# Bayraktars and Grenade-Dropping Quadcopters

## How Ukraine and Nagorno-Karabakh Highlight Present Air and Missile Defense Shortcomings and the Necessity of Unmanned Aircraft Systems

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The onboard camera of a Russian Lancet one-way attack unmanned aircraft targets a Ukrainian SA-8 "Gecko" air defense system in April 2023, seconds before the aircraft struck and destroyed the vehicle. (Screenshot from Funker530)

The Turkish-made Bayraktar TB-2 armed with lightweight, laser-guided bombs, shown here on 2 November 2014, carried out successful attacks by Azerbaijan against Armenian and Artsakh forces in 2020 and by Ukraine against Russian targets in the early stages of that conflict. (Photo by Bayhaluk via Wikimedia Commons)

The increased use of unmanned aircraft systems (UAS) in modern war is no surprise. Modern drones provide outstanding aerial capabilities at all echelons, from a frontline infantry soldier using a small, commercial quadcopter to surveil enemy positions, to large UAS equipped with advanced precision munitions and the ability to operate beyond line of sight from its operator. Necessarily, armed groups seek to counter their adversaries' UAS capabilities by destroying, disabling, or negating them and their effects on the battlefield.

While we can look to almost any conflict fought in the last decade for important lessons on the use and countering of UAS, two of the most recent conflicts provide numerous examples of how modern militaries are fighting the UAS fight. The 2020 Nagorno-Karabakh war between Armenia and Azerbaijan saw widespread use of UAS but also the weaponization of information about that use. The ongoing war in Ukraine reinforces many observations from Nagorno-Karabakh, but it also shows how modern warriors not only would prefer to have, but inherently require, UAS at the lowest echelons. Russian's full-scale invasion of Ukraine reveals how small UAS (sUAS), sometimes purchased commercially or even donated through crowdfunding campaigns, can provide an offensive capability against a larger, technologically capable adversary.

The numerous lessons could likely fill an entire journal, so this article focuses on four lessons. First, we saw the effective use of one specific UAS platform in both conflicts: the Turkish-produced Bayraktar TB-2. The TB-2 flew into popular war songs and crowdfunding campaigns as the world watched clip after clip of TB-2s effortlessly destroying enemy air defenses, tanks, command posts, and supply convoys.[1] With its lethal effects on the battlefield, the TB-2 and similar UAS will undoubtedly be ubiquitous in future conflicts. Second, all sides of the conflicts have used UAS in information operations. The abilities of UAS on the battlefield have captured the public mind, and government information outlets have capitalized on that by publishing video feeds from their UAS or sharing statistics and footage of their forces destroying an enemy's UAS.

Third, more specifically in Ukraine, military forces have acquired drones outside their military procurement channels to equip frontline forces with sUAS to execute the tactical fight, often with strategic effects.

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Ukrainian soldiers watch drone feeds from an underground command center in Bakhmut, Donetsk region, Ukraine, 25 December 2022. The Ukrainian government minister in charge of technology says his country has bought some 1,400 drones, mostly for reconnaissance, and is now developing air-to-air combat drones that can attack the drones Russia is using against Ukrainians. (Photo by Libkos, Associated Press)

While not a new tactic in war, Ukrainian and Russian forces alike have made widespread use of modifying commercial sUAS to drop munitions on enemy forces, providing their forces with an accurate, immediately correctable offensive weapon. Fourth, despite the widespread use and success of UAS, both conflicts reveal how present air defense systems and tactics currently fail to provide adequate counter-UAS (C-UAS) defense against these threats.

These lessons reveal critical shortcomings in the United States' C-UAS—specifically C-sUAS—capabilities, as well as the lack of organic tactical sUAS capabilities, training, and fielding for use by our forces. Future conflicts, regardless of the adversary, will inevitably require U.S. forces and our allies to protect against enemy UAS. As the conflicts show, any viable C-UAS program requires widespread air defense and force protection capabilities at all echelons, not just one short-range air defense (SHORAD) battalion per Army division that rarely, if ever, train together. It will require novel C-sUAS capabilities and tactics in addition to traditional SHORAD and C-UAS defense. And, just as important as negating an adversary's UAS

is providing the benefits of such UAS to friendly forces at all echelons and for all types of units.

## Bayraktars in Nagorno-Karabakh and Ukraine

For decades, the United States and other technologically advanced militaries were the only ones with the technical expertise and money to put unmanned aircraft in the sky. However, as both military-designed and commercial drones become cheaper, more plentiful, and easier to operate, they will continue to proliferate to militaries and armed groups around the world, bringing their deadly capabilities with them.[2]

Take the Azeri's Bayraktar TB-2s. When Azerbaijan launched its offensive against Armenian and Artsakh forces in 2020, it made effective use of the TB-2s. It destroyed Armenian air defenses, tanks, battle positions, and much more, thereby enabling ground forces to maneuver effectively against Armenian forces and rapidly advance through the territory of Nagorno-Karabakh.[3] Armored assets in fortified battle positions with cover and concealment as well as air defense systems actively searching for air tracks were not safe from

A Ukrainian serviceman attaches a hand grenade to a drone to use in an attack against Russian targets near Bakhmut in the Donbas region of Ukraine on 15 March 2023. (Photo by Aris Messinis, Agence France-Presse)

Azeri TB-2s.[4] Yet, Azerbaijan had only just acquired the TB-2 a few months prior to the war. The government announced the acquisition in June 2020 and were employing them on the battlefield by November 2020.[5] Similarly, Ukraine received its first TB-2s in July 2021 and used them for its first kinetic strike in the Donbas region against militants of the Donetsk People's Republic on 26 October, just three months later.[6] Ukraine's acquisition and use of such an advanced UAS was a potential impetus, or at least a purported one, for Russian President Vladimir Putin's decision to begin building up forces along the Ukrainian border before the full-scale invasion on 24 February 2022.[7]

Both Azerbaijan and Ukraine were able to acquire, field, and employ the TB-2 in just a few months. While both militaries are relatively modern and well-equipped, they are not what the United States would typically consider near-peer or a comparable conventional adversary. This shows how easily modern militaries can acquire, train on, and effectively deploy a UAS comparable to the TB-2's capabilities. While such systems are surely not impervious to current air defenses, video feeds from both conflicts show a startling ability to fly directly above enemy air defenses unthreatened, targeting and destroying them instead.

UAS like the TB-2, which are larger and require more logistical and communications support to operate, are classified as Group 4 or 5 UAS.[8] They often provide an organic kinetic strike capability in addition to reconnaissance, intelligence, surveillance, and target acquisition (RISTA). As a result of real-time information sharing, these UAS can also perform immediate battle damage assessment (BDA) and provide data for prompt correction of artillery or other fires on a target, as Azerbaijan and Ukraine have done.[9]

The proliferation of Group 4 and 5 UAS will give many militaries and armed groups the abilities that Ukraine and Azerbaijan employed to great effect. The TB-2 has already seen use in various African states, and worldwide sales show no signs of slowing down.[10] United States and allied ground forces and their leaders should expect any adversary to effectively employ such UAS against them. Even if a potential adversary does not possess such UAS now, Ukraine and Azerbaijan's rapid acquisition and deployment of the TB-2 demonstrate that any modern military can, and likely will, acquire Group 4 and 5 UAS and use them

A video feed from a Ukrainian TB-2 shows it guiding a missile onto a Russian Buk M-3 air defense system outside Kyiv on 28 February 2022. The missile struck and destroyed the Buk system. (Screenshot courtesy of the Ministry of Defence of Ukraine via Twitter)

to great effect, often sidestepping current air defense platforms. Such UAS may even soon become a C-UAS weapon in its own right.[11]

## UAS in the Information Fight

As critical as the TB-2 and other UAS were to the parties of both conflicts on the battlefield, they were also a major factor in the information wars. Government media outlets shared drone feed footage of their UAS striking or surveilling enemy forces. In the face of such public fascination with the purported successful employment of UAS, the opposite side would often attempt to discredit such reports, usually by sharing footage or reports of shooting down UAS. Both conflicts clearly show how important UAS have become in the information domain, as the public perceives successful UAS use as crucial to battlefield success.

In Nagorno-Karabakh, Azerbaijan published numerous clips of its TB-2 feeds and its Israeli-made Harpy drones, which are one-way loitering attack UAS that fly into their targets to destroy them.[12] These clips showed the destruction of Armenian vehicles, artillery, troop positions, and more. Azeri government

outlets shared these clips on social media sites like Twitter directly on the official ministry of defense page for the world to access and view. Third-party sites like Funker530, a combat footage website, and other social media users and platforms reshared these clips, increasing worldwide viewership.[13] Fascination with the Azeri's use of UAS presented an image that the Azeri military was highly successful and effective on the battlefield. The government's goal was clearly to paint a picture of battlefield success to ensure domestic support and international awe at the military's effectiveness.

The Armenian government sought to counter this information, especially as the forces of their military and that of their ally, Artsakh, lost territory during the conflict. As domestic turbulence grew in light of Armenia's losses, the government published its own footage showing an air defense intercept and destruction of an Azeri UAS, a modified AN-2 Colt. Armenia shared this footage on its Twitter page as well, likely hoping for high viewability just as Azerbaijan was able to garner with its drone footage.[14] Government accounts also tweeted photos purporting to show debris from Azeri TB-2s after being shot down.

While Azerbaijan's injection of UAS footage dwarfed Armenia's C-UAS information operations, it was still an interesting development. That Armenia felt the need to respond to the effects of Azerbaijan's drone information operations illustrates how important and effective they can be. The 2020 Nagorno-Karabakh conflict ushered in a new technique of state-sponsored

In future conflicts, the United States should expect that the success of UAS and C-UAS employment, whether real or purported, will be an increasingly important aspect of information operations. Successful UAS employment is therefore significant not only for the effects they bring to the tactical battlefield but also on mobile devices and social media platforms.

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UAS-related information operations that Russia and Ukraine have exploited.

Ukraine's government outlets also quickly published TB-2 recordings on official government channels such as the messaging application Telegram. They included strikes on the Russian backed-up convoy outside Kyiv, thwarting Russia's attempt to topple the capital.[15] These clips have also featured in Ukraine's recent counteroffensives such as showing the destruction of air defenses and boats on the strategically and symbolically important key terrain of Zmiinyi (Snake) Island, which forced Russia to withdraw on 30 June 2022.[16] Just like in Nagorno-Karabakh, third-party sites republished these clips, increasing viewership and global fascination. The TB-2 became so famous that Ukrainian fighters wrote songs and shared videos of them dancing along.[17]

And just as Armenia sought to counter this information effect, Russia shared stories of shooting down TB-2s. They even went so far as to stage a fake air defense kill of a TB-2, all to appear to be successfully countering Ukraine's UAS employment.[18] Ukrainian government sites have also touted their own C-UAS capabilities, sharing videos of shooting down Russian UAS, posing with downed UAS, and sharing destroyed UAS counts in their daily briefings.[19] While all sides oftentimes inflate such counts and reports in a conflict, the fact that they are so central and oft-reported reveals how important the conflict parties view them in their information operations.

The public is increasingly fascinated with unmanned operations in conflict and associate UAS/C-UAS success with success in the overall war effort. This will apply to information consumers domestically, in allied nations, in a potential adversary's nation, and worldwide.[20] Finally, as unmanned ground and naval vehicles become increasingly capable and autonomous, there is little reason not to expect those platforms to impact the information domain as armed groups and state militaries begin employing them in combat.

## Group 1–3 sUAS in Ukraine

While the Nagorno-Karabakh conflict lasted six weeks, the full-scale Russian invasion of Ukraine has continued for a year and a half. Further, the war in Ukraine has resulted in mass mobilization within Ukraine, resulting in hastily organized units such as the Territorial Defense Force and the Ukrainian International Legion for foreign volunteers.[21] As the war continued, both the newly organized units and firmly established units began employing smaller, cheaper, Group 1–3 sUAS extensively.

Ukrainian forces (and, to a lesser extent, at least in Western media, Russian forces) have purchased or received donations of commercial drones for their use. While not as large, capable, or long-range as standard military designed UAS, these drones can still provide an essential RISTA and BDA capability. Frontline personnel, such as at the platoon or squad level, can employ their own UAS rather than relying on UAS held as

intelligence assets at the battalion-or-above level. This permits them and their leaders to see the battlefield in real time, make immediate adjustments, and better avoid ambushes or prepared enemy positions.[22]

Video footage from Ukraine also shows that Ukrainian forces modified such Group 1–3 sUAS to carry and drop munitions—often antitank rounds,

radars and are usually too small to counter with current U.S. Army SHORAD systems like the FIM-92 Stinger missile, whether fired in a Man-Portable Air Defense System (MANPADS) configuration or from the legacy Avenger or new Maneuver-SHORAD (M-SHORAD) platforms. While the United States has developed and acquired a litany of C-sUAS systems

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grenades, or mortar rounds—onto enemy positions, vehicles, and personnel.[23] This is far from the first time we have seen commercial drones fitted to carry and drop such munitions; in Syria, militant groups like the Islamic State pioneered this technique as early as 2015.[24] However, Ukrainian forces appear to use them in large numbers and outside of formal military acquisition and development channels. Their effectiveness can be seen plainly in the published video footage. Furthermore, Ukraine has acquired purpose-built munitions-dropping sUAS. A Taiwanese-based producer, DronesVision, sent eight hundred purpose-built munitions-dropping UAS to Ukraine via Poland. The Revolver 860 system can carry eight 60 mm mortars to drop directly onto targets below.[25]

Whether purely commercial sUAS conducting surveillance, jerry-rigged commercial drones carrying whatever munitions available, or purpose-built munitions-dropping sUAS, the United States must expect to face an ever-increasing quantity and variety of Group 1–3 sUAS on today's battlefield, no matter the adversary.[26] Ukraine's rapid acquisition, proliferation, and employment of commercial sUAS shows that any potential adversary can exploit current technology similarly. Taiwan's Revolver 860 UAS is an example of one of the first, but certainly not the last, of a small munitions carrying UAS.

These Group 1–3 sUAS have such a low radar cross-section that they can avoid detection by most modern U.S. Army air and missile defense (AMD)

(e.g., Fixed Site-Low, Slow, Small Unmanned Aerial Vehicle Integrated Defeat System [FS-LIDS]; Mobile Low, Vehicle Integrated Defense System [M-LIDS]; and Mobile Air Defense Integrated System [MADIS]), they are not currently fielded to trained personnel across the force, especially our maneuver forces, in sufficient numbers to counter this exponentially growing threat. There is also an immediate need for highly mobile C-sUAS systems to accompany friendly forces that must remain agile to avoid detection and targeting by those same sUAS and other enemy collection techniques. If Ukraine and Russia are rushing "drone busters" to their forces, why aren't we?

## Providing Friendly sUAS Capabilities in the Tactical Fight

The lessons of Ukraine and Nagorno-Karabakh are not limited to C-UAS. They also reveal the necessity of all tactical units having a sUAS RISTA capability. In Ukraine, sUAS have become so essential to the battlefield that Ukrainian forces have sent sUAS on sUAS-recovery missions behind enemy lines—a drone rescuing a drone.[27] Maneuver platoons can employ sUAS to surveil an objective before occupying, conducting movement, or attacking. RISTA/BDA sUAS are clearly essential for correcting indirect fire of all types, whether used by forward observers or any front-line soldier.

sUAS benefits should not be limited to maneuver units only, however. The ability for real-time,

A Ukrainian soldier controls a drone as its camera shows Russian troop positions during heavy fighting at the front line in Severodonetsk, Luhansk region, Ukraine, 8 June 2022. (Photo by Oleksandr Ratushniak, Associated Press)

on-demand aerial reconnaissance or surveillance is essential for all units. For example, a battery—whether air defense or field artillery—conducting a Reconnaissance, Selection, and Occupation of Position performs a ground reconnaissance of a potential new site and the routes there.[28] A sUAS would allow them to add a real-time air reconnaissance capability, protecting the ground element until they have surveilled the site and route. Any unit—logistics, medical, engineer, etc.—conducting a road march or occupying a new position can use a Group 1–3 sUAS to conduct an air reconnaissance of the route ahead of them, doing so even as they move. A sUAS RISTA capability at echelons lower than brigade combat teams will also reduce the number of priority intelligence requirements submitted to higher headquarters, thereby freeing up brigade-and-above intelligence assets.

Equipping units with Group 1–3 sUAS—ideally government-developed but, if necessary, commercial off-the-shelf as Ukraine has done—will also benefit the defense of fixed sites from ground attack. This includes command posts at all echelons, forward arming and refueling points, tactical assembly areas, communications relay sites, and many more. sUAS can monitor the site perimeter, entry control points, and routes in and out of the area with a live feed direct to the element tasked with site security or the local command post.

Of course, the internal proliferation of sUAS would necessitate training in discretion; if I fly a small quadcopter over the brigade command post twenty-four hours a day, it will be quite easy for an enemy force to determine where we are and target us, both visually and based on electromagnetic emissions. But the benefits of having the capability of a sUAS for monitoring relatively fixed sites and conducting reconnaissance of new sites and routes, employed with proper discretion, far outweigh the risks, especially since the adversary is very likely to be using comparable sUAS to try to find our positions anyway. If Ukraine and Russia are rushing Group 1–3 sUAS to their forces, why aren't we?

## Current AMD and C-sUAS Shortcomings

Both Nagorno-Karabakh and Ukraine show the inability of current AMD systems to defend friendly forces against new UAS like the Bayraktar TB-2 and

Group 1–3 commercial sUAS adapted for military use. A number of videos released by both Azerbaijan and Ukraine during their respective conflicts show the TB-2 striking Soviet-era AMD platforms, still in use by a number of countries—including NATO countries—like the SA-8 "Gecko" or the Buk M-1/2 (SA-17 "Grizzly"), and others.[29] Russia also recently shared video of a Lancet one-way attack UAS striking and destroying an American-made Avenger system.[30] Ukraine and Russia's use of commercial Group 1–3 sUAS demonstrates the requirement for a vast expansion in C-sUAS coverage, and combatants there have scrambled to rapidly equip their forces with C-sUAS weapons.[31] Even if current AMD platforms could adequately intercept such sUAS (which they cannot), their high quantity, cheapness, ease of use, and proliferation among tactical-level units means modern militaries need a C-sUAS capability interspersed throughout their forces. From a warfighting function perspective, this is both a fires and a protection issue.[32]

What does this mean for air defense and protection against sUAS? First, there is little doubt that modern militaries will require more air defense. As Group 4 and 5 UAS like the TB-2 increase in quantity and capability, militaries will need more C-UAS AMD systems to deny those systems airspace and, ideally, intercept and destroy them. AMD and the fires warfighting function, including incorporating nonlethal fires via electronic warfare capabilities, are best suited to counter Group 4 and 5 UAS. Indeed, Russia has reportedly vastly improved its ability to counter Ukraine's TB-2s, incorporating electronic warfare capabilities alongside traditional air defense systems to relegate the TB-2s to reconnaissance duties safely away from potential intercept.[33]

Second, there is also an urgent need for a robust C-sUAS capability that can detect, identify, respond to (including engagement), and report the enemy sUAS, with the aim of negating the effects of the enemy's sUAS.[34] The current radars and weapon systems that most militaries, including the United States, rely upon were designed and maintained with a counter-aircraft mission, adept at detecting and destroying fighters, bombers, and helicopters, not small, slow UAS. While the United States and other modern militaries possess capable C-sUAS systems such as M-LIDS and various "drone buster" guns, these systems must be available

organically—not as a just-before-deployment attachment or fielding—for maneuver and support units alike. Just as all units can receive and deploy with antiarmor systems like the AT-4, or formerly deployed to Iraq and Afghanistan with counter-improvised explosive device systems, all units require a short-range C-sUAS capability to at least defend against Group 1–3.[35] Most importantly, they need this capability *now*. The next fight, whoever it is against, will see widespread use of sUAS by our adversary.

Third, units must train with UAS, including Group 1–3, in mind. Tactics thought to be left to the history books—air guards, react-to-air attack, using small arms to fire at aircraft—need to return and adapt to the C-UAS fight.[36] Even if units cannot train with an air defense unit directly, trainers can provide their opposing forces with sUAS to conduct RISTA operations against the training audience. They can even rig them to drop foam Nerf footballs or tennis balls to mimic current battlefield tactics. And while these changes will come at a financial cost, they cannot exist solely at combat training centers.[37] Adversary UAS need to be incorporated into regular field training exercises, combined live-fire exercises, command post exercises, convoy training, small-unit training, and more.

The question quickly arises: How best to address these shortcomings? There are a variety of options available to policymakers and planners. The Army's current approach to counter armored threats provides a possible framework with multiple options. Ground forces could field C-sUAS weapons systems directly to lower-echelon units, just as we currently do with AT-4s and did for counter-improvised explosive devices in Iraq and Afghanistan. After Russia's illegal annexation of Crimea and support for separatists in eastern Ukraine in 2014, the Army began the Additional Skill Identifier A5 program, training infantry soldiers on the Stinger platform. One option is to expand this program or make such training standard, just like AT-4s, or supplement the current Additional Skill Identifier A5 program with additional C-UAS training and equipment.

There is also an option to add a separate SHORAD/C-sUAS element to units organically. This would prevent haggling over command and support relationships and reduce demand for AMD/C-sUAS resources when, as is the current doctrine, U.S. SHORAD battalions are "potentially" distributed to Army divisions,

not organically a part of the maneuver units.[38] An element organic to maneuver units could be a new type of SHORAD battery, minimally reliant on integration with other air defense sensors and shooters, in each brigade combat team, perhaps within the brigade engineer battalion. This battery might consist of a platoon of sensors, a C-sUAS platoon with electronic warfare weapons systems to counter Group 1–3, and a typical SHORAD platoon with weapons like the Stinger missile in MANPADS configuration to counter aircraft and Group 4 and 5 UAS.

Or, again looking to the example of antiarmor capabilities within maneuver units, every maneuver battalion could include a platoon within the battalion headquarters and headquarters company or weapons company dedicated to C-UAS, perhaps with two squads for C-sUAS and one squad of traditional SHORAD. After many decades of risk-averse air defense, the increased risk of decentralized air defense shooters is necessary in this emerging world of UAS. The Army could look to how Air Force tactical air control parties, embedded in Army maneuver forces, receive a tactical air picture as inspiration for how to integrate the necessary SHORAD/C-UAS capabilities in maneuver forces into the joint AMD fight. Whether this hypothetical C-UAS element resides organically at the battalion, brigade, or division level, with or without a C-UAS weapons system fielded directly to frontline personnel, or a mix of all of these, the key takeaway is that maneuver units need C-UAS organically and in adequate numbers to defend their battlespace independent of external support. Better minds can determine the precise form of the solution—the *immediate* need, however, is all too apparent.

Whatever the solutions, a few principles are evident, principles that the Joint Counter-Small Unmanned Aircraft Systems Office may consider in their strategies, particularly when updating the Department of Defense C-sUAS strategy that has not been updated since January 2021 despite the stream of lessons from Nagorno-Karabakh and Ukraine.[39] As mentioned, we need more air defense force protection assets, better equipped for C-UAS and specifically C-sUAS, dispersed to the lowest level, organic to maneuver and nonmaneuver units alike, and with more integrated and accountable training. The large-scale drone fight is already here; our ground forces need the equipment, knowledge, and training to counter and survive it.

## Conclusion

The wars of Nagorno-Karabakh and Ukraine show us the present and the future of UAS warfare. Whether it is the employment of Group 4 and 5 UAS like the TB-2 Bayraktar or ingeniously adapting and rigging commercial off-the-shelf sUAS for RISTA and offensive capabilities, the wars show that any potential adversary, and the United States itself, can and should rapidly acquire and employ such UAS. These drones have reshaped the battlefield, reshaped the information fight, and obviated or revealed gaps in older air defense systems. It has ushered in new urgency to a latent shortcoming in the U.S. Army and Department of Defense-wide—its C-UAS capability.[40]

Just as the United States and allied ground forces should seek to distribute the benefits of small RISTA UAS to all units at low-level echelons, they must also rapidly add, improve, and integrate C-UAS force protection capabilities with all units down to the tactical-unit level. Failure to do so before the next conflict, whomever it may be against, will lead to public embarrassment in the information domain, tactical losses of materiel and personnel, and lost opportunities in the offense. Domination of the skies will not just depend on advanced fifth-generation aircraft—it will require the Group 1–3 quadcopters and C-sUAS weapons we are seeing proven on the battlefield every day in Nagorno-Karabakh and Ukraine. ∎

## Notes

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9. Ibid., para. 1-9.

10. Stijn Mitzer, "Drone Warfare Turns Hot over Ethiopia's Oromia Region," Oryx, 17 January 2022, accessed 27 April 2023, https://www.oryxspioenkop.com/2022/01/drone-warfare-turns-hot-over-ethiopias.html. It's difficult to count how many nations operate,

or have signed contracts to purchase, the TB-2, given how often the list grows. The number at the time of publication is at least nineteen. Stijn Mitzer and Joost Oliemans, "An International Export Success: Global Demand for Bayraktar Drones Reaches All Time High," Oryx, 2 September 2022, accessed 27 April 2023, https://www.oryxspioenkop.com/2021/09/an-international-export-success-global.html; Tony Osborne, "Poland Takes Delivery of Bayraktar TB2 Drones," Aviation Week, 1 November 2022, accessed 27 April 2023, https://aviationweek.com/defense-space/aircraft-propulsion/poland-takes-delivery-bayraktar-tb2-drones; "Turkey's Baykar to Deliver Drones to Kuwait in $370 Million Deal," Reuters, 18 January 2023, accessed 27 April 2023, https://www.reuters.com/world/middle-east/turkeys-baykar-deliver-drones-kuwait-370-million-deal-2023-01-18/. Selçuk Baykar, Baykar's chairman of the board and chief technology officer, has declared: "The whole world is a customer." Nailia Bagirova, "Exclusive: After Ukraine, 'Whole World' Is a Customer for Turkish Drone, Maker Says," Reuters, 30 May 2022, accessed 27 April 2023, https://www.reuters.com/business/aerospace-defense/exclusive-after-ukraine-whole-world-is-customer-turkish-drone-maker-says-2022-05-30/.

11. "Turkish Drone Company Baykar to Develop Air-to-Air Missiles to Counter Kamikaze Drone Attacks in Ukraine," *Kyiv Independent* (website), 30 October 2022, accessed 27 April 2023, https://kyivindependent.com/news-feed/turkish-drone-company-baykar-to-develop-air-to-air-missiles-to-counter-kamikaze-drone-attacks-in-ukraine.

12. A note on citations to clips of drone footage. First, many of the clips depict war footage, at times graphically, so viewer discretion is advised. Second, the citations in this article are merely to provide a reference to one or two examples of each development discussed in this piece. Anyone can simply search on the internet for "Ukraine grenade-dropping drone," or any similar search, and find hundreds of related videos, which further substantiates the points made in this article. As one of many examples, see an Azeri Ministry of Defense tweet with TB-2 feed footage: Azerbaijan Ministry of Defense (@wwwmodgovaz), "#Azerbaijan Army destroyed #OPs of armed forces of #Armenia located in Azerbaijan territory," Twitter, 9 October 2020, 12:40 a.m., accessed 27 April 2023, https://twitter.com/wwwmodgovaz/status/1314440465920528385.

13. "Azerbaijani Kamikaze Drones Are Crushing Armenian Military Targets," Funker530, 2 December 2020, accessed 27 April 2023, https://funker530.com/video/azerbaijani-kamikaze-drones-armenian/. This is collecting and reposting a series of videos originally released by Azerbaijan government outlets.

14. Ministry of Defense of Armenia (@ArmeniaMODTeam), "Destruction of an #Azerbaijan'i drone," Twitter, 1 October 2020, 12:08 p.m., accessed 27 April 2023, https://mobile.twitter.com/ArmeniaMODTeam/status/1311699432132546564; "Karabakh Air Defense Shoots Down Another Turkey-Made Bayraktar Drone of Azerbaijan," News.am, 8 November 2020, accessed 27 April 2023, https://news.am/eng/news/612134.html.

15. Defense of Ukraine (@DefenceU), "Знищення з БПЛА 'Bayraktar TB2' російського ЗРК 'Бук' біля с. Іванків Київської області. Все буде Україна!" [Destruction of the Russian "Buk" air defense system from the "Bayraktar TB2" UAV near the village of Ivankiv, Kyiv region. Everything will be Ukraine!], Twitter, 28 February 2022, 10:47 a.m., accessed 27 April 2023, https://twitter.com/DefenceU/status/1498324064527691777.

16. Defense of Ukraine (@DefenceU), "Ukrainian Bayraktar TB2 destroyed another Russian ship. This time the landing craft of the 'Serna' project. The traditional parade of the Russian Black

Sea fleet on May 9 this year will be held near Snake Island - at the bottom of the sea." Twitter, 7 May 2022, 7:15 a.m., accessed 27 April 2023, https://twitter.com/DefenceU/status/1522897994701549573?s=20&t=uFJUQ_7q7RF2DgnwSTmp_A; Antonia Colibășa-nu et al., *The Strategic Importance of Snake Island* (Washington, DC: Center for European Policy Analysis, 27 September 2022), accessed 27 April 2023, https://cepa.org/comprehensive-reports/the-strategic-importance-of-snake-island/.

17. Сухопутні війська України, "Кара за українських дітей."

18. David Axe, "The Russians Got Caught Faking a TB-2 Drone Shoot-Down," *Forbes* (website), 28 April 2022, accessed 27 April 2023, https://www.forbes.com/sites/davidaxe/2022/04/28/the-russians-got-caught-faking-a-tb-2-drone-shoot-down/.

19. As an example, for a purported Ukrainian shootdown of a Russian Orlan-10 UAS with an American-made FIM-92 Stinger missile, see 93-тя ОМБр Холодний Яр [93rd Mechanized Brigade], "Західна зброя в дії!" [Western weapons in action!], Facebook video, 28 July 2022, accessed 27 April 2023, https://www.facebook.com/93OMBr/videos/1396244900896667. *Today, the IAEA Mission Arrived at Zaporizhzhia NPP. Address by the President, 1.09.2022*, YouTube, posted by "Office of the President of Ukraine," 1 September 2022, 7:45, accessed 27 April 2023, https://www.youtube.com/watch?v=Fx3YvrAmCkU. Ukraine's touting of their counter-unmanned aircraft system (C-UAS) achievements have made their way into President Volodymyr Zelensky's daily evening addresses. On 1 September 2022, he claimed that Ukrainian forces had eclipsed eight hundred downed Russian UAS.

20. Theodore W. Kleisner and Trevor T. Garmey, "Tactical TikTok for Great Power Competition: Applying the Lessons of Ukraine's IO Campaign to Future Large-Scale Conventional Operations," *Military Review* 102, no. 4 ( July-August 2022): 23–43; Field Manual 3-13, *Information Operations* (Washington, DC: U.S. GPO, 6 December 2016).

21. Maksym Butchenko, "Ukraine's Territorial Defence on a War Footing," International Centre for Defence and Security, 13 April 2022, accessed 27 April 2023, https://icds.ee/en/ukraines-territorial-defence-on-a-war-footing/; Isaac Tang, "The Latest in a Long Line: Ukraine's International Legion and a History of Foreign Fighters," *Harvard International Review* (website), 2 September 2022, accessed 27 April 2023, https://hir.harvard.edu/the-latest-in-a-long-line-ukraines-international-legion-and-a-history-of-foreign-fighters/.

22. 93-тя ОМБр Холодний Яр [93rd Mechanized Brigade], "Нічого особливого, просто точна робота холодноярських артилеристів по позиціях росіян" [Nothing special, just the precise work of the Holodoyarsk artillerymen on the positions of the Russians], Facebook video, 18 October 2022, accessed 27 April 2023, https://www.facebook.com/93OMBr/videos/639599104225843; Sam Skove, "Near the Front, Ukraine's Drone Pilots Wage a Modern War on a Shoestring Budget," Radio Free Europe/Radio Liberty, 31 October 2022, accessed 27 April 2023, https://www.rferl.org/a/ukraine-drone-pilots-modern-war-shoestring-budget/32108994.html.

23. "Lessons from Use of Drones in the Ukraine War," DroneShield, 13 July 2022, accessed 27 April 2023, https://www.droneshield.com/blog-posts/lessons-from-drones-in-ukraine-war; "Ukrainians Are Bombing Russians with Custom Drones," Vice News, 17 June 2022, accessed 27 April 2023, https://video.vice.com/en_uk/video/ukrainians-are-bombing-russians-with-custom-drones/6267c399f-85e1243221cd521?fbclid=IwAR3mY1U5MjrhYxTox-GjUXzGTPVdA8vOlI53tqxNczoi98aliWlY5okl2xm8&latest=1.

24. Nick Waters, "Death from Above: The Drone Bombs of the Caliphate," Bellingcat, 10 February 2017, accessed 27 April 2023, https://www.bellingcat.com/news/mena/2017/02/10/death-drone-bombs-caliphate/; Reuben Dass, "Militants and Drones: A Trend That Is Here to Stay," Royal United Services Institute, 6 September 2022, accessed 27 April 2023, https://rusi.org/explore-our-research/publications/commentary/militants-and-drones-trend-here-stay.

25. "Revolver 860," DronesVision, accessed 27 April 2023, https://dronesvision.com/mortar-revolver-bomber-drone/; Ashish Dangwal, "Ukranie Gets 800 Taiwan-Made 'Carpet Bomber' Revolver 860 Combat Drones to Thwart Russian Aggression," EurAsian Times, 29 August 2022, accessed 27 April 2023, https://eurasiantimes.com/ukraine-gets-800-taiwan-revolver-860-drones/; Keoni Everington, "Taiwan's Revolver 860 Combat Drones Being Used by Ukrainians on Battlefield," Taiwan News, 18 August 2022, accessed 27 April 2023, https://www.taiwannews.com.tw/en/news/4630475.

26. Andrew E. Kramer, "Homemade, Cheap and Lethal, Attack Drones Are Vital to Ukraine," *New York Times* (website), 8 May 2023, accessed 10 May 2023, https://www.nytimes.com/2023/05/08/world/europe/ukraine-russia-attack-drones.html. Ukraine and Russia alike have made substantial use of one-way attack small UAS (sUAS) as well, including the U.S.-supplied Switchblades to Ukraine and the Russian Lancet. Numerous videos of such one-way attack sUAS are available online, as well as commercial off-the-shelf sUAS modified for one-way attack use.

27. "Ukrainian Drone Recovers Another Crashed Drone," Funker530, 30 December 2022, accessed 27 April 2023, https://funker530.com/video/ukrainian-drone-recovers-another-crashed-drone/.

28. ATP 3-01.87, *Patriot Battery Techniques* (Washington, DC: U.S. GPO, August 2018), para. D-23–D-24.

29. In Ukraine: "Russian BUK-M2 Air Defense System Obliterated by Bayraktar TB2 Drone," Funker530, March 2022, accessed 27 April 2023, https://funker530.com/video/russian-buk-m2-air-defense-system-obliterated-by-bayraktar-tb2-drone/. In Nagorno-Karabakh: Azerbaijan Ministry of Defense (@wwwmodgovaz), "#Enemy's combat ready anti-#aircraft #missile systems were destroyed," Twitter, 10 October 2020, 10:07 a.m., accessed 27 April 2023, https://twitter.com/wwwmodgovaz/status/1314945583870816257.

30. "Российский дрон «Ланцет» уничтожил в зоне спецоперации американский ЗРК Avenger" [Russian drone "Lancet" destroyed the American Avenger air defense system in the special operation zone], RT, 7 May 2023, accessed 10 May 2023, https://russian.rt.com/ussr/news/1145579-lancet-zrk-avenger; "Lancet Kamikaze Drone Hits Ukrainian AN/TWQ-1 Avenger," Funker530, 7 May 2023, accessed 10 May 2023, https://funker530.com/video/lancet-kamikaze-drone-hits-ukrainian-antwq-1-avenger/.

31. "Ukraine's Anti-Drone Rifle Takes Aim at Russian UAVs," Radio Free Europe/Radio Liberty, 23 June 2022, accessed 27 April 2023, https://www.rferl.org/a/ukraine-anti-drone-gun-russia-war/31912255.html.

32. Glenn A. Henke, "Once More Unto the Breach: Air Defense Artillery Support to Maneuver Forces in Large-Scale Combat Operations," *Military Review* 103, no. 2 (March-April 2023): 74–75 (discussing the role of ADA in both the fires and protection warfighting functions).

33. Alia Shoaib, "Bayraktar TB2 Drones Were Hailed as Ukraine's Savior and the Future of Warfare. A Year Later,

They've Practically Disappeared," Insider, 28 May 2023, accessed 31 May 2023, https://www.businessinsider.com/turkeys-bayraktar-tb2-drones-ineffective-ukraine-war-2023-5.

34. ATP 3-01.81, Counter-Unmanned Aircraft Systems Techniques, para. 1-11.

35. Kyle Rempfer, "Drones Are Biggest Tactical Concern Since the Rise of IEDs in Iraq, CENTCOM Boss Says," Army Times (website), 8 February 2021, accessed 27 April 2023, https://www.armytimes.com/news/your-army/2021/02/08/drones-are-biggest-tactical-concern-since-ieds-rose-in-iraq-four-star-says/. Indeed, Marine Corps Gen. Kenneth McKenzie Jr., then U.S. Central Command commander, acknowledged in early 2021 that the emerging sUAS threat was analogous to IEDs in Iraq.

36. Ibid.; Andrew E. Kramer, "'We Heard It, We Saw It, Then We Opened Fire,'" New York Times (website), 23 October 2022, accessed 27 April 2023, https://www.nytimes.com/2022/10/23/world/europe/ukraine-russia-drones-iran.html; Henke, "Once More Unto the Breach," 74; ATP 3-01.81, Counter-Unmanned Aircraft Systems Techniques, Appendix A. Appendix A includes training requirements for counter-sUAS, including small arms engagement like Ukrainian forces described in the New York Times article, and have occurred in a number of other situations worldwide. Appendix A's training requirements need to be harmonized with C-UAS (Groups 4 and 5) air and missile defense training and traditional counter-air training. These training models need to be established as requirements, not just recommendations, for units' evaluations and included in mission essential task lists alongside traditional force protection measures.

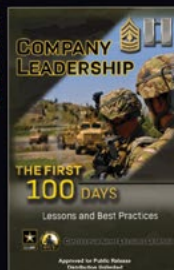37. ATP 3-01.81, Counter-Unmanned Aircraft Systems Techniques, fig. A-1.

38. ATP 3-91, Division Operations (Washington, DC: U.S. GPO, October 2014), para. 1-11, 1-44, 1-52.

39. U.S. Department of Defense, Counter-Small Unmanned Aircraft Systems Strategy (Washington, DC: U.S. Department of Defense, 7 January 2021), accessed 27 April 2023, https://media.defense.gov/2021/Jan/07/2002561080/-1/-1/1/DEPARTMENT-OF-DEFENSE-COUNTER-SMALL-UNMANNED-AIRCRAFT-SYSTEMS-STRATEGY.PDF.

40. John R. Hoehn and Kelley M. Sayler, Department of Defense Counter-Unmanned Aircraft Systems (Washington, DC: U.S. Congressional Research Service, 17 April 2023), accessed 27 April 2023, https://crsreports.congress.gov/product/pdf/IF/IF11426. Congress has taken an interest in this issue as well, and an updated April 2023 Congressional Research Service "In Focus" publication lists some of the shortcomings and slow developm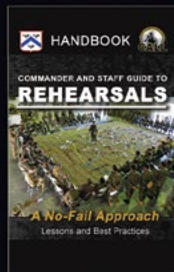ent of a response across all branches of the military.