Incorporating LMs into TSOs

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The U.S. Army Engineer Regiment faces challenges during large-scale combat operations (LSCO). With continued technological innovation, the proliferation of less expensive weapons, and the persistent threat of conflict, how can engineers use readily available, technologically enabled tools to better shape terrain in support of the maneuver commander's scheme of maneuver? Loitering munitions (LMs) play a crucial role in the overall answer to this question.

Imagine that the commander of an engineer company attached to a brigade combat team prioritizes countermobility efforts during defensive operations. An engineer company could use available countermobility options, including hand-emplaced mines, scatterable mines, antivehicular ditches, craters, and concertina wire. However, most of these options require labor-intensive efforts and numerous resources. Shouldn't the Engineer Regiment seek tools that are less labor-intensive and require fewer resources while achieving the same effect? LMs could be the solution.

What Are LMs?

LMs are one-time-use weapons designed to find a target and crash into it.[1] Once airborne, LMs can hunt for a target and "loiter" for an extended time. As the munition identifies the target, it engages it by colliding with it. These munitions continue to grow smaller as more commercial companies produce them. Using commercially available drones, fighters have undergone numerous iterations to produce other versions capable of dropping grenades or mortars and directly attacking targets.

Many variants of purpose-built LMs are currently available, including the Russian Zala Lancet, the Ukrainian RAM II unmanned aerial vehicle (UAV), and the AeroVironment Switchblade© 600. These LMs are unmanned aerial systems armed with explosive warheads capable of disabling or destroying personnel and vehicles. However, as the Ukrainian army has proven multiple times, improvised LMs are just as effective and less costly than the Lancet, RAM II, and Switchblade 600.

The proliferation of LMs in modern conflicts grew from their utility in battle. Both nation-state militaries and paramilitary units benefit from using these LMs. Commercially built variants are estimated to cost approximately $100,000, while improvised systems may be available for just a few hundred dollars.[2] If the Army opted for low-cost variants of LMs, they could become a feasible option for countermobility operations.

When Did LMs First Appear?

Before the 2022 Russian invasion of Ukraine, LMs appeared in large numbers during the 2020 Nagorno-Karabakh War. Israel provided Heavy Aerial Reconnaissance and Observation Platform (HAROP) LMs to Azerbaijan during this conflict, giving Azerbaijan a considerable advantage.[3] The HAROP system resembles a guided missile that is housed and launched from a platform such as a high-mobility artillery rocket system.[4] Israel provided these systems to Azerbaijan, enabling Azerbaijan to destroy Armenian forces and equipment with devastating effects.

In the ongoing Russian-Ukrainian war, LMs continue to decrease in size and increase in numbers. As a result, LMs are changing the character of battle in several ways. To begin with, the expanse of "no man's land" is significantly larger than what was observed during World War I. Instead of being measured in meters, this space can now be measured in kilometers. The proliferation of unmanned aerial systems, including LMs, forces both sides to extend their distances to remain beyond the reach of enemy weapons. Next, LMs offer inexpensive precision strike capabilities to countries previously incapable of affording them in large quantities. Lastly, LMs can be improvised from commercially available components. This is significant because a large defense industrial base, like that required for a high-mobility artillery rocket system or the HAROP, is unnecessary.

As LMs shrink in size and proliferate in numbers, conflict actors find them useful. LMs are leveling the capabilities of previously mismatched adversaries because they are cheaper to obtain and easier to improvise. They are certainly helpful in a direct attack. But could they be useful in other ways?

What is Terrain Shaping?

When discussing defensive strategies, commanders rely on engineers to excel in terrain shaping operations (TSO). Terrain shaping affects the enemy's ability to move and maneuver as the Army "shapes" the terrain to its advantage.[5] Terrain shaping is fundamental for creating engagement areas where forces want to kill the enemy. To create an engagement area, engineers first identify where the enemy will approach. Next, they determine how the enemy will maneuver against U.S. forces. Then, they establish where the enemy will be killed. Finally, they plan and integrate obstacles. This step is the manifestation of engineer expertise. The observation of both natural (hills, wooded areas, water) and man-made (urban areas, bridges) elements of the terrain is crucial. Once the terrain is studied, engineers shape that terrain with obstacles to maximize the destruction of enemy forces.

Engineers enable maneuver commanders to destroy the enemy en masse by shaping terrain. For example, engineers might place antivehicular ditches into heavily forested areas where track vehicles struggle to maneuver. Alternatively, if asphalt roads are the only traversable terrain due to heavy amounts of rain and mud, creating a road crater at a key intersection could disrupt enemy movements. There are many possibilities that creative engineers can use to support the plans of maneuver commanders. Engineers use obstacles to shape the terrain and direct the movement of enemy forces. Shaping the terrain supports the destruction of the enemy at the time and location designated by the maneuver commander.

What Is Used to Shape the Terrain?

Engineers use tactical obstacles to shape terrain. Tactical obstacles attack enemy maneuver from march, prebattle, and attack formations.[6] The Army uses tactical obstacles as key components of the engagement area to block, disrupt, fix, and turn enemy formations into the most desirable locations. Shaping the terrain benefits the commander's plan and degrades enemy plans. Available methods for terrain shaping include, but are not limited to, hand-emplaced minefields, scatterable minefields, antivehicular ditches, wire, craters, berms, abatis, and barriers. Depending on the natural terrain and desired effect, engineers integrate these methods into obstacle groups, belts, and zones to implement them on a larger scale.

Obstacle effects include blocking, fixing, disrupting, and turning. Each has its use and can be combined to create larger, and at times different, effects depending on various factors. The key concept behind an obstacle is not what constitutes it, but rather its effects on the enemy formations. For example, the intended effect of a disrupting obstacle is to break up enemy formations and force the commitment of assets earlier than the planned scheme of maneuver. A disrupting obstacle can be created by using a combination of mines and antivehicular ditches, or alternatively through the use of wire and craters. There is no single solution. The current operating environment effectively demonstrates this concept.

What Is Being Observed During the Russian–Ukrainian War?

Once Russia completed its initial invasion of Ukraine in 2022, both sides settled into a defensive stance. Although Russia originally intended to move swiftly to capture Kyiv, Ukraine's capital, it failed to do so. To consolidate its gains during the initial offensive, Russia created large defensive lines. Ukraine created similar defensive lines to prevent the further penetration of Russian forces. As the war continues, both countries continue to shape the terrain through countermobility operations across the battlefield.

The Russian military has constructed trenches, minefields, dragon's teeth, and other barriers to slow Ukrainian forces during offensive operations. However, a review of past wars reveals that fortifications and other measures do not ensure an advantage for the defender. Militaries must use strategy, technology, and geography to effect offensive and defensive operations.[7] Unfortunately, the U.S. Army countermobility toolkit lacks readily accessible, technology-enhanced solutions.

Could LMs Be Used to Achieve Obstacle Effects?

Picture a scenario where engineers integrate LMs into their countermobility toolkit. Commercial industries continue to produce LMs in ever-growing quantities. LMs do not require the full amount of research, development, testing, and experimentation because the Army has acquired them, and industry has been producing them for years. LMs are proven in active combat because the Ukrainian Army has been using them with catastrophic impact against Russian forces. As an alternative to using resource-intensive obstacles, the U.S. Army could employ LMs to shape the terrain faster while maintaining accuracy. With the addition of LMs to countermobility options, terrain could be effectively and efficiently shaped.

The integration of advancing LM technology into TSO is feasible today. LMs do not require fuel, need to be buried like antitank mines, or require endless quantities of manually pounded pickets. Instead, LMs are deployed on the surface, eliminating the need for a fratricide fence, while possessing the capability to identify targets and attack vulnerable points on vehicles. Unfortunately, the Army is not currently integrating LMs into TSO. However, if they adopted these tools, the Engineer Regiment could increase lethality and provide more options to maneuver commanders.

Deploying LMs can disrupt enemy formations, forcing enemy commanders to disperse their formations, employ obscurants earlier than anticipated, interrupt the timetable, and fragment their attack.[8] LM effects could be massed in attempts to block enemy movement or engaged over time to disrupt or turn enemy formations. When included in countermobility options, LMs can expand existing capabilities, decrease labor, reduce fuel consumption, and enable selective target engagement.

Incorporated with other obstacles, LMs can reinforce, complement, or exacerbate their effects. For example, combining LMs with antivehicular ditches can destroy an enemy gap-crossing asset at its most vulnerable time—when the asset is employed across the gap. This would destroy the enemy's high-value assets, stall the breach, and force the commitment of other assets or a change to the enemy's scheme of maneuver.

How Will the Army Acquire LMs?

The Department of Defense is accelerating the acquisition of LMs through its Replicator initiative.[9] The Army signed a $1 billion contract for Switchblades in August 2024. These systems are becoming more readily available to Army units, and they must be immediately integrated into TSO. Only through integration can engineers increase the efficiency and effectiveness of TSO in support of maneuver commanders.

If the Engineer Regiment added LMs to available countermobility options, units could develop new tactics, techniques, and procedures in preparation for LSCO. With the continued use of these systems, less expensive versions with additional acquisitions are possible. This technological growth offers valuable benefits.

What Are the Benefits of LMs?

Integrating LMs into TSO provides several advantages for the Army. First, the aforementioned reduction in labor hours is evident. Second, LMs enable maneuver units to more rapidly transition to offensive operations, allowing troops to move freely rather than navigating minefields or antivehicular ditches. Third, LMs can be packed up quickly and reused, enhancing operational efficiency. Finally, LMs use software that can be updated. They could become even more effective if artificial intelligence (AI) was incorporated, further improving their capabilities.

After the conflict, LMs contribute to a reduced postwar cleanup effort. While some unexploded LMs will require clearance, they pose far fewer lingering hazards than traditional mines. Unlike mines, which can remain a persistent danger for civilians, LMs do not leave widespread remnants of war. Their design ensures that they remain unarmed while in their launch tube or stationed on the ground, meaning any abandoned units present a significantly lower threat than an armed mine.

What Comes Next?

The U.S. Army and the Engineer Regiment must integrate LMs into TSO planning and training. Through experimentation with these systems, another capability is added to the Army TSO inventory. LMs also introduce the potential for AI integration, allowing for more precise target identification. Unlike traditional obstacles such as antivehicular ditches, mines, and wire, these systems can determine attack timelines, providing greater strategic flexibility. By deploying LMs in mass, engineers can create block effects, stagger them for disruption, or concentrate them on a specific terrain area to turn enemy formations.

These systems are readily available, and the Army must shift its perspective to adapt to the evolving character of warfare, as demonstrated in the 2022 Nagorno-Karabakh conflict and the ongoing Russia-Ukraine war. Leveraging LMs to create obstacle effects reduces labor demands, shortens construction time, enhances precision, and introduces new tactical options to TSO that were previously unavailable. The U.S. Army must actively test and refine this capability to be successful in LSCO.

Endnotes:

[1]Brennan Deveraux, "Loitering Munitions in Ukraine and Beyond," *War on the Rocks*, 22 April 2022, <https://www.warontherocks.com/2022/04/loitering-munitions-in-ukraine-and-beyond>, accessed on 5 May 2025.

[2]Sam Skove, "Army Orders Loitering Munition for Testing as Soldier-Borne Tank-Killer," DefenseOne, 11 October 2023, <https://www.defenseone.com/defense-systems/2023/10/army-orders-loitering-munition-testing-soldier-borne-tank-killer/391136/>, accessed on 5 May 2025.

[3]Isabel Debre, "Israeli Arms Quietly Helped Azerbaijan Retake Nagorno-Karabakh, to the Dismay of Region's Armenians," *AP News*, 5 October 2023, <https://apnews.com/article/armenia-azerbaijan-nagorno-karabakh-weapons-israel-6814437bc-d744acc1c4df0409a74406c>, accessed on 5 May 2025.

[4]"Harop Long Range Loitering Munition," *IAI*, <https://www.iai.co.il/p/harop>, accessed on 6 May 2025.

[5]FM 3-34, *Engineer Operations*, 18 December 2023, p. 4-13.

[6]Army Techniques Publication (ATP) 3-90.8, *Combined Arms Countermobility*, 30 November 2021, p. 1-4.

[7]Seth G. Jones, Alexander Palmer, and Joseph S. Bermudez Jr., "Ukraine's Offensive Operations: Shifting the Offense-Defense Balance," *Center for Strategic International Studies*, 9 June 2023, <https://www.csis.org/analysis/ukraines-offensive-operations-shifting-offense-defense-balance>, accessed on 6 May 2025.

[8]FM 3-90, *Tactics*, 1 May 2023, p.17-6.

[9]"Deputy Secretary of Defense Kathleen Hicks Announces Additional Replicator All-Domain Attritable Autonomous Capabilities", Department of Defense, 13 November 2024, <https://www.defense.gov/News/Releases/Release/Article/3963289/deputy-secretary-of-defense-kathleen-hicks-announces-additional-replicator-all//>, accessed on 6 May 2025.

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