced manufacturing to achieve modernization of weapons capabilities and the Army's industrial base.

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(4) serve as the technical authority for the research, development, and engineering of advanced manufacturing.

(5) continue, in coordination with the ASA (ALT) and Commander, AMC, to invest in research, development, and engineering of new advanced technologies, processes, and materials and transition the technology and knowledge to ASA (ALT) and Commander, AMC.

(6) Work with the ASA (ALT) and Commander, AMC to write requirements for a digital thread to support system development from concept through production and sustainment, which will be developed using the BCAC process and DoD Instruction 5000.75.

(7) contribute to drafting an advanced manufacturing implementation plan. The ASA (ALT) will develop and publish the plan.

(8) write capability requirements accounting for performance and readiness gains that can be made using advanced manufacturing methods and materials.

(9) identify applicable technologies, processes, standards, and best practices for advanced manufacturing.

(10) assess advanced manufacturing techniques and processes.

(11) provide technical support to the ASA (ALT) and Commander, AMC for advanced manufacturing matters pertaining to technology advancements, certification, qualification, and best practices.

(12) work with defense and commercial standardization offices and other standards development organizations to establish standards and identify best practices for the qualification, certification, inspection, and acceptance of advanced manufacturing parts, materials, processes, and equipment.

(13) establish and maintain collaborations within the defense industrial base, DoD engineering laboratories and centers, academia, and industry to ensure the integration of best practices in manufacturing.

(14) establish, in coordination with the ASA (ALT) and Commander, AMC, relationships with other DoD and Federal activities to leverage and integrate advanced manufacturing and digital engineering efforts.

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(15) establish, in coordination with appropriate life-cycle/configuration managers and standards development organizations, standards, specifications, and test methods for parts and materials used in Army materiel when standards do not exist.

(16) establish, in coordination with life-cycle/configuration managers, processes for expediting the qualification, certification, inspection, and acceptance of advanced manufacturing parts, materials, and equipment to support readiness of fielded systems.

(17) establish, in coordination with the Commander, AMC, training for Army civilian personnel involved with science, engineering, and systems engineering related to advanced manufacturing. This includes personnel involved in the handling, storage, and processing of advanced manufacturing parts, materials, and equipment to quickly and continuously integrate advanced manufacturing in the organic industrial base, science and technology, and capabilities development communities.

(18) participate in joint-DoD advanced manufacturing collaborative activities.

(19) explore, in coordination with the Commander, TRADOC; Commander, AMC; and DCS, G-4, uses of advanced manufacturing methods at the tactical level to reduce the logistics footprint.

e. The DCS, G-2 will contribute to drafting a threat-based strategy for the application of, investment in, and protection of advanced manufacturing to achieve modernization of weapons capabilities and the Army's industrial base. AFC will develop and publish the strategy.

f. The DCS, G-4 will:

(1) develop policy for tactical and operational uses of advanced manufacturing.

(2) contribute to drafting an advanced manufacturing implementation plan. The ASA (ALT) will develop and publish the plan.

(3) explore, in coordination with the Commander, TRADOC; Commander, AMC; and Commander, AFC, uses of advanced manufacturing at the tactical level to reduce the logistics footprint.

(4) identify supply chain metrics to assess trends and determine indicators for using advanced manufacturing to augment existing supply chains.

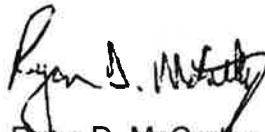
g. The DCS, G-8 will program funds for validated and approved advanced manufacturing activities needed for materiel life-cycle management and readiness.

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9. Proponent. The ASA (ALT) is the proponent for this policy and will incorporate the provisions of this directive into Army Regulation (AR) 70-1 and AR 70-77 within 2 years of the date of this directive. The ASA (ALT) will coordinate with the Director of the Army Staff and the DCS, G-4 to ensure they update AR 385-10 and AR 750-1, respectively within the same timeframe.

10. Duration. This directive is rescinded upon publication of the revised regulations.

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REFERENCES

- a. Title 10, United States Code, section 2521 (10 U.S.C. § 2521) (Manufacturing Technology Program).
- b. Defense Federal Acquisition Regulations Supplement, Part 252, Title 48, Code of Federal Regulations, 1998.
- c. Department of Defense Instruction (DoDI) 5000.02 (Operation of the Defense Acquisition System); January 7, 2015; Incorporating Change 4, August 31, 2018.
- d. DoDI 5000.74 (Defense Acquisition of Services); January 5, 2016; Incorporating Change 2, August 31, 2018.
- e. DoDI 5000.75 (Business Systems Requirements and Acquisitions), February 2, 2017, Change 1 Effective August 31, 2018.
- f. Department of Defense Digital Engineering Strategy, June 2018.
- g. Memorandum, Under Secretary of Defense for Acquisition and Sustainment, Jan 31, 2019, subject: Implementation of Title 10, United States Code, section 2443 – Sustainment Factors in Weapon System Design.
- h. Defense Acquisition University, Glossary, available at <https://www.dau.edu/glossary/Pages/Glossary.aspx>
- i. Army Directive 2018-26 (Enabling Modernization Through the Management of Intellectual Property), 07 Dec 2018.
- j. Army Regulation (AR) 27-60, Intellectual Property, 1 June 1993.
- k. AR 70-1 (Army Acquisition Policy), 10 August 2018.
- l. AR 70-77 (Program Protection), 8 June 2018.
- m. AR 385-10 (Safety), 24 February 2017.
- n. AR 750-1 (Army Materiel Maintenance Policy), 3 August 2017.
- o. Report, Strategy for American Leadership in Advanced Manufacturing, Subcommittee on Advanced Manufacturing Committee on Technology of the National Science and Technology Council, October 2018.

p. MIL-STD-3046, Department of Defense Interim Standard Practice Configuration Management, 06 March 2013.

q. MIL-STD-31000B, Department of Defense Standard Practice Technical Data Packages, 31 October 2018.

GLOSSARY

Additive Manufacturing. The process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies.

Advanced Manufacturing. Advanced manufacturing refers to activities that depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or make use of cutting-edge materials and emerging capabilities enabled by the physical and biological sciences. It encompasses new ways to manufacture existing products and the manufacturing of new products resulting from advances in technology. It includes, but is not limited to, additive manufacturing (also known as three-dimensional (3D) printing), artificial intelligence, robotics, and advanced composite materials.

Computer Software. Computer programs, source code, source code listings, object code listings, design details, algorithms, processes, flow charts, formulae, and related material that enable software to be reproduced, recreated, or recompiled. Computer software does not include computer databases or computer software documentation.

Conventional (Traditional) Manufacturing. For the purposes of this advanced manufacturing directive, manufacturing processes that include forging, cutting, milling, molding, casting, welding, and other generally subtractive processes that transform raw materials into a finished item or product.

Current Design Activity. The design activity currently responsible for the design of an item. It may be the original design activity or a design activity the design responsibility has been transferred to.

Digital Engineering. An integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support life-cycle activities from concept through disposal.

Digital Thread. An extensible, configurable, and component enterprise-level analytical framework that seamlessly expedites the controlled interplay of authoritative technical data, software, information, and knowledge in the enterprise data-information-knowledge systems, based on the Digital System Model template, to inform decision makers throughout a system's life cycle by providing the capability to access, integrate, and transform disparate data into actionable information.

Intellectual Property. A product of the human mind that is protected by law. It includes, but is not limited to, patents, inventions, designs, copyrights, works of authorship, trademarks, service marks, technical data, trade secrets, computer

software, unsolicited inventive proposals, and technical know-how. The intangible rights in such property are described as intellectual property rights.

Technical Data. Recorded information, regardless of the form or method of the recording, of a scientific or technical nature (including computer software documentation). The term does not include computer software or data incidental to contract administration, such as financial and management information.

Temporary Use. For the purposes of this advanced manufacturing directive, systems, subsystems, and parts that have not been qualified and certified by the Current Design Activity or approved by the life-cycle manager can only be used for immediate operational requirements and must be replaced with an item from the supply system as soon as possible.