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Inside Ukraine’s Killer-Drone Startup Industry

Justin Ling ⋮ 20-26 minutes ⋮ 5/2/2024

On the top floor of a building somewhere in Ukraine is a drone workshop.

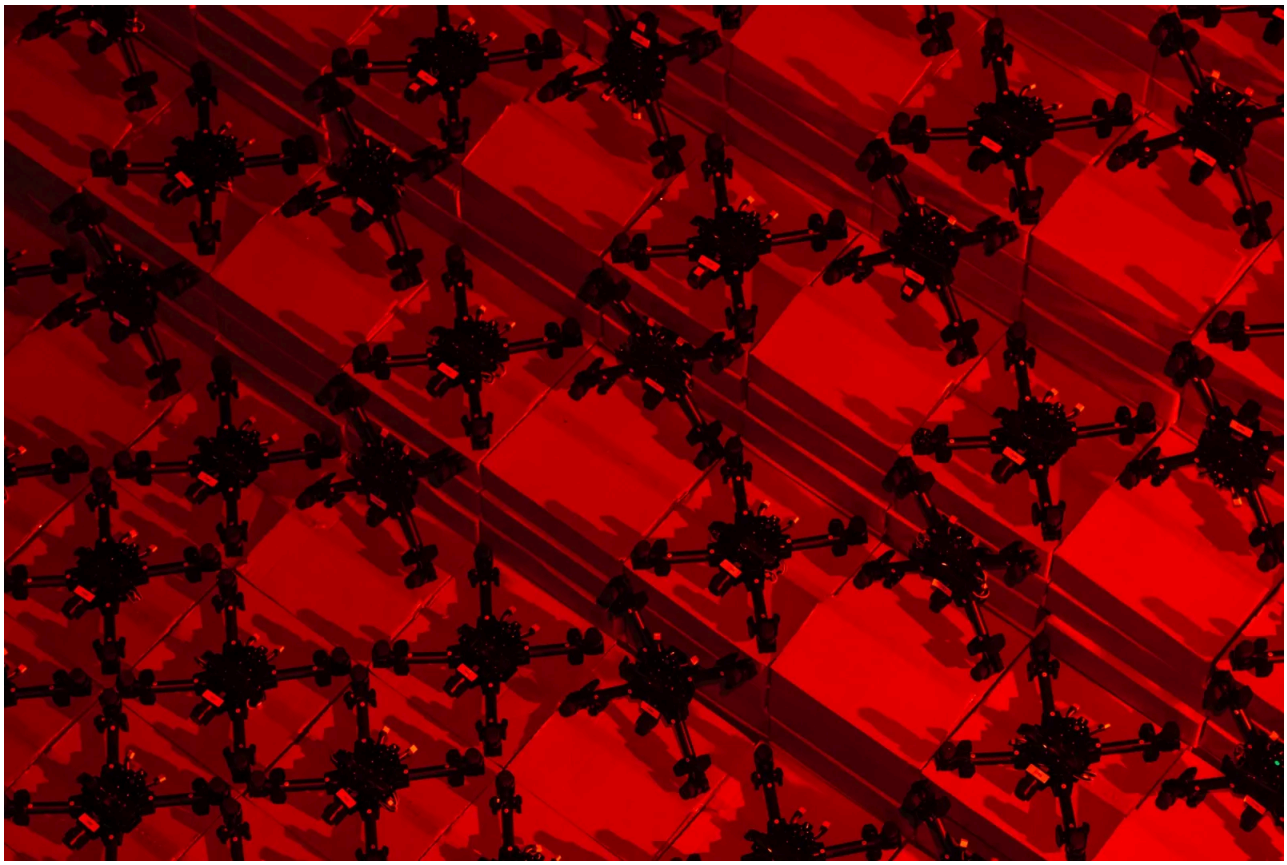
Inside is a chaotic workbench covered in logic boards, antennas, batteries, augmented reality headsets, and rotor blades. On one end of the room is a makeshift photo studio—a jet-black quadcopter drone sits on a long white sheet, waiting for its close-up.

This particular workshop’s Geppetto is Yvan. He grins as he shows off his creations, flittering around with a lit cigarette in his mouth, dangling ash, grabbing different models. (Yvan is a pseudonym; WIRED granted some of the people in this story anonymity due to the security risk.)

Yvan holds up a mid-size drone: This model successfully hit a target from 11 kilometers away, he says, but it should be capable of traveling at least 20. He’s trying different batteries and controllers to try to extend the range. He screws on a stabilizer tailpiece to a hard plastic shell—Yvan 3D-prints these himself—and holds up the assembled bomb. It’s capable of carrying a 3.5-kilogram explosive payload, enough to take out a Russian tank.

He uses his index finger and thumb to pick up a nondescript beige chip: This, he says, is what he’s really proud of.

One big problem with these drones—which are based on commercially available first-person-view (FPV) or photography drones—is that their explosive payload is jimmy-rigged on. It requires the drone to crash in order to close the circuit and trigger the explosion.



Photograph: United24

This chip, Yvan says, allows for remote detonation from a significant distance, meaning the operator can park their drone and lay in wait for hours, even days, before it goes off. He expects this technology could, eventually, be connected to AI—exploding only if it registers a nearby tank, for example. He has created a long-range smart land mine, I note. After the idea is passed through our translator, he nods enthusiastically.

There are many of these FPV drone workshops around Ukraine—Kyiv estimates there are about 200 Ukrainian companies producing aerial drones, with others producing land- and sea-based uncrewed vehicles. But Yvan, grinning proudly, insists that the manufacturer which he represents, VERBA, is the best.

Ukraine is facing increasingly tough odds in its defensive war against a better-resourced, better-equipped enemy. Thanks to delayed aid from Washington and shortages in other NATO warehouses, Ukraine has lacked artillery shells, long-range missiles, and even air defense munitions.

These drones, however, represent a bright spot for the Ukrainians. Entrepreneurship and innovation is scaling up a sizable drone industry in the country, and it's making new technological leaps that would make the Pentagon envious.

The age of drone warfare is here, and Ukraine wants to be a superpower.

After Yvan showed off his workshop, we loaded into the car to visit one of his factories.

Behind a steel door is a room filled with racks, where 30 3D printers are working simultaneously, printing various drone components in unison. The twentysomething

employees seem accustomed to the screeching alarm—some are soldering the drones together, others are tinkering with designs in AutoCAD, one is lounging on a sofa.

Strung across one shelf of 3D printers is a black flag, a take on Blackbeard's (apocryphal) pirate flag. It shows a horned skeleton wearing an AR headset and holding a controller, thrusting his spear toward a bleeding heart as a quadcopter flies above.

In the first year of the war, when FPV drones were providing extraordinary footage of the front lines and viral video of unmanned aerial vehicles (UAVs) dropping grenades on Russian tanks captivated the world, Ukraine was snatching up every consumer drone it could find. Chinese technology giant DJI became a household name in Ukraine, thanks to its drones' ubiquity on the front lines. Ukraine's early advantage was quickly lost, however, as Russia scrambled to snatch up these Chinese-made UAVs.

"When Russia sees, from Instagram, my product, Russia starts buying all these components in China," a VERBA executive says. The new demand from Moscow can often cause either shortages or inflation, squeezing out the Ukrainian companies. So entrepreneurs like Yvan began building their own.

When Yvan began his operation in the early months of the war following Russia's February 2022 full-scale invasion, he was creating a handful of frankendrones to send to the Ukrainian Armed Forces. Now, Yvan says, his operation is producing 5,000 FPV drones per month. He offers a range of systems, from a mammoth 12-inch model to a 4-inch prototype.

At first, these entrepreneurs were pursuing this project on their own—scrambling, like most of the country, to be useful in helping Ukraine defend itself. Kyiv was initially cool to the idea that a domestic drone industry was worth the money and attention, especially given the demand for more conventional arms. Some in the military, one executive says, dismissed the utility of these innovative weapons and surveillance platforms as merely "wedding photography drones." (One executive said Oleksandr Syrskyi, Ukraine's new commander in chief, had been an early adopter inside the military, directly contracting 10 firms in early 2023 to begin assembling new technology for his forces.)

That attitude changed in 2023, when Ukraine set up Brave1, a government-run technology agency and incubator that helps connect private enterprise to the Ukrainian Armed Forces.

Since its creation, Brave1 has worked to streamline design, development, and procurement of new defense technology, while helping companies navigate government and military bureaucracy. Brave1 has already awarded more than $3 million in research and development grants and connected more than 750 companies to the Ukrainian Armed Forces.

Photograph: United24

When United24, the Ukrainian government's in-house crowdfunding platform, first pitched an "army of drones" to its donors in 2022, it aimed to buy just 200 units. Today, Ukrainian president Volodymyr Zelensky projected late last year that his country would produce over 1 million drones in 2024.

“I would say that we can even double this number,” Natalia Kushnerska, head of Brave1’s defense technology cluster, tells WIRED.

“We have the responsibility and the motivation to do it today and to do it very fast,” she says. “Because we don't have any other choice.”

This is a war, one executive told me, “where the economy matters.”

Even hampered by sanctions, Russia has a $2 trillion economy—about 6 percent of that is geared toward its wartime production. Ukraine’s entire GDP, by contrast, is less than $200 billion.

While Kyiv has received substantial support from its NATO partners, it faces constant pressure to find efficiencies. The economics of these drones are looking better and better.

Yvan’s drones are, compared to conventional munitions, cheap. His most expensive unit runs about $2,500, but the cheapest is only $400.

Early in the war, the Ukrainians could reasonably expect—depending on weather, the mission, and Russian jamming efforts—that about 30 percent of their drones would connect with the target. Today, good Ukrainian-made systems are approaching a 70 percent success rate.

It can often take four or five artillery shells to successfully destroy a medium-range target, such as a tank. At $8,000 per shell—which are in short supply and high demand—that is an expensive proposition. Even if it takes two of Yvan’s most expensive drones to achieve the same objective, that’s thousands of dollars in savings. The proliferation of these drones reduces the “cost-per-kill,” as one executive phrased it, and reduces the strain on those dwindling ammunition stockpiles.

Even if Yvan and other producers are making more and more of their systems in Ukraine, they still rely on Chinese suppliers for critical onboard components. That comes with a trade-off—Chinese suppliers are cheaper, but they tend to be of lower quality and are happy to do business with Russia as well. Other options, such as companies in Taiwan, the United States, Canada, or Europe, are better quality but can be several times more expensive.

These supply chains, Yvan says, are “complicated.” Drone manufacturers who spoke to WIRED say anywhere between 40 percent and 80 percent of their drone components are made in Ukraine. Asked how long it would take before Ukraine manufactures nearly everything in these drones, from the rotor blades to the onboard components, Yvan provides a bullish estimate: “six months.”

It’s not an entirely unrealistic dream. Mykhailo Fedorov, Ukraine’s deputy prime minister and also minister responsible for digital transformation, said late last year that Kyiv hopes to break ground on a semiconductor factory, capable of producing 50,000 chips a year, by 2025. Ukraine produces about half the world’s supply of neon, necessary for the lasers used to make the chips.

There are already companies in Ukraine that have developed electronic design automation software—a necessary tool for producing chips—and that do electronic

assembly inside the country itself. An industry source tells WIRED that a working group was formed in late 2023 to chart out how Ukraine could be a player in the semiconductor industry.

Another defense technology executive, Igor, manufactures considerably more-sensitive drones. “We definitely don’t buy anything from China,” he says. His products are more expensive, he says, “but we are looking for something that would differentiate us from the Russians.” At the moment, he says, “Russia is ahead.” He’s hoping to close that gap.

For any of this to work, however, there needs to be demand for these drones. The more they can sell, the more they can invest. “The things that they need,” Kushnerska says: “contracts and money.” Demand has certainly grown—fundraising platform United24 helped finance a fleet of naval drones and raised funds to purchase 5,000 surveillance UAVs. Other organizations have led similar purchases. The drone-makers, however, say it’s just not enough.

In early 2023, Ukraine’s parliament passed new laws to regulate how drone manufacturers can contract with the state; while profiteering is generally discouraged in the wartime economy, the law specifically allows the companies to charge up to 25 percent profit.

Yvan says he charges just a 10 percent premium for his drones and reinvests all that profit back into his operation. Representatives from other drone companies who spoke to WIRED say they operate on a similar basis.

More orders will mean more investment. Thus far, NATO countries have preferred to purchase locally-made equipment and ship it to Ukraine. That may be changing.

Bill Blair, Canada’s minister of defense, visited Kyiv shortly before I was there. While there, he announced that Ottawa would donate 800 Canadian-made drones to Ukraine. While the donation was lauded, a senior official asked the minister, “Why didn't you buy our drones?” After being briefed on the various innovations taking place in the Ukrainian drone industry, Blair was convinced. “We're also going to find ways to invest in Ukrainian industry,” he tells WIRED. “The point of the [Ukraine Defense Contact Group drone coalition] is to create capability, not only in the countries that are in the coalition but also capability in Ukraine.”

Even still, bureaucracy moves slowly. What’s more, startups—some of which are helmed by technologists or special effects gurus with no experience in procurement, let alone war—are often learning as they go. One executive, covering his eyes with his hand, says: “It’s like going completely blind.”

Not every company has been able to hack it. One executive says he’s aware of five defense technology startups that have shut down since the war began.

Much attention has been paid to FPV drones. They reinforce the idea that Ukraine’s defense is a scrappy, homespun effort. But even as the country has professionalized production of these light, agile drones, it has rapidly spun up production of other, more complicated systems.

One of Ukraine's biggest disadvantages, from the start of the war, has been its difficulty in hitting targets inside Russia. Because Moscow has so effectively dominated the skies, Ukraine has been left playing defense.

That equation has changed substantially in recent weeks. Ukraine has had enormous success in attacking Russian oil refineries—knocking out as much as 15 percent of the country's total refining capacity—and bombing Russian air bases. This has all been made possible by Ukrainian-made long-range attack drones.

Igor, who represents a company responsible for producing those long-range bombers, says they have developed a unit capable of flying 1,000 kilometers and carrying a 25-kilogram payload and has produced "several hundred" units for the Ukrainian Armed Forces. And they are actively working on a new model, capable of flying up to 2,500 kilometers. (It will pack a smaller punch, he said: "The longer you go, the lighter the payload.")

These systems are more expensive: from $35,000 to $100,000. But if they can destroy millions of dollars worth of Russian equipment, that's a bargain.

"These are no simple drones," Igor says. "We don't have the luxury, like the Western guys, to spend years in development."

They're not stopping with drones, either. They're using the same technology to develop Ukrainian-made missiles, capable of flying farther and doing more damage to Russian military infrastructure, tucked well behind the front lines, which is regularly used to attack Ukrainian cities.

Igor's goal is to "bring the war to Russia." FPV drones have broadcast the realities of the front lines in high definition—long-range bombers could successfully make it feel real, he says. "They don't suffer like we suffer."

The effort to bring the war to Russia is advancing on multiple fronts. One of the most famous uncrewed systems of the war has been Kyiv's Sea Baby drones. Videos have gone viral of these sleek ships clipping along the waters of the Black Sea.

According to Kyiv, they can carry 850 kilograms of explosives, go 90 kilometers per hour, travel some 1,000 kilometers—and they are invisible to radar. This is the kind of capability that the Pentagon, and other defense departments, has spent years trying to develop. "We like to joke that everything we do now, in Ukraine, takes three days—globally, it takes three years," Brave1's Kushnerska says.

Ask around Kyiv about these drones, however, and everyone is mum. Even otherwise talkative defense sources go quiet when asked about the Sea Babys. Asked about the vehicles, one defense executive smiled and said simply, "That's classified."

Kushnerska is equally evasive: "We need to keep silent about new solutions and new surprises that we are preparing for the enemy."

The skullduggery is understandable. These uncrewed vehicles have been responsible for doing massive damage to Russia's prized Black Sea fleet and spearheading the first major attack on the Kerch Bridge, in Crimea, in 2022.

Developing naval drones, however, is relatively easy compared to uncrewed land systems.

Over tea with Stepan, another defense entrepreneur, he lists the litany of difficulties of trying to build uncrewed land systems: They don't travel well over tough terrain, they don't operate well in inclement weather, and they don't tend to go very far.

And yet, Stepan says, his company has overcome all those obstacles—which the Pentagon is still wrestling with—and has put these land systems in the field. Plus, Stepan says he's "pleasantly surprised by how they're being used." He says their smallest unit, which has generally been used to deliver food and equipment, recently rescued and evacuated a wounded soldier from the front line.

Ukraine is not the only side deploying these land systems, however. In late March, pro-Kremlin channels celebrated what they said was the successful deployment of Russian-made uncrewed land systems, outfitted with an AGS-17 grenade launcher.

Ukraine believes its advantage will come from how it dispatches these systems. "You need a mesh system," Stepan says. And that's one of the single hardest things to do. Ukraine has started dispatching repeater UAVs, which are used to extend the base station signal, allowing the drones to fly farther and defend better against Russian jamming.

One ground drone, basically a mobile machine-gun turret, boasts an 800-meter range. What's more impressive, however, is what happens when the land system is paired with a surveillance drone. Rather than them firing directly ahead, Stepan's team has been training Ukrainian soldiers how to raise the weapon's trajectory, firing in a parabolic pattern and using the drone's camera to adjust its aim. This tactic, he says, extends the drone's firing range to 2.4 kilometers.

Doing combined operations with a couple of drones is hard enough. If Ukraine wants to really take advantage of these autonomous systems, it will need to figure out how to command multiple systems across land and air—and that's where artificial intelligence comes in.

Stepan walks through the four levels of how AI can augment warfare: One is reconnaissance, where machine learning can be used to collate large volumes of footage and satellite imagery. Two is "copiloting," as he calls it, where AI can analyze that intelligence and help draw insights. Third is planning, where AI can help develop "interlinked, complex orders" for multiple systems across land and air; he likens that to having AI develop football plays. Finally, step four is full autonomy, where AI collects intelligence, analyzes it, develops orders based on the intelligence, and dispatches and commands autonomous units based on that information—although humans review and approve each step of the process.

There are steps beyond this, Stepan notes, that remove human involvement entirely, but he isn't interested in going there. Another executive recounted a story of how one company designed an autonomous machine gun, capable of conducting object detection and opening fire on its own—that was a "big, big problem," he says, after the weapon's radio signals were jammed and it began firing wildly. "I think we can do this slowly," he adds.

Stepan's systems are capable of operating at step four, he says. It means his systems have the "ability to take in variables" in real time—it allows his drones to change tactics depending on the environment. He provides examples: "What if our team is close? What if there is [electronic warfare]? What if one system loses connection?"

Kushnerska says Ukraine, alive to the concerns about and risks of AI on the battlefield, is mostly interested in using artificial intelligence only in the "last mile."

It's not enough to build drones. Ukrainians also have to know how to pilot them.

The last stop on Yvan's tour is at a strip mall some distance away. Outside, a group of fresh-faced young men smoke cigarettes and enthusiastically greet him as he walks past.

Inside is a sterile classroom, with a dozen desks laid out—each featuring a tablet, a workstation, and an array of tools. In the back corner are pallets of FPV drones waiting to be unloaded.

This is Yvan's drone school. Here, students learn not just the ins and outs of piloting these quadcopters but also how the machines work and how to repair them. Down the hallway is a large conference room where the students first test their skills—flags and checkpoints are propped up on cardboard boxes taped together into platforms of different levels. Once students can successfully navigate this makeshift course, they graduate to piloting the drones outside.

Yvan's drones are normally painted jet black, designed to look as nondescript as possible. One drone, sitting on a desk in the training school, is spray-painted a bright orange. Yvan grins: "We're sick of losing them in the grass."

As Kyiv mobilized tens of thousands of ordinary Ukrainian men to fight, training has been a critical necessity. Particularly as ammunition supplies have dwindled, virtual training has been especially attractive. High-tech combat simulators have allowed Ukrainian troops to simulate real combat scenarios with rifles, rocket-propelled grenades, even anti-tank missiles. Ukrainian entrepreneurs are hoping to have dozens of these simulators online in the near future, with the goal of training 100,000 troops.

An industry source tells WIRED that a drone combat simulator went online last month, allowing trainees to simulate the entire process of launching a long-range drone strike. Version 2.0 is being rolled out now, they say, adding that it is likely the first immersive offensive drone simulator in operation. The simulator is also intended to help Ukrainian pilots practice integrating their drones with land systems, which is notoriously difficult for even experienced soldiers.

While Yvan's drone school offers hands-on experience for users of the FPV drones, this new drone simulator allows pilots to practice long-range targeting, flying in adverse weather conditions, and countering electronic warfare.

All of this—the FPV drones, the long-range bombers, the flight simulators—is Ukrainian innovation at work. And it is moving remarkably fast. Some day, after the war is over, Yvan may well be on the front lines of a Ukrainian technology renaissance, fulfilling orders for the Pentagon. First, both he—and Ukraine—need to survive.

In recent weeks, Russian forces have made modest but steady advances along the front lines. Defense executives, meanwhile, see sabotage and industrial espionage as constant problems. Even more acute is the threat of Russian air strikes. One executive recently recounted how one of his company's main facilities was nearly hit by two Russian cruise missiles. The risk is very real.

Leaving the school, Yvan opens up the back of his car. He rummages around and hands me two patches: One features a cartoonish and scantily clad woman wearing an FPV headset with the Ukrainian flag on the side, piloting one of Yvan's rotocopters. The other, an army-green Canadian flag, carries the words "ALWAYS BE READY."