Combat Employment of Drones by the Ukraine Military

Results of a 15-Day Site Survey 20 June – 5 July 2022

Background

Independent researchers, John Gerlaugh and Greg Holt, conducted a review of drone use by Ukrainian forces during June and July 2022. The purpose of the survey was to develop a common operating picture of drone use by the Ukrainian military and civil defense forces.

Eight locations were visited shown in figure 1 below.

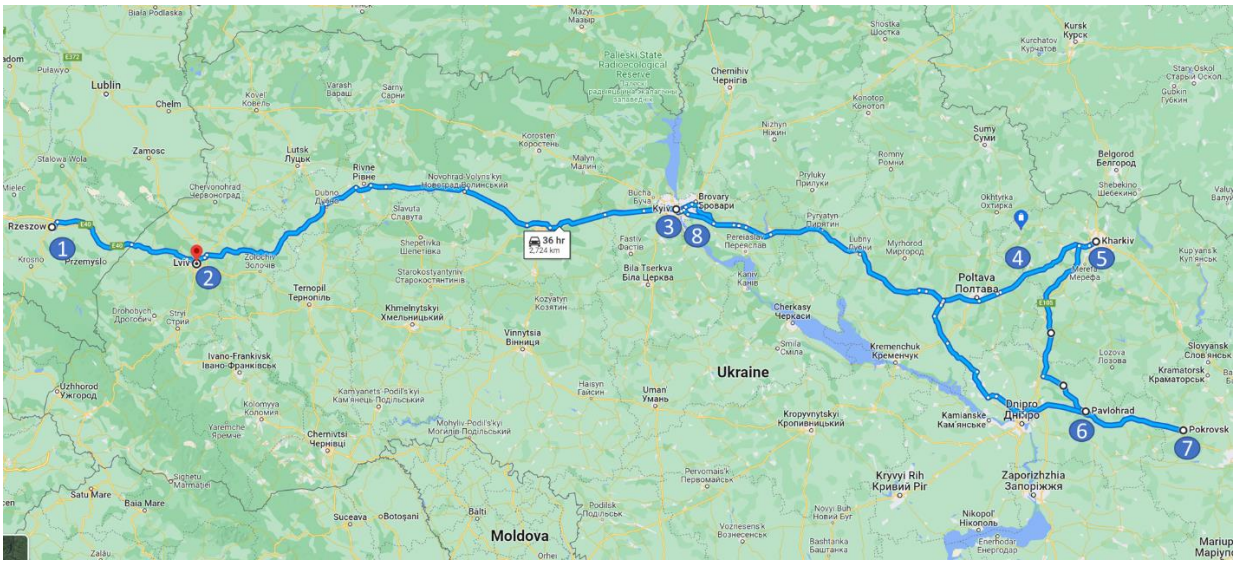

Figure 1

Twelve individuals were interviewed but will not be named for security reasons. The twelve individuals included:

1. Civilian leader of small partisan unit, Kharkivskaya Oblast, along with his drone operator and one scout team member.
2. Territorial Defense Unit leader and his drone operators in Kramatorsk/Izium (Note: for security reasons we met in Pokhrivsk, Donetskaya Oblast).
3. A Ukrainian Lieutenant Colonel, the commander of anti-aircraft missile battalion Kharkivskaya Oblast.
4. American civilian who runs a drone training mission in Ukraine.

5. Ukrainian commander of long-range drone unit and two team members involved in procurement in Kyiv.
6. A "Tier I" drone operator in Kyiv (note: Tier I copied from a term used by US forces to describe SEAL Team 6 or Delta Force).
7. American whose team trains Ukrainian soldiers near Mykolaiv.
8. American volunteer serving in the Ukrainian armed forces who leads small unit raids in the Donbass region, interviewed in Pokhrovsk, Donetskaya Oblast.
9. American who performs infantry training for new recruits in the Kharkivskaya Oblast.
10. The mayor of a small village in the Kharkivskaya Oblast.
11. Ukrainian woman civil engineer who provides support with her car to Ukrainian TDUs by driving her car with medial and non-lethal military supplies around the country. Home based in Lviv.
12. American and former military officer who has lived in Ukraine for eight years and has delivered by personal car non-lethal aid to Ukrainian forces since the annexation of Crimea in 2014.

Focus

This paper focuses on Ukrainian supply chain, domestic development and modification, employment, and effectiveness of drone use against the Russian military. During our interviews we mainly sought information on small and medium size, commercially available drones. The larger fixed wing drones or UAVs such as Predator, Reaper and Turkish made Bayraktar TB2 were not considered and are mostly outside the scope of this study.

The ultimate objective of this effort is to encourage U.S. drone manufacturers, perhaps under the leadership of their associations, to support and assist Ukraine's development, production, and employment of commercially available drones against Russian military forces.

Executive Summary

Drones of all sizes are being employed by both warring parties in Ukraine. Russia is better resourced and uses large, fixed wing drones for strike and surveillance. Russian tactical units use smaller commercially available drones for tactical surveillance. They are rumored to be receiving a large shipment of unspecified drones from Iran soon.

We assess Russian forces lack initiative and creativity in their tactics and therefor are not employing drones, especially smaller tactical drones, as effectively as their Ukrainian opposition. We conclude this is partly driven by Russian military practice of tight centralized command and control, and a cultural aversion to individual initiative along with low education

levels of the average Russian conscript. This is exacerbated by endemic corruption within the Russian central government placing even Russian military drones at risk of faulty operation.

Ukrainian forces are better educated on average and fight with the "home field advantage" of familiar terrain inside of a supportive population. Ukrainian forces and their civilian leaders are creative by necessity as they suffer from resource shortfalls and destruction of their infrastructure by Russian artillery and missile strikes. Unlike their Russian counterparts, Ukrainians are fighting for their national survival spurred on by discoveries of mass executions of Ukrainian civilians, torture, force displacement to labor camps, and public characterization of Ukrainians by Russian military authorities as "subhuman".

Examples of Ukrainian creativity may be seen in the employment of SpaceX provided StarLink internet terminals along with Uber-style software to create applications that allow for very rapid calls for artillery fire. Drone use by Ukrainian forces is an exercise in innovation and individual initiative.

Critical needs on the Ukrainian side include drones with longer range, greater altitude, longer dwell time over a target area (longer battery life), greater payload, jam-proofing, quieter operation, laser designation, and thermal viewing.

Comment: Ukraine's "drone warfighting space" represents a significant real-world innovation laboratory where U.S. drone manufacturers could benefit from lessons learned while actively supporting the defense of the Ukrainian people.

Collection Methodology

Data collection was conducted through personal interviews with drone operators, supported unit commanders, drone trainers, civilian militia personnel and Americans supporting in various capacities. Cultural norms often precluded an organized interview. In many instances, the collection interviews defaulted to casual conversation centered on cell phone photos and videos. All interviewees were enthusiastic and helpful. Data was generally collected against the questions listed below in figure 2.

1	Would Ukraine welcome assistance from the US private sector regarding drones?
2	What form of assistance is needed? What is the priority?
3	What US support for Ukraine's drone program has already been provided and by who?
4	Are drones considered a critical enabler in the fight against Russian forces?
5	What is the domestic capacity of Ukraine to develop and manufacture drones?
6	For imported drones and related equipment, what does the supply chain look like?
7	What drones have been most useful and how are they being employed?
8	What sorts of counter-drone activities might we assist with?
9	What other related areas could we help with?
10	Is there a drone master plan for the Ukrainian Army?
11	Is there a school or schools where drones are taught to the Army?
12	Is drone operation a formal occupational field in the Ukrainian Army?
13	What are the key Ukrainian doctrinal issues regarding TTP's for drone operations?
14	What technology gaps currently exist where private industry might provide solutions?

Figure 2 Questions use for data collection

Supply Chain

Ukraine possesses the technical knowledge to design and build drones but lacks the supply chain to sustain domestic production. All interviewees noted availability of drones and drone production lags severely behind military operational requirements.

Shortages are due in part to Ukraine's underdeveloped technical sector and economic factors including a small pre-war market for drones. Ukraine is mostly an agrarian society with sophisticated centers of technical expertise in and around the major cities, but with a majority population working in the agricultural sector.

Until 2014, Ukraine was mired in corrupt Soviet-era politics, slowing adoption of western businesses practices and retarding economic growth. Following the change of national government in 2014-15, generally pro-western administrations presided, helping to launch sustainable economic growth including adoption of closer ties with the technical West. Late adoption of western-style free-market economic practices is a major cause of Ukraine's shortages of technical capacity and productivity.

Since February 2022, war has closed seaport access for Ukraine. Land transport remains the only source of resupply as the airspace over Ukraine is contested and closed to all but military aircraft. These factors likewise impact a sustainable supply chain to support domestic production of drones needed to sustain its military operations.

Recommendation: U.S. private sector drone manufacturers should leverage their substantial capacity to help fulfill Ukraine's wartime drone requirements. This may include advising on

development of more robust supply chains, sharing industry best practices, temporary co-production agreements, technical evaluation site visits, collaboration workshops and training.

Domestic Development and Modification

One source we interviewed claimed there were 200 drone companies operating in Ukraine. An internet search showed 17 Ukrainian companies that produce drones or drone related technology including jammers. Several of these companies appeared to be closed as their web sites were down. Active companies included Anthlon Avia, AgriEye, Kray Technologies, Kvertus Technologies, UADCOM, ABRIS Design Group, Aviation Systems of Ukraine (ASU), and UAS Components.

As already discussed, domestic capacity to fabricate drones is hampered by supply chain challenges. However, several interviewees provided testimony and produced videos showing drones locally modified to carrying ordnance and a domestically manufactured jammer. 3-D printing of some spare parts was also present. These are crude modifications and US technical support could play game-changing role here.

War is a meatgrinder of men and equipment. Ukraine is no different. Due to jamming, anti-aircraft fire, operator error, weather and mechanical malfunctions a typical unit supported by drones may lose as many as 4 drones a day on the battlefield. Students also crash them in training. Because of the volume of drones needed, we assess the major gap remains Ukraine's under-developed supply and production capacity.

Recommendation: U.S. drone companies support Ukraine's war efforts through partnering initiatives, technical training assistance visits, and capacity building resources.

Employment of Drones in the Ukrainian Battlespace

Ukrainian military forces are organized on three levels – Ukrainian military (Army/Air Force/Marines), Ukrainian National Guard (reserves), and village-level forces referred to as Territorial Defense Units (TDUs). There is a fourth branch known as the Foreign Legion or International Force, but we have no assessments regarding this organization.

Most of our interviews were with village level forces and reservists. On one occasion we interviewed a "tier one" force member taken to be a "Delta Force-like" level of military capacity. Others included Americans training Ukrainian forces, drone procurement officials, an anti-aircraft battery commander, and an American civilian with experience in drone training.

The Ukraine battlefield is populated mostly with small commercial drones, purchased from neighboring countries (Poland, Romania, Germany), or donated as charitable contributions for the war effort. The result is small numbers of different models and types in use.

Small "tactical" drones are generally used for three types of missions by Ukraine against Russian military forces: (1) intelligence, surveillance and reconnaissance (ISR); (2) target identification for indirect fire adjustment (calls for fire); (3) direct delivery of munitions onto targets (strike).

One drone brand emerged as the most commonly used civilian drone, DJI. A distant second was Parrot, and some few Autel drones. Locally made Ukrainian drones are also present but no particular brand dominates.

Supporting peripherals for effective employment of tactical drones includes internet connection through StarLink by SpaceX; tactical radios by Collins Communications and Motorola, and 3D printing of spare parts.

Organizations that directly enhance the effectiveness of tactical drone use include those that monitor open-source internet information on social media (e.g., Bellingcat); unencrypted radio watchers (e.g., ShadowBreak Intl); and real-time geographic information providers (e.g., ESRI).

A certain level of squeamishness exists among some companies when adopting their drones for combat use, especially when employing drones in the strike mission. This use of drones is a reality of modern war and companies must choose to either support the Ukraine's right to defend itself against Russia's invasion (and by extension the national security interests of the US) or not. There is no gray zone here.

Jamming

Drone communication protocols generally use the same frequency bands as Wi-Fi transmissions, particularly in the 2.400–2.483 GHz and 5.725–5.825 GHz. A drone equipped with a camera usually transmits a video stream to its control unit through the same wireless channel. These transmissions are subject to jamming by Russian forces and likewise can be used to locate drone operators and target them.

Aeroscope, a device produced by the drone company DJI, is used to locate both drone and operator. Ukrainians told us the DJI 2 drone software has been modified to prevent this and now can be safely used without being detected by the Aeroscope. However, the newer more capable DJI 3 drone contains software that is more difficult to modify and remains susceptible to detection by Aeroscope.

Drone software modification is carried out by Aerorozvidka (Aerial Intelligence), a Ukrainian civilian organization founded in 2014. The organization has now been integrated into the Ukrainian armed forces. It is staffed primarily by volunteers.

Jamming and drone operator location detection were the principal concerns registered by the drone operators we spoke to. Most stated Russian jamming has increased and is now the

primary cause of Ukrainian drone losses. Threat to operators is also a factor with location detection capacity being fielded against some drone types. Several operators suggested frequency hopping of drone data links would prevent or reduce Russian jamming and detection effects. It can't be emphasized enough that jamming is the number one issue for drones; that it is across all sectors of the front; and that the jammers are plentiful, simple devices mounted on cheap Kamaz trucks making their defeat by direct attack a daunting task.

Recommendations: Provide support to field a frequency hopping capability for small, low-cost drones. Support the use of older "dumb tech" for basic drone missions whereby the drone is given a flight path and executes this blindly without the use of GPS. For example, a recon drone which flies a predefined path with no communication with controller or satellites (hence unjammable) and videos whatever is along its flight path or strike drones which launch from grid coordinate point A, fly to point B, and attack.

Summary

1. Jamming is ubiquitous. A drone solution which doesn't account for this isn't worth much.

2. Static frontline with massive Russian artillery advantage supported by Russian Orlan-10 and some civilian drones.

3. Civilian drone use by Ukrainians had major impact a month or two ago. They are still used effectively, but significantly reduced impact due to jamming.

4. Private donations have fulfilled some of the small drone requirements so far. Donor fatigue is setting in. Need corporate sponsors for a longer-term sustainable solution.

5. Money is scarce. Should consider cheap, mass-produced options for both recon and strike drones.

6. Manufacturing in Ukraine with US joint venture would be the fastest way to have an impact.

7. Ukrainian morale is bolstered anytime US private enterprise provides support. Any commitment by the US drone industry would have a positive military and morale impact.

Researcher's Bonafides

Greg is a West Point graduate (BS double major - physics and math), Army officer, combat veteran of both Iraq and Afghanistan, and a Massachusetts Institute of Technology graduate (MS in supply chain management). Greg lives in Kryvyi Rih, Ukraine where he teaches English and speaks Ukrainian.

John is a Marine Corps officer, graduate of the National Defense University (MS in Industrial Mobilization), graduate of the University of South Florida (MA Middle East Studies), formerly Defense Department's Director of Counterterrorism Policy, and a veteran of both Iraq and Afghanistan. John lives in Austin, Texas.

Important videos and drone footage from Ukraine:

https://youtu.be/mT5FKNQ2Fg8

Important articles to better understand Ukrainian drone story:

https://www.csis.org/analysis/keep-western-assistance-flowing-ukraine-must-engage-corruption-concerns-head