How Suicide Drones Transformed the Front Lines in Ukraine

Outnumbered and desperate, the nation began hacking cheap consumer drones with explosives — bringing a brutal new form of violence to 21st-century warfare.

Trader, a Ukrainian drone technician, preparing for an attack.

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The suicide drone beelined toward a strip of forest separating two agricultural fields. A remotely piloted quadcopter with a wingspan narrower than that of a duck, a camera in its nose and an antenna protruding from its tail, it crossed into Russian airspace unchallenged minutes before. An armor-piercing warhead hung from its underside. Now, about 18 miles south of Belgorod, it descended toward cropland with about five minutes of battery power remaining. It was time to hunt.

Several miles away, in the basement of an abandoned home inside Ukraine, the drone's pilot, who uses the name Prorok, Ukrainian for "Prophet," clutched the miniaircraft's controller with both hands and gazed into goggles displaying its live video feed. His team leader, who uses the name Buryi, or "Brown," sat to his right, monitoring the flight on the bright screens of two

tablets while communicating with a distant lieutenant via a laptop. Minutes earlier, a bomb-laden quadcopter flown by another team slammed against a howitzer hidden in the tree line. Prorok and Buryi's mission was to assess damage, find survivors and kill them. Russian artillery pieces were rarely unattended or alone.

Smoke rose from vegetation where the cannon had been. "Fly to the target," Buryi said.

Prorok's fingers manipulated the tiny flight controls. Moving about 30 miles per hour, the drone slipped below the tree line's canopy, pointed its lens at the smoke and slowly approached. Nearing the plume, it banked left with its nose angled down.

The sweep — the controlled choreography of a mechanical dragonfly — allowed Prorok and Buryi to scan the smoldering spot. It also intensified the buzzing whir of the quadcopter's electric motors and plastic propellers, the telltale acoustic signature of an improvised weapon that has saturated the air above the front lines. Known as first-person-view drones, or FPVs, the weapons have altered the human experience of war and flooded the internet with footage chronicling the desperate last seconds of lives ended by miniaircraft that transmit video of the people they pursue, then smack into them and explode.

The first pass yielded nothing. If Russian soldiers remained near the cannon, they did not show themselves. Prorok lowered the drone and flew it over a pair of tire tracks, tracing their path where cropland met woods. Its camera revealed a surprise: a Russian T-80 tank parked in the foliage. A $3 million military machine had been discovered by a $400 repurposed toy.

Buryi notified his lieutenant, who uses the name Andy and was watching a live video feed from a surveillance quadcopter hovering high above. The order came back: "Take it out."

Prorok hovered the quadcopter to examine his quarry. The tank was well defended. Its crew had backed the 44-ton vehicle into undergrowth, blocking access to its vulnerable exhaust grate. Slats of reactive armor, which can thwart armor-piercing charges, bedecked its sloped front end. Its rotating turret carried a metal frame and netting, a combination derisively referred to as a cope cage, designed to snag drones and prevent warheads from making direct strikes on hulls. All its hatches were closed, blocking Prorok from flying the warhead inside.

Prorok (right) and Buryi, members of First Platoon, First Company of the Achilles Strike UAV Battalion.

In the past, attacking an armored vehicle with such a warhead typically required a soldier to risk exposure to take a hasty shot with a rocket-propelled grenade, sending a projectile at almost 1,000 feet per second that may not hit the vehicle at all. Weaponized FPV drones have created a new way. In the field south of Belgorod, the combination of the tank's defensive measures and the drone's peculiar characteristics made for an exercise that was almost surreal. Time seemed to slow down. The little drone hovered patiently before the massive military machine, rising and falling, swaying on the breeze, emitting its high-pitched buzz while Prorok flew it safely from afar, deciding his attack's best place, which he could strike with uncanny precision.

Prorok selected the turret's base, where armor was thinner. "Yes, yes," Buryi said. Prorok leaned forward as he pushed the flight controller and the drone plunged into the spot. The screen went blank. Watching from the surveillance drone, Andy called out. "I see an explosion!" he said.

In late 2023, President Volodymyr Zelensky of Ukraine announced an ambition never before heard in the history of war. Ukraine, he said, would provide its forces with one million FPV drones in the next calendar year. The announcement, which followed battlefield disappointments and long delays of arms shipments from the United States, pushed this unusual new class of weapon to the front of Ukraine's bid for survival and rapidly reordered contemporary combat along the way.

Drones became entwined with modern armed conflict years before President Vladimir V. Putin sent Russian mechanized divisions over Ukraine's borders in 2022. But no previous conflict had involved drones used so extensively by two sides, in so many forms or in so many roles. The pivot blended necessity with cold calculation. After Ukraine blunted Russia's incursions and the two armies settled into opposing trench lines, tacticians in the two countries grasped the lethal punch, disruptive qualities and economic advantages of unmanned weapons. Drones cost much less than other weapons of equivalent power or range, and they reduced risks to those using them, who operate out of view, typically beyond the reach of many weapons that otherwise might reply. When paired with mobile internet routers and secure communication apps, they proved to be remarkably responsive and precise. For nations squeezed between the twin pressures of heavy casualties and recruiting difficulties, they multiplied combat power while preserving thinned ranks.

In the past, drones used by state forces generally shared a common characteristic: They were purpose-built, closely held weapons from nations with extensive histories of arms production. Ukraine's turn to smaller armed drones tapped a different source: hobbyist miniaircraft, sold for recreational use and aerial photography, available to civilian purchasers worldwide. At first Ukraine principally used models of the Mavic line. Manufactured in China by the DJI company, they descended from the radio-controlled toy aircraft of generations before but were enhanced by the technical superpowers of the digital age: tiny cameras, GPS sensors, easy-to-learn flight apps and rechargeable lithium-ion batteries. Sturdy and relatively inexpensive, they weighed less than two pounds, accommodated add-on features from 3-D printers and paired with civilian laptops and tablets — traits rendering them malleable for combat service and attractive to imaginative fighters. Their miniaturization was valuable, too. Unlike many fixed-wing drones flown by the United States and other national militaries, with wingspans dozens of feet across, these drones could be carried by hand and launched from most anywhere.

A first-person-view drone, equipped with an armor-piercing warhead.

Along with fighters in Syria and Iraq, Ukrainians were among the pioneers, with several crews using quadcopters in the war against separatists in eastern Ukraine in 2014. “From the first flights at the front, I understood that this will be our future,” said Maria Berlinska, one of Ukraine’s early drone pilots. After Russia invaded in force in 2022, Ukrainian units quickly acquired and flew drones at a larger scale, for reconnaissance, coordinating fire support and dropping bomblets. Among them was an infantry company led by a young commander, Yurii Fedorenko, who used the name Achilles. In April 2022, a scout who worked in the film industry before the war joined the company and brought with him his own Mavic drone. Unfamiliar with quadcopters, Fedorenko watched him launch the puzzling little device, then marveled as it hovered over Russian units and streamed back information he craved. With the drone’s help, Fedorenko soon arranged for Ukrainian artillery to hit a Russian refueling point, causing a conflagration and making the company commander an instant convert. Having seen his enemies through the unblinking digital eye of a low-cost quadcopter, he understood that standard infantry weapons were not enough. “I made a decision,” he said, “to teach all the gunners as fast as possible how to use drones.”

Russian soldiers saw the value of Mavic drones, too. As their scale of use climbed, Ukraine renewed its experimentation with another class of retail quadcopter: FPV drones. Flown by pilots wearing goggles displaying live video feeds, they were popular among drone-racing enthusiasts and were briefly tried in eastern Ukraine by 2016, Berlinska said. Fast, powerful and less expensive than Mavics, they drew the attention in mid-2022 of the Security Service of Ukraine, or S.B.U. The agency's secretive counterterrorism unit, Center for Special Operations "A," saw their potential for one-way flights with munitions attached.

Thus armed, Ukraine began rolling out a weapon unlike anything the world's militaries had previously seen. FPV drones blended the power of anti-tank projectiles, the range of mortars and the accuracy of sniper fire, but with an added feature: aerial agility. Here was a weapon that could fly horizontally or vertically, change speed or direction, stop in midair, loop around corners and slip through windows, doors or an open hatch. If an FPV drone overshot a target, which for any other weapon would be a miss, it could swing around and try again — all while transmitting video of its panicked victim. In the full-spectrum warfare between Kyiv and Moscow, an emotionally brutal contest for global support, the video streams offered another value. Filmed from the pursuers' point of view, they broadcast visual receipts in a style reminiscent of slasher movies. These could be edited, put to music and circulated online, useful for boosting morale, sowing fear and raising cash to buy more drones.

The S.B.U. used them in small numbers on many fronts, then took them by late 2022 to Bakhmut, scene of the bloodiest siege in Europe since World War II. FPV drones were not perfect. Like any aircraft, they could be grounded by weather. Flown one at a time with minutes between sorties, they were incapable of rapid fire. But once fielded at scale, they proceeded to stop Russian mechanized assaults, explode against people in trenches, hunt for artillery and resupply vehicles behind enemy lines — and win believers among soldiers and commanders alike. "Bakhmut is not the first place where kamikaze drones were used," said one of the S.B.U.'s first drone team leaders, who uses the name Babai, a boogeyman from Slavic lore who abducts victims at night. "But it was the first place where they were commonly used." With artillery shells scarce because of political infighting in Washington, weaponized toys filled in.

FPV drones helped Ukraine hold on to Bakhmut until mid-2023, exacting terrible tolls on Russian attackers for months. In Fedorenko's unit alone, he said, drone teams killed 210 mercenaries from the private military company known as the Wagner Group, wounded 360 more and destroyed 23 self-propelled howitzers and other heavy equipment.

All that was needed for an FPV breakout was for the public and politicians to catch up. That happened in the months after the siege when Serhii Sternenko, a young Ukrainian lawyer, prominent YouTuber and impassioned drone advocate, visited a brigade of surviving Ukrainian soldiers where they regrouped. There they shared descriptions of a "shell hunger" so severe the entire brigade received only 11 artillery shells a day to fight off endlessly replenished waves of invaders. Sternenko, an activist who fought in the street melee in Kyiv in 2014, had raised money to supply units with FPV drones. He wanted feedback on how they were working. What he heard was both jarring and illuminating. Shell-rationing forced Ukraine to make kamikaze drones primary tools of defense. Pressed into service, they produced astonishing results. "I found that 90 percent of the Russian equipment that was destroyed by Ukraine was destroyed by drones," Sternenko said of the siege. The country's survival, he thought, had come to depend on drones.

Driving back, Sternenko recorded a YouTube video for his almost two million subscribers. He opened with notes of grave concern. "I won't provide specific numbers, to avoid plunging you into depression, but I'll say this: We have very, very few artillery shells," he said. "And when I say 'very few,' I mean in the critical areas of the front line where they are most needed, where the enemy is carrying out active assaults." After describing the efficacy of FPV drones and relative costs ($320 to $600 per drone; $3,200 or more for an artillery shell), he shared his analysis: "In many places, our defense is holding only because of these drones." He warned that Russia copied Ukraine's success, was fielding its own FPV drones and might soon outpace Ukraine in their use.

Sternenko made a plea. “I want to use this opportunity — since I have a large audience and many people will watch this video — to publicly address the minister of defense, all relevant officials and, most importantly, the president of Ukraine,” he said. “Please raise the issue of providing FPV drones to Ukraine’s defense units to the maximum, highest level. Make it a priority. If we can’t solve the artillery shell shortage right now, let’s find an alternative.” FPV drones, he said, would determine Ukraine’s fate: “Whoever wins the drone race will win this war.”

Within two hours, senior officials were calling. Two weeks after Sternenko’s frontline visit, President Zelensky announced the million-drone goal for 2024.

Soldiers from the Achilles Strike UAV Battalion on a training range away from the front lines in the Kharkiv region.

By last fall, Ukraine had a new branch of its armed forces dedicated solely to unmanned weapons, and Fedorenko’s company had grown to a battalion with a projected strength of about 500, up from several dozen soldiers. In October, Zelensky announced that Ukraine met its million-drone milestone months ahead of schedule and could now produce as many as four million drones annually. With its ever-growing fleet of small suicide quadcopters, the country survived another year against its much more powerful foe and was positioned for cease-fire negotiations that both sides appeared to be expecting to follow the inauguration of President-elect Donald J. Trump.

Earlier in the day, before a pastel glow spread low through the black eastern sky, Buryi and his team woke to begin a three-day rotation at the front. They had arrived in darkness, dashing in an S.U.V. across the forlorn countryside of the Kharkiv region. Though under Ukrainian control, the farmland and narrow roads were an almost uninhabited security buffer, guarded by checkpoints and often watched over by Russian surveillance drones and Lancets, loitering munitions that dive on targets from high above. To reduce time exposed, the driver accelerated to speeds approaching 80 miles an hour, weaving past potholes and shell craters on the route. After about a half-hour, the truck stopped behind an unlit home overlooking Russian positions a few kilometers away. Buryi's team trotted in. The departing team rushed out and climbed into the vehicle, which lurched away, vanishing with haste.

The house, formerly inhabited by Russian soldiers, exhibited the obscenities of forceful dispossession. On the floor of one bedroom, behind sandbagged windows, a child's snowsuit rested face down beside a pink and tan bra. A sundress hung by a sole strap in the ransacked wardrobe. The kitchen, its cupboard doors ajar and drawers scattered about, was a dull mess. Empty water bottles stood beside a forgotten bayonet and soiled plates. A tuna can stuffed with cigarette butts rested on the refrigerator. Through a shattered window, the stink of the outhouse floated in, competing with a more foul smell from next door, which the team attributed to a Russian soldier rotting where he died.

The team was part of First Platoon, First Company of the Achilles Strike UAV Battalion, the unit that Fedorenko's former infantry company had grown into since the war began. Trader, 28, the team's technician, set up in the garage, which was lined with green ammunition crates left behind by Russian troops. Here he prepared suicide drones. His process involved strapping batteries and bombs to the miniaircraft's carbon-fiber or textolite frames, attaching fuzes and blasting caps to explosive charges and, at Buryi's command, hustling each drone outside for launch. He was a currency and crypto trader before the war. Now beside him were enough loose parts to construct dozens of flying weapons. Around the corner were wooden boxes filled with bombs of varied power and designs, including repurposed land mines, anti-armor projectiles, cluster bomblets, workshop-brewed thermite charges and fragmenting anti-personnel grenades.

Buryi with quadcopters rigged for attacks. Before the war, Buryi designed mobile-phone apps in Kharkiv.

Buryi, 36, and Prorok, 30, worked from the basement, accessed by a steep staircase descending past a shelf holding dusty jars of homemade pickles. Like Trader, they were white-collar workers less than a year before. Buryi designed mobile-phone apps in Kharkiv; Prorok was a human resources manager for a trading company near Kyiv. Illuminated by LED lights, they now sat at a table below ground with their tablets and Prorok's controller and goggles, waiting for orders. These would come from Andy, who was miles away, watching video feeds from surveillance drones.

Andy, who trained before the war to be a criminal defense attorney, supervised multiple FPV teams, each hidden similarly and arranged in overlapping sectors. In this way, drone teams neither searched randomly nor fought alone. They sheltered out of view while Andy monitored the front, selected targets and assigned missions. When he ordered pilots to fly, he talked them to targets over Google Meet as they flew.

Andy's voice came over the speaker at first light. He ordered Buryi's team to fly a drone through its sector and disrupt any Russian soldiers who might be gathering to attack. Sorties at first light are important, drone teams say, because Russian assaults tend to happen early; detecting them protects Ukraine's infantry. Trader stepped outside, into the brightening gray, and placed an FPV drone on a wooden stool resting on its side. This was the launchpad. Plastic propellers screamed to action. The drone climbed fast and zipped away. Stillness returned. "We hunt," Prorok said.

Trader, the team's technician, preparing an FPV drone for launch.

The team's armed FPV drones can reach speeds exceeding 70 miles an hour. To save battery power, Prorok flew slowly. He sent the drone across the shimmering Travyanske Reservoir into a no man's land of fields and farms separated by stands of trees. Ahead was Hlyboke, a Ukrainian village under Russian occupation. The open fields around the shattered settlement were shredded by tire tracks, pockmarked with shell craters and littered with rusting husks of destroyed military vehicles. Some contained corpses of those who rode in them. Hlyboke, too, was wreckage. Buildings stood roofless in rows. What remained of the

town's center was a kill zone. A person stepping outside or a driver daring the roads risked being spotted immediately, then coming under artillery fire or being chased by drones. The dismal scene appeared empty of human life. It was not. Conditioned by the war's particular dangers, small groups of Russian soldiers infiltrated over the border by darkness to slip into basements or bunkers beneath trees. They seeped forward rather than marched, a tactic one retired Ukrainian general called "meltwater" that was hard to spot, much less stop. Once in place, most soldiers stayed out of view — a rational reaction to the deaths of many who preceded them to the lines.

The shattered village Hlyboke as seen by a reconnaissance drone.

Everyone at the front knew the sound of drones. Even soldiers who had yet to see firsthand the hunter-quadcopter's grisly effects had witnessed onscreen an uncountable number of peers die from the attacks, brought to them by the messaging app Telegram. War-related Telegram accounts posted constantly updated streams of short videos showing the fates of soldiers chased by drones. The accounts accumulated together as a sort of DeathTube, an expanding montage of cornered men frantically doing whatever they could to survive, only to die nonetheless, each spending his last seconds alive as an unwilling extra in the public visual chronicle of the rise of homicidal flying machines.

The Russian Army, in the eyes of Ukrainian fighters, is but a horde. Its dehumanization is baked into frontline attitudes and speech. Many Ukrainians refer to their foes with slurs for residents of Moscow or for gay men, and as bitches, whores or "businessmen," a jab at recruits who accept cash bonuses for volunteering to fight in Ukraine. Often they call them orcs. But the cornered Russian soldiers were men, and their will to live was strong. When quadcopters rushed in, they sought escape. Some ran, some crawled, some leaped from the beds of speeding trucks. Occasionally one scurried in circles around a disabled vehicle, a utility pole or the trunk of a tree. Others hid in bushes or under blankets they believed cloaked them from the digital eyes flying around or above.

Some fighters, of course, fight. These Russians squared up. They fired Kalashnikovs or shotguns at incoming quadcopters, threw their own helmets or rifles into the path of their descending tormentors or swung long sticks, trying to knock 21st-century drones to dirt with weapons from eons ago. When all other defenses failed, the instant before incoming warheads impacted torsos and limbs, a few swatted or kicked at the quadcopters with bare hands or booted feet, lashing out reflexively at the candid cameras sent to kill them. Then they absorbed shrapnel and blast. The explosions claimed many victims instantly. Others were thrown down and expired slowly, gasping or twisting or rolling in pain, sometimes with uniforms aflame, while observation drones collected footage of their agonies. Occasionally, wounded Russian survivors ended their own lives with hand grenades or by shooting themselves with rifles. Some played dead and ended up that way.

FPV drones transmit live video and frequently capture their victims' efforts to escape.

With such scenes the daily smartphone fare, Russian soldiers kept out of sight. They ventured out for supplies, but generally the occupation of Hlyboke, their prize, was so perilous they lived it underground. When they did emerge in large numbers, Buryi said, they attacked in assaults that Ukrainians call "meatwaves." Occasionally the crude tactics succeeded. Usually they matched their miserable name.

Their most recent try occurred a week earlier, when four T-72 tanks and several troop transports gathered for a mechanized charge. It was a powerful ensemble, potentially enough to pierce the lines. Knowing well the risks, the Russians advanced with their latest defensive adaptations. The tanks wore anti-drone "garages." These are welded superstructures resembling turtle shells, cope cages on steroids, from which 125-millimeter barrels protruded. The tanks also maneuvered along strips of forest and carried jammers designed to interfere with the radio signal connecting drones to pilots, which can cause a drone to crash while a vehicle drives on.

The protective measures failed. A tank struck a mine; the assault bogged down; the attackers grew confused. Video footage showed the resulting scene. In repeated sorties, drones flew under the openings of the garages and exploded. Before Russian troops reached Ukrainian trenches, FPV drones destroyed all their vehicles except two tanks and a logistics car, which withdrew, leaving behind the broken hulls of unlucky machines, some burning like ovens. Several surviving Russian soldiers fled for trees. Others hesitated. One FPV drone fluttered toward four helmeted infantrymen huddled together on stubby cropland, as visible as grown men hiding in front-yard shrubs, and buried its nose in the black earth beneath them. The explosion killed them all. When the last tank escaped, the front lines remained unchanged. Prorok's laconic recounting belied a lopsided horror. "It was a busy few hours," he said.

Not all flights were so successful. Many functioned as routine patrols, as did Prorok's first drone of a new day. He sat calmly as the quadcopter cleared the reservoir. But when it flew near Hlyboke, something went wrong. The video feed turned to snow. Through the controller, Prorok urged the drone to climb. The screen went blank. For reasons unknown, the quadcopter crashed. It may have flown near a jammer, come under fire or, as Prorok suspected, fallen to earth on its own, victim of a manufacturing flaw.

He removed his goggles and sighed.

Manufacturing and fielding one million FPV drones a year required sweeping changes to national policy. First came deregulation. Beginning in late 2022, the Ukrainian government slashed taxes, simplified customs clearance and streamlined contracting procedures for armament manufacturers, including for drone firms, and increased profit margins for sales of unmanned weapons to 25 percent from 1 percent.

It also granted exemptions from military conscription to employees of drone manufacturers, a plum welcomed by citizens hoping to avoid frontline duties legally and by businesses facing wartime labor shortages, and it opened a drone-testing range and created a new multiagency office, Brave1, where manufacturers, investors and entrepreneurs collaborate with government officials on defense-related proposals. Together the changes helped companies swiftly engage in R&D, find funding and ramp up production. "We've created the best conditions in the world for private companies to produce drones," says Mykhailo Fedorov, Ukraine's minister of digital transformation.

In late summer 2024, the ministry helped create an ongoing competition, the Army of Drones Bonus program, that keeps tallies of battlefield strikes on a leaderboard. Contestants must upload two or three video confirmations of each successful attack to be awarded points. The competition is further divided into categories, including a tank division, an aircraft division and a dead-Russians division, each registering effects on different elements of Moscow's military machine. Points earned in the contest can be exchanged for additional combat drones. More than 300 units signed up by late November, the ministry said in a statement. (The Achilles Strike UAV Battalion ranks among Ukraine's top 10 units, according to the ministry.)

With drone production an urgent national priority, much of the country was involved, from civilians assembling drones at home to volunteers like Sternenko, who continued to organize drone purchasing and distribution and to help spur innovation, including with night-vision cameras and classified adaptations that allow specialized FPV quadcopters to pursue high-flying Russian surveillance drones. Berlinska, one of Ukraine's first combat drone pilots, is now a leader of a private volunteer organization, Victory Drones, which she says has trained 5,000 FPV drone specialists. Zelensky participated personally in the expansion, at times decisively. Viktor Yevpak, chief executive of eDrone, a quadcopter startup he founded in 2023 in central Ukraine, initially sold FPV drones directly to army brigades but struggled to find a national market. In early 2024, he met Zelensky and asked for help. "'Consider it done,'" he recalls the president saying. Doors swung open. "Within a week," Yevpak says, "we got an order for 40,000 drones." By last summer, eDrone was providing Ukrainian forces 10,000 drones a month.

Billboards across Ukraine encourage citizens to enlist in the military and help fight off Russian occupiers with FPV drones.

The S.B.U. also supported the effort, vetting workers with background checks and polygraph tests to prevent infiltration by Russian spies and reviewing manufacturing locations, which tend to be concealed and unmarked, to avoid sabotage or missile attacks. Fears were amplified by a Russian missile strike in summer 2023 on a drone manufacturers' conference at a theater in Chernihiv, which wounded more than 140 people and killed at least seven. Yevpak and two of eDrone's senior managers were present and survived, though Yevpak's car was destroyed. The company mitigated risk to its own operations by having employees work in multiple assembly lines scattered apart from one another and during regular workday hours, to avoid attracting unwanted attention. Its main office is elsewhere and rarely staffed. "We are worried about a rocket," Yevpak says. "We are worried about a Shahed," a long-range Russian suicide drone of Iranian design.

The million-drone goal also required newly specialized soldiers to fly and maintain them, and tactical adaptations at all levels. To manage such shifts, in June 2024 Ukraine established a new armed service, the Unmanned Systems Forces, and appointed Col. Vadym Sukharevsky to lead it. Known for his "cold hatred of enemies," according to one account, Sukharevsky has been a prominent officer since 2014, when he violated a standing national order, intended to keep Ukraine from being goaded into all-out war, that forbade soldiers to fire under any circumstances at Kremlin-backed separatists in Ukraine's east. Sukharevsky, then a lieutenant, obeyed until he could not. In April 2014, gunmen ambushed an S.B.U. convoy on a highway. Orders are orders, and Sukharevsky had his. He chose the other code. He rushed to the bullet-riddled cars and bleeding countrymen and opened fire

with a heavy machine gun, driving the separatists off. These were Ukraine's opening shots in a war that Russia has escalated since. He later explained himself in terms soldiers understood. Had he not acted, he said, "responsibility for the death of our brothers would lie with me."

In an interview in Kyiv, Sukharevsky discussed plans. He said his forces had about 2,000 drone specialists as of autumn and would have 10,000 by the end of 2025. The expansion, he said, was elevating drone warfare from "a kind of subculture" to the military's core. To meet these goals, his service ran courses on drone operation and tactics, including instruction for deep strikes into Russia and drone-on-drone dogfighting. (Many units trained drone teams themselves or received instruction from Ukrainian manufacturers and organizations like Victory Drones.)

Ukrainian soldiers at a demonstration of drones. The trench behind them is for their protection in case of a Russian missile attack.

Among other ideas for expansion under Sukharevsky's review was a proposal from a veterans group for all-female drone units. The colonel found the idea appealing. He saw parallel utilities — not just an untapped means to kill more Russian soldiers, whom he called orcs, but an emotionally productive outlet for a grieving population. "I am considering this," he said, "because widows want to avenge the deaths of their husbands."

With the new schools and training taught by the Unmanned Systems Forces, many more teams were being trained quickly, allowing combat drone use to expand throughout the year. News reports and battlefield sights highlighted rapid advances, with accounts of long-range drones striking fuel depots or arsenals far inside Russia, of modified FPV drones downing helicopters and of so-called dragon drones spraying molten thermite on Russian positions in tree lines. Large multicopters, called Vampyrs, were flying to friendly positions to drop off supplies or crossing over lines to bombard enemy dugouts or place land mines. Waterborne drones pursued Russian warships. Land drones, on wheels or tracks, were carrying out suicide strikes; new prototypes aimed and fired machine guns. Manufacturers and unit workshops were also experimenting with drones that fly and chase targets with the help of A.I., a development that, once fielded, could allow drones to hit moving targets without human guidance if their radio link to a pilot was degraded or jammed. “What we have created here,” Sukharevsky said, “is a huge step into the future.”

A Vampyr multicopter being armed at the front.

Drone units also organized independently. The Achilles battalion ran multiple workshops in 2024 to sustain its fight, including one assembling FPVs, another assembling drones used for surveillance or dropping bombs, a third for R&D and a shop for ammunition. The munitions workshop, in a basement, largely converted conventional ordnance from old storehouses for uses its original manufacturers could not have imagined. Yuzyk, a shop foreman, stood at a workstation with a metal lathe, which he used to remove the metallic outer casing from RPG warheads, reducing weight and thereby increasing drone battery life and range.

RPG warheads formed the basis of many of the battalion's FPV charges. But the shop turned out other payloads, including thermobaric bombs, high-explosive charges for flying into bunkers and anti-personnel charges, some of which resembled the improvisations of nonstate actors. One was made by sliding a ring cut from a plastic bottle around an RPG warhead, filling this makeshift collar with quarter-inch stainless-steel ball bearings and sealing them against the warhead's sheath with an electric heat gun. Another was formed by duct-taping a spherical hand grenade to a cylindrical cluster bomblet, a case of converting a weapon regarded as indiscriminate into a precisely guided killing tool. (When used as designed, cluster munitions have been globally condemned in a treaty ratified by more than 100 nations, although neither Russia nor Ukraine has signed the treaty, and each side has used cluster munitions against the other.)

The cluster bombs around Yuzyk were manufactured in Soviet arms plants during the Cold War and bequeathed to Ukraine by the luck of geography and the shortsightedness of its aggressor. In the final years of Mikhail Gorbachev's rule in the Kremlin, as Moscow's forces withdrew from garrisons in the former Warsaw Pact, countless logistics trains of the contracting army passed through Ukraine, then still part of the Soviet Union. There they dumped ammunition stockpiled for a third world war in quantities NATO later estimated to be on the order of 2.5 million tons.

Yuzyk (left), a shop foreman, in the munitions workshop, which largely converted conventional ordnance from old storehouses for drone-based warfare.

With Ukraine's declaration of sovereignty and self-determination in 1991, it assumed possession of the Kremlin's old stores. Much of it rotted and rusted. Some was destroyed by sabotage. But when Moscow's troops returned, this time to conquer, the remaining inherited stockpile was exhumed by the former vassal to fight back. In this way, this musty basement, a cavern full of war widgets, powders and wires, was both a secret pop-up arms plant of the "Mad Max" genre and a living museum of regional war, telling a sweeping history through the lethal detritus of Soviet times, discarded by the Kremlin's soldiers in a previous contest of global will. Here weapons ordered into existence decades ago to fight the West were revived for final acts against a new generation of Russian soldiers, sent over the border by the whim of the Kremlin's latest occupant — a long and winding case of the boomerang effect, aided by Chinese consumer tech.

From the team's vantage point overlooking the Hlyboke front, the two sides were stalemated. Meatwaves added Russian deaths to the war's toll without changing the local status quo. Stand back, pan out, and larger views were dreary, too. Per Western estimates, Russia's military suffered as many as 1,000 casualties a day across the entire front in summer and fall, the ceaseless workings of a death lottery for men sent over a border into forests and fields littered with land mines, crisscrossed with supersonic bits of lead and steel and patrolled by kamikaze drones. Ukraine's losses were smaller but also brutal. Even failed Russian attacks caused damage, requiring a wearied army to stand in continuous defense while the invading force pushed more soldiers forward. Season by season, more Russians came — in trucks, in cars, on foot, any way they could.

Late in the morning, Andy called again to say he had spotted a Russian soldier on a motorcycle speeding across the occupied ground. Trader reached for another kamikaze drone. Nimble and small, dirt bikes helped Russian troops dash among positions motocross-style, faster and more evasively than in armored personnel carriers or trucks. After generations of rumbling tanks over Red Square to broadcast a heavyweight image, the Kremlin's army learned in Ukraine to save its heavy stock for assaults. Dirt bikes improved its soldiers' odds in the front's day-to-day perils.

Sometimes drones hit motorbikes anyhow. Videos attested to gruesome results: bikers blasted off seats, tumbling on asphalt or dirt. But this motorcyclist's 15-minute head start gave him an advantage. As Prorok angled the whirring quadcopter toward him, the man passed into a radio shadow where the signal between pilot and drone grew faint. He escaped.

Andy reacted. He ordered Prorok and Buryi to divert their quadcopter to a patch of trees standing in farmland. Woodlots offered concealment from surveillance and attack, and the dirt surrounding this grove was scuffed by foot trails, suggesting Russian arrivals by night. When the drone reached the vegetation's edge, Prorok maneuvered it through a search. Nothing. The drone zipped across a field to another stand of trees. This acreage contained bunkers, including a dugout with overhead cover. Again the quadcopter hunted. Again Prorok and Buryi saw no one. When the drone's battery ran low, Prorok flew it into the dugout entrance, where it exploded. Living quarters in frontline bunkers tend to be set back from entrances, often reached after a right-angle turn. The blast most likely did little harm. But if the Kremlin's troops could not be driven back, they could be kept in place. "In this situation," Buryi said, "our mission is to block, to just stop them."

Around Hlyboke, the lines held. Elsewhere, Russian assaults supported by airstrikes and artillery barrages crashed against defenses, and Ukraine yielded ground. The war of attrition favored the larger force.

That ominous fact propelled Buryi and his soldiers to take their places on the thin green line. Prorok felt no earlier pull to military life; he was generally against it. The infantry, he thought, was a mob of people, opinions and noise. But as cemeteries swelled, his position changed. "I started thinking, What can I do?" he said, of his decision to enlist in early 2024. Trader tried joining in 2022, but he was under the minimum age at the time, 27, and a friend in the army discouraged him from rushing into service. "Think carefully," Trader recalled him saying. "You have a son, a wife; be with them while it is still possible." His friend was later wounded and referred him to the Achilles battalion. Trader no longer worried about Ukraine's future from afar. "Who else but us can end this?" he said. "Wait and hope? No. We must act." On the fourth day of the invasion, Buryi and his wife observed their daughter's second birthday with bombs hitting their city. It was not a world with a future for a child. He donned camouflage in 2024, too.

Their six weeks of initial training covered basic soldier skills and came with a peer-to-peer message as blunt as any martial aspiration can be: Each Ukrainian on frontline duty must take the life of at least one Russian soldier, preferably more, before dying himself. If not, a Ukrainian's death fell beyond sorrow: It was a waste. Prorok considered these distillations sound — elements of an inescapable bloodmath in a war he did not seek but did not intend to lose. The mismatched sizes of the opposing forces, he said, meant many more invaders must die than defenders, or Ukraine would be lost. Far from nihilism, the idea informed a code of personal sacrifice animating a military ethos among recent civilians now repelling Russian attacks. "It is a very common thought in the army: Will I be able to kill someone before I go?" Prorok said. "It doesn't make any sense to go to war and just die, and not have any achievement of your mission." For a force fighting under the weight of such understandings, FPV drones were more than weapons. They were a means to work the ugly score.

Prorok, on a rotation away from the front, training with an FPV drone to maintain his pilot skills. The water bottle roughly simulated the shape and mass of ordnance flown in combat.

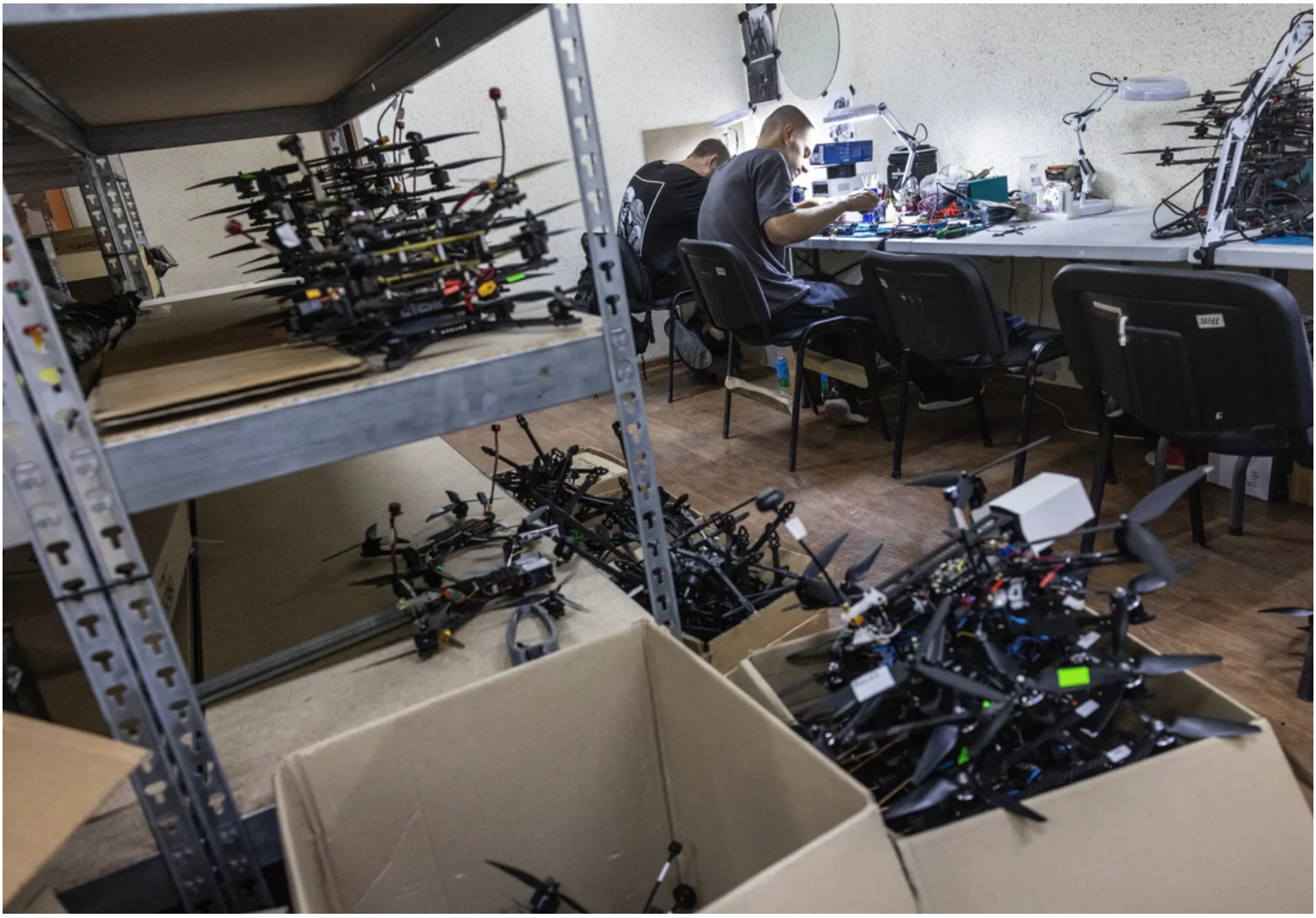
After training, Buryi, Prorok and Trader reported to their platoon. Their enlistment contracts had no end dates. Barring death or incapacitating wounds, they expected to serve until the war's end. At first Achilles embedded them individually as apprentices in more experienced teams. Buryi's duties took him near Donetsk, where the team hosting him fought from hiding in a shattered village with the bones of six dead Russian soldiers scattered around the ground nearby. Heavy glide bombs, known as KABs, sometimes crashed to earth in the ruined town. Orders of magnitude more powerful than FPV drones, KABs were released by attack aircraft inside Russian airspace and descended toward Ukrainian targets with precision guidance packages steering their way. They landed with blasts that collapsed buildings, obliterated bunkers and heaved hot soil high into the air. Two KABs hit in a double strike near his mentors' hide-out, creating a crater, Buryi said, "the size of a small swimming pool."

On Prorok's first shift as a pilot in training, a surveillance quadcopter spotted two Russian soldiers walking on a road beside trees. Prorok's FPV drone, already in flight, carried a high-explosive charge designed for busting bunkers — a weapon creating a powerful blast but with little shrapnel, so not ideal against people. He turned the quadcopter toward the men, pushed it into a descent and slammed it into the ground between them. He hoped its explosion would wound both seriously enough to buy time for a second drone to arrive bearing a fragmentation-producing payload and complete his task.

The blast knocked the men down. While Prorok's team readied the next weapon, the surveillance drone streamed silent video of the road. One wounded soldier regained his feet, checked his badly hurt comrade and dragged him toward the promise of safety in the trees. Prorok flew the second quadcopter, which carried a fragmenting anti-personnel submunition salvaged from a Soviet-era cluster bomb. He steered it to the tree line and searched, a mechanical vulture seeking weakening men, then maneuvered it slowly under the canopy of a woodlot green in the bloom of Ukrainian spring. On the second pass, the less wounded Russian appeared onscreen. Hearing the drone, he ditched his peer and bolted. Prorok chased him for about 20 meters, overshot, then turned and buried the drone's nose into the dirt. "I hit two meters away from him with that heavy munition," he said. "That is guaranteed to kill."

Prorok had never taken another human life. He once wondered how he would feel when he did. The act summoned a first answer: He had killed a Russian before a Russian killed him. No matter his fate, according to the coldest principle of his military service, his life would not be wasted. "If I am bombed today," he thought, "it is already one to one." Of many possible emotional permutations, he felt one: professional satisfaction.

Buryi's team formed soon after and began its routine of frontline shifts. Less than two years before, Fedorenko's first FPV team received six drones a month and used two types of bombs. As the autumn light of 2024 warmed the swaying grasses of no man's land, Buryi's team flew as many as 40 FPV drones a day, with more than six types of ammunition. Unsurprisingly, Prorok's bloodmath trended up. He estimated he had killed at least 50 Russian soldiers. He had been a soldier less than a year, an FPV pilot for fewer than 90 days.



An engineer at the Achilles battalion FPV workshop, where flight-control software is installed and drones are tested before being sent to the front.

Andy's voice came over the laptop speaker to share an urgent warning. Radar had detected a Russian Supercam overhead. Supercams are fixed-wing surveillance drones with a 10½-foot wingspan that transmit video more than 60 miles. Russia's military uses them to find Ukrainian targets for pinpoint attack by other weapons.

Trader was ready with another drone, but Andy ordered the team to stay inside. If anyone left the building, the Supercam's remote pilot might see them and put the position's coordinates on a target list. Prorok relaxed with a cigarette. "If they find out about us and what we are doing here, it would mean two or more KABs would hit here at night," he said. Supercams often flew above the lines. Darkness provided no relief. It was arguably even more dangerous: Drones with infrared cameras detect the heat emitted by a soldier's body, making positions dimly lit by the moon even easier to spot than by day. "At night we absolutely do not go outside, unless we have a mission to fly," Buryi said. The team knew the routine. The Supercam loitered. The soldiers sat.

This was part of the war's new reality. Once drones filled the air, many practices long central to conventional warfare abruptly changed. Foot patrolling near forward positions, once considered foundational to defense, all but ceased along much of the front. Retrieving the dead, a time-honored requirement of martial codes, became in places impossible. Russian soldiers often left their peers' corpses where they fell, to be consumed by insects, crows or the feral cats, dogs and pigs that roamed the forests and

neglected farmland after the invaders drove their owners away. The alternative was for soldiers on retrieval duty to join the dead. Everyone hid. Prorok's drones flew each day over a front that seemed devoid of human life. When a Russian drone was overhead, Ukrainian drone teams kept out of sight, too.

"Rain, rain, go away," Buryi said.

After the Supercam flew on, Andy's voice sounded again. Five Russian soldiers and a Ural truck had appeared alongside an island of trees north of Hlyboke. A Ukrainian Mavic drone watched them. Their behavior bordered on stupid. They stood about a mile inside Ukraine, having a meeting in a circle on the grass. Their truck was outfitted with anti-drone netting. "I see it," Buryi said. "We need to hit the Ural at full speed before they take us down."

Prorok's quadcopter crossed the reservoir and raced toward the spot. It soon glitched and tumbled from flight, end over end, transmitting a spinning motion picture of blue sky and brown fields. The ground rose to meet it. The video went dead as it struck dirt and exploded.

Trader set another for launch. The failed first attack had most likely informed the Russians that they were being watched, so Prorok flew quickly, hoping to reach them before they fled. Ukrainian artillery began pounding the area with shells. Prorok steered toward the impacts, seeking survivors as explosions erupted before his drone's lens. "Don't shoot me down," he said. The quadcopter skirted above the blasts and spun its nose toward the trees. There was the Ural, engulfed in flames.

Smaller explosions peppered the forest and grasslands. These were cluster munitions. The quadcopter flew through their impacts, witness to a man-made storm. Rising smoke and dust interfered. "Damn, I can't see," Prorok said. Buryi guided him. The only movement was churning soil and dancing flame. There was no sign of the soldiers. Prorok slammed the quadcopter near the roasting truck.

The team took a break, eating sandwiches and scrolling through phones, which showed ever more drone strikes, including Russian FPV attacks on Ukrainian troops. An old pattern was new again. In the forever anxious realm of arms design, when a new class of weapon succeeds, copycats follow. In this way, revolutionary weapons arrive with a promise of relief, and linger for a legacy of horror. Artillery, machine guns, attack aircraft, tanks. Each shared an arc. They gave early adopters much-heralded advantages, subjected enormous numbers of human beings to new ways of killing and dying, and became universal. FPV drones — already embraced by Lithuania, Britain, the Czech Republic, Sudan, Taiwan and Syrian fighting groups — were on this path, and it seemed doubtful that any nation on Earth knew how to counter them in large numbers, much less in swarms. Moreover, with innovators testing FPV quadcopters enhanced by artificial intelligence, small drones in a not-distant future could be resistant to electronic warfare jamming, which would render one of the primary current defenses obsolete. (Russia and Ukraine have also developed FPV drones operated by ultrathin fiber-optic cable, which makes them harder to detect and impervious to radio-wave jamming.)

What would it all mean? No one knew yet. But among Ukrainians involved in drone warfare, one set of sentiments was consistent. In 2023, Ukraine had a choice: adopt FPV drones at an outsize scale or cease to exist, which was not really a choice at all. Ukraine intended to live, and as its troops continued to stand up to a far more powerful military, they regarded the million-drone goal as a mark of popular resilience and national success, and they hoped to have more drones, in more roles, as fast as possible.

Beyond these widely held views, ambivalence reigned, and unsettling questions abounded. The low cost and easy availability of quadcopters raise concerns that forces that do not adhere to the laws of armed conflict could use them in purposeful campaigns against civilians and civilian infrastructure. Human Rights Watch, for example, has been investigating Russian use of FPV quadcopters to drive Ukrainian residents from urban areas by attacking civilians walking, on bicycles or in cars, along with strikes on firefighting equipment, shops and public transportation. "Historically, if you look at armies that want to carry out precise attacks, they were using very expensive weapons, including cruise missiles or laser-guided aviation bombs," says Belkis

Wille, associate director of the organization's crisis, conflict and arms division. "What you have now is a world in which drones with arms are cheap enough, and effective enough, that you can carry out precise targeted campaigns against civilians, among other targets, at limited financial cost." The organization expects to publish its findings this spring.

Some Ukrainians worried about criminals or terrorists deploying similar drones, though this, they said, was a problem to be tackled later, like all the others, including the many nations watching the war and starting to field new drones for wars of their own. Hayat Tahrir al-Sham in Syria used FPV drones, reportedly with Ukrainian help, in the swift sweep through Syria that forced the country's dictator, President Bashar al-Assad, to flee to Moscow. (The Ukrainian government declined to answer questions about sharing combatants or technology with the rebels.)

Other quadcopter attacks risk being illegal, including targeted killings by FPV or bomb-dropping drones of soldiers clearly incapacitated by wounds — a practice that Telegram channels show to be widespread and that violates the Geneva Conventions protections of combatants rendered *hors de combat,* or incapable of performing their duties. Ukrainian drone use also appears to be a source of fury for Russian soldiers; on at least one occasion, they summarily executed Ukrainian drone teams after capturing them. Other Ukrainians expressed concern for the long-term well-being of FPV drone teams, who have killed extraordinary numbers of human beings, typically while observing their victims' fear and suffering. Even a sturdy soldier's mental health could be at risk from such experiences, though Buryi's team was not concerned.

Buryi himself found the question academic. "What emotion can I have after three years of this big war?" he asked, and he answered with a shrug. He wanted to drive the Russian Army back and go home to his family, he said, the sooner the better. Trader felt the opposite of remorse. He enjoyed helping to kill Russians and offered a practical reason. "The more I like killing them," he said, "the less of them we will have on our land." Prorok sat by the jarred pickles on the staircase of the despoiled home of a fellow Ukrainian family. He had wondered how it would feel to kill, but with experience his mind had moved on. Necessity removed gray, gave license to bloodmath and allowed space for neither hesitation nor regret. "I think I have strong motivation for this war," he said, softly. "It's in my interest, my national interest, the interest of all of my family and friends." He had pondered why he killed and accepted his answers. In such an invasion, he said, "there is no possibility where you can start grieving about your lost soul."

Andy called back with instructions. The team would send quadcopters to scour the ruined neighborhoods of Hlyboke, searching for openings in the rubble that Russian soldiers slipped through to enter basements. Rat holes, soldiers called them. A fresh round of work began. Andy pointed out holes in particular foundations, and Prorok flew drones with thermobaric charges down them. Explosion after explosion shook the town.

After a few strikes, Prorok's drone flew near a collapsed building he had hit before. Andy had spotted Russian soldiers there, and when the quadcopter passed by, two of them emerged from a shadow under a tree and wove their way through rubble, as if navigating a broken maze. "There they are!" Andy shouted.

Pulses sped up. Prorok's FPV drone flew lower than Andy's Mavic. He could not see them. Buryi talked him in. "Turn a bit toward me," he said. "Right here, under the tree." The directions worked. The two soldiers appeared on the screen in Prorok's goggles. "I see them," he said, leaning forward and rushing the drone their way.

Men can be fast. Drones are faster. Hearing the miniaircraft's whine, the soldiers broke in different directions. The soldier most clearly in Prorok's line of sight carried two bags, an ungainly load that slowed his pace. He reached a wall a second before the FPV caught up. Prorok's screen went blank. The Mavic feed told the rest. A bright explosion flashed where man and wall had been. "Yes!" Andy shouted.

For a while the Mavic hovered, though at first there was nothing much to see. After the smoke drifted away on the breeze, the scene revealed itself. One man had escaped. "*Blyat!*" Andy said, a general-purpose profanity that translates literally to "whore." He called for another drone with a fragmentation charge, to find and kill the survivor. The man at the wall was dead. His corpse

lay unattended under bright sun.

The Mavic watched for a while, but no one came for him. Like the decomposing Russian beside the home from which Buryi's team flew its drones, he was left behind, another luckless soul in a human-hunting routine brought to the world after a cornered people, choosing between collective life and collective death, opened Pandora's box.

Yurii Shyvala contributed reporting.

Read by Robert Fass Narration produced by Emma Kehlbeck and Krish Seenivasan Engineered by Steven Szczesniak

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