Spc. Brian Fenimore-Klein, allied trade specialist with the 308th Brigade Support Battalion, 17th Field Artillery Brigade, monitors the 3D printing progress of the N-95 respirator protective mask prototype on April 1, 2020 at Joint Base Lewis McChord, Washington. ***(US Army photo by Sgt. Casey Hustin, 17th Field Artillery Brigade)***

3D Printing in Multidomain Operations

United States Army Engineer Regiment

By Chief Warrant Officer Three Darius J. Cooper

The contents of this article do not represent the official views of, nor are they endorsed by, the U.S. Army, the Department of War (DoW), or the U.S. Government.

This article was edited with the assistance of artificial intelligence (AI) tools. Final review and editing were conducted by authorized DoW personnel to ensure accuracy, clarity, and compliance with DoW policies and guidance.

Additive manufacturing (AM) is the term the U.S. Army uses for 3D printing, and it is the wave of the future—especially for the U.S. Army Engineer Regiment as we transition to large-scale combat operations in multidomain environments. The increasing complexity of modern battlefields against near-peer adversaries with similar military capabilities challenges engineering units to develop needs for rapid adoption in general and combat engineering disciplines.

The U.S. Army Engineer Regiment, a key player in this initiative, gained a battlefield edge in multidomain operations by using 3D printers to quickly create needed obstacles and structures. This technology has proven effective in providing a tactical advantage in a dynamic battlefield environment. However, to fully leverage this technology, the Army must address challenges, including preventing enemy exploitation, overcoming material limitations, and managing logistical complexities.

The Department of Defense (DoD) Additive Management Strategy states that the expeditionary use of AM should incorporate materials, machinery, and personnel. These standards include forward-deployed expeditionary and afloat locations.[1] The subsequent evidence will outline the main points of this initiative.

According to articles on sites like 3dprint.com, military research and development is no longer being relegated solely to academic and nonprofit institutions but is taking place at the ground level, on the fly, and in the next decade is poised to move at an exponential rate to the frontlines.[2] Along with several other government and private sector entities, the U.S. Army Corps of Engineers Engineer Research Development Center (ERDC) Construction Engineering Research Laboratory (CERL) is leading this initiative for the U.S. Army.

The potential of 3D printing for the U.S. Army Engineer Regiment is limitless as military and civilian developers strive

The U.S. Army Central Innovation and Manufacturing Center uses 3D printing for rapidly prototyping products focused on enhancing combat operations. ***(U.S. Army photo by Sgt. Alison Strout)***

toward units that can create rapid obstacles, structures, and maintenance parts on the battlefield while reducing logistical supply chains. "The additive manufacturing community employs a digital library of 3D printed parts called the 'Repository for Additive Parts for Tactical and Operational Readiness,' or RAPTOR. As Soldiers or engineers produce parts, they put the blueprint in the system."[3]

AM allows capable engineer units to print needed creations, providing a tactical advantage in a dynamic battlefield environment. The speed and efficiency of 3D printing in creating maintenance parts, fortifications, barriers, and other defensive structures are integral in the ability of an engineer unit to impede enemy movement in protected areas and provide cover and concealment to defend critical and defense assets such as unmanned aerial systems (UAS) and engineer ground vehicles.

"The U.S. Army's Battle Damage Repair and Fabrication (BDRF) process combines computer-aided design with additive manufacturing to produce temporary replacement parts for ground vehicles, particularly focusing on components with long procurement times or obsolete status."[4]

BDRF will enhance the operational resilience of engineer ground vehicles in contested environments, unlike in past conflicts where part shortages and long lead times hindered maneuver capabilities.

According to Major John Spencer, based on his experience in the early invasion Iraq, "Adaptability is the number-one requirement, for any military, for future wars."[5] AM takes this concept to a new level. Adaptability and the aptitude for on-demand customization and modification of structures and parts on site minimize transportation needs and reduce the logistical burden in terms of cost, speed, and operational flexibility on the battlefield.

The challenges of engineer units implementing AM in multidomain operations are significant, including the potential for cyber security exploitation, capture, the sabotage of equipment by enemy forces, and material limitations on the battlefield.

In 2019, Lieutenant General Aundre Piggee, serving as the Army's Deputy Chief of Staff, G-4, stated that intellectual property rights could restrict the Army's authority to reverse-engineer a part or produce a component locally.[6] The Army must investigate this proprietary setback to find possible solutions to avoid hindering military operations on the battlefield.

Given the rapid advances in information technology and cyber capabilities by our near-peer adversaries such as North Korea, China, and Russia, there will always be a threat of our 3D printing capabilities being captured, compromised, or incapacitated. "Adversaries contest logistics in every domain. We need every innovation to set a theater and sustain Soldiers in future missions—whether artificial intelligence, autonomous vehicles dropping off supplies, or a 3D printer at the point of need," Piggee said.[7]

Large 3D printing machines represent high-value targets on the battlefield. To ensure they remain fully mission-capable and continue delivering critical products needed across the operational spectrum, they must be protected.

The limitations of 3D printing lie in the possible limited outsourcing of construction or fabrication materials. While current 3D printing materials face limitations in strength, durability, and environmental resistance, research institutions such as ERDC-CERL are actively exploring locally sourced alternatives. Ongoing research continues to explore solutions that leverage the surrounding environment to support and sustain troop operations.

Moreover, according to Harrison, the Army must consider available power, utilities, equipment size, survivability,

Developed through a proof-of-concept with the 101st Airborne, this drone highlights the potential of 3D printing to quickly create customized tactical equipment. ***(U.S. Army photo by Kendall Swank)***

serviceability, training, and tooling. As technologies move toward cloud-based software, solutions for secure digital file transfer and machine operations must be adopted.[8]

Specialized training of Soldiers to operate 3D printing capabilities is at the forefront of continued testing to validate competence for units on the battlefield. Managing logistical complexities in operational environments will continue to test engineer units as they push to forecast and overcome challenges they may face during conflict.

A key strategy for efficiently implementing AM includes developing a secure, resilient 3D printing system that protects units from enemy capture and exploitation. Many 3D systems can operate continuously under the supervision of trained Soldiers, helping to prevent malfunctions and maintain consistent production.

Engineer counter mobility and fortification 3D prints use concrete mixes, slump tests, and ongoing quality checks throughout the printing process to ensure structural integrity and validate strength. Accelerants and other polymers are typically added to concrete batches to speed up the curing time.

ERDC-CERL's investment in advanced materials research to remains a top priority for LSCO with a strong emphasis on improving the performance and versatility of 3D printing materials.

To advance the U.S. Army Engineer Regiment's additive manufacturing capabilities in multidomain operations, the Army must integrate emerging technologies with comprehensive Soldier readiness training. This dual approach is essential to prevent enemy exploitation, overcome material limitations, and navigate logistical complexities in contested environments.

3D printing will continue to revolutionize military engineering, providing a significant battlefield advantage. The Engineer Regiment's initiative must continue field testing and evaluation to increase its AM capabilities and prepare for the next conflict.

DEVCOM CBC Engineering Technician, Rashad Scott, uses 3D printing to make a plastic prototype. ***(U.S. Army photo by Gabriella White)***

Chief Warrant Officer 3 Darius Cooper *is the senior construction & facility engineer for the 20th Engineer Brigade. He holds a master's of business administration degree with a concentration in project management from Liberty University, Lynchburg, Virginia.*

References

1. Vance, 2024, "DoD Additive Manufacturing Strategy," DoD Research & Engineering, OUSD(R&E), May 14, cto.mil/dod-additive-manufacturing-strategy/ (no longer available).
2. Michael Kremenetsky, "U.S. Military Innovation Pushed to the Frontlines with Advanced Manufacturing," 3DPrint.com, June 9, 2023, 3dprint.com/300778/u-s-military-innovation-pushed-to-the-frontlines-with-advanced-manufacturing/.
3. D.L. Suits, 2019, "3D Printing Technology Enhancing Logistics for Army," Army.mil, February 22, army.mil/article/217433/3d_printing_technology_enhancing_logistics_for_army.
4. 3DPrinting.com, 2025, "3D Printing Boosts U.S. Army Vehicle Maintenance and Combat Capability," 3D Printing, March 7, 3dprinting.com/news/3d-printing-boosts-u-s-army-vehicle-maintenance-and-combat-capability/.
5. Mark Wallace, 2017, "How U.S. Soldiers Are Using Their 'Warhacks' to Change Combat," Fast Company, October 10, 2017, fastcompany.com/40477904/how-u-s-soldiers-are-using-their-warhacks-to-change-combat.
6. D. L. Suits, 2019, "3D Printing Technology Enhancing Logistics for Army," Army.mil, February 22, army.mil/article/217433/3d_printing_technology_enhancing_logistics_for_army.
7. Ibid.
8. J. Harrison, 2021, "Evolution of needing Expeditionary Manufacturing," ManufacturingTomorrow, July 13, manufacturingtomorrow.com/article/2021/06/evolution-of-the-need-for-expeditionary-manufacturing/17228.