Do Androids See Electronic Films? The Use of Drones and Algorithmic Vision in Russia's War against Ukraine

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The View from Above

The image shows an industrial winter landscape from an altitude of over 300 metres. The camera shakily approaches a sandy embankment, and, as it approaches, a trench becomes visible, with a green target marker in the middle of the frame constantly in focus. The marker serves as an autoguidance function and corrects the drone's flight trajectory. At an altitude of 30 metres, the footage becomes slow motion, and two people in the trench are visible just before the explosion occurs. This footage was taken by a Switchblade kamikaze drone during a strike on Russian troops, supposedly during the battle of Bakhmut in the winter of 2022. The moment of hitting the target is not shown from the drone's point of view – another reconnaissance drone captured the moment from a distance of several hundred metres away. After the explosion, one of the wounded soldiers tries to crawl out of the trench.[1]

Another image from the front line shows autumn fields from about the same height, with the date stamp and zoom level visible on the screen. When the camera starts zooming out, an explosion blinds the screen. Only a slow-motion replay allows us to see the moment an antiaircraft missile attempts to hit the drone. According to the authors of the publication of the video, it withstood this strike (Fig. 35).[2]

1 @clashreport (Clash Report), "Ukrainian Switchblade-300 Kamikaze UAV in Action", X (formerly Twitter) post, 13 December 2022, https://twitter.com/clashreport/status/1602560451732275200 [accessed: 14.03.2023].

2 Povernys' Zhyvym (Facebook profile) "Rosiyany bezuspishno namahayutsya znyshchyty 'Leleku-100'" ("Russians unsuccessfully attempt to destroy 'Leleka-100'"), Facebook post, 04 December 2022, https://www.facebook.com/backandalive/videos/росіяни-безуспішно-намагаються-знищити-лелеку-100/507872847965418/ [accessed: 10.03.2023].

Figure 35: A Valkyrie drone captures an unsuccessful attempt of a Russian missile to strike it.

Image by Army SOS, 01 May 2022, https://www.facebook.com/groups/armia.sos/permalink/3344841992411050. Image provided courtesy of creator Yaroslav Tropinov (Army SOS, volunteering organisation).

In the combat zone, drones are used to conduct reconnaissance, identify targets, and guide artillery. They are used to carry out strikes, evaluate the results of a strike, even clear mined positions,[3] and help evacuate civilians[4] or take soldiers captive.[5] People hide from them, try to jam them, or shoot them down.

As civilian drone technology has become widely used and affordable in recent decades, it has become an integral part of Russia's war in Ukraine. Since the beginning of the invasion, social media and news reports have regularly shared and discussed drone footage from the war. While this is not the first time that views from above have been used in war, it is unlikely that the visuals of combat in any other war have been so dominated by this view.[6]

The idea of a bird's-eye view itself is not new. It can be easily traced back to the Renaissance practices of mapping and depicting cities, such as Jacopo de' Barbari's panoramic *View of Venice* from 1500. Such a view has long been intriguing and interesting for humans because of its ability to cover a larger and more complex area than the human eye can see from a human height. On the one hand, *View of Venice* shifted the humanlike gaze from the hustle and bustle of a single street to an elevated perspective of the city below us, as if it were a godlike gaze, an attempt to grasp the city in its entirety, to offer a universal view. On the other hand, it showed how useful such a view is for military purposes and opened the city's defence vulnerabilities to the eyes of hostility. This view became so valuable and militarily sensitive that the Venetian state did not produce any more such detailed panoramas of Venice in the following 150 years.[7]

As Caren Kaplan shows, the view from above was anticipated as a promise to reveal an all-encompassing perspective in various historical and technological contexts (i.e., maps, towers, air balloons, drones, satellites, etc.). Military use became apparent with the invention of planes and photography. Since World War I, aerial

3 Butusov Plus, "'Ya osobysto zrobyv minus 500 okupantiv' – operator drona 10-yi OHShBr 'Skyba' u boiu." ("'I have personally made minus 500 occupiers' – drone operator of the 10th Brigade 'Skiba' in combat."), YouTube video, 15:03, 18 February 2023, https://www.youtube.com/watch?v=OmsXSk5VCXc [accessed: 14.03.2023].

4 Shoot_shoot, "SHOCKING DOCUMENTARY FILM 'FOLLOW ME' On the military rescue operation in Ukraine 2023", YouTube video, 31:25, 18 January 2023, https://www.youtube.com/watch?v=QTCwmV7Rh8c [accessed: 06.04.2024].

5 The Wall Street Journal, "Watch a Russian Soldier Surrender to a Ukrainian Drone in Bakhmut | WSJ", YouTube video, 07:05, 14 June 2023, https://www.youtube.com/watch?v=n2W8yRa9XuA [accessed: 14.06.2023].

6 My factual knowledge about this topic is mainly based on publications available as of February–March 2023, when this text was written. The use of drones and algorithms by the military in Ukraine, as well as the public discussion around this, has intensified since then.

7 Juraj Kittler and Deryck W. Holdsworth, "Digitizing a Complex Urban Panorama in the Renaissance: The 1500 Bird's-Eye View of Venice by Jacopo de' Barbari", *New Media & Society* 16/5, 2014, 770–788.

photography has become commonly used for reconnaissance with a definitive military value.[8] Ever since, these panoramic views have been an unquestionable part of military action, and over the decades the technology has shifted from aerial photography to satellite and computational views (i.e., Sputnik, GPS, etc.).

In current warfare, the bird's-eye view of Ukrainian cities has been completely subordinated to military purposes to keep it away from hostility. Since the beginning of the full-scale invasion, drone flights have been completely banned for civilians. Bird's-eye views of Ukrainian cities have become militarily sensitive.[9] Currently, such footage is primarily used for monitoring and reconnaissance by – and for – the military. Short episodes – rather visually impressive – are published by press officers with a few days' delay, with no harm to operational security. Obviously, the context is very limited, as it might have a direct impact on combat, so civilians see drone videos but do not really see what purpose they originally served. This footage does not really inform the general public about warfare developments. They are shared to assure civilians that they have a voyeuristic gaze on the battlefield. And this is, after all, the position from which this essay is written. It is just my civilian opinion, based on fragments of public reports, and does not contain any military insights or expertise.

Drone footage is a key element of any combat in this war. However, a single piece of drone footage is only a fragmentary view, with its scope limited to a certain area and time. A simple high-altitude view from a drone is not enough when the scale of the warfare stretches over hundreds of kilometres. Each particular view from above is eventually supposed to be integrated into something much bigger – a universal view of the entire frontline area, military tactics, and strategy collected from hundreds of instances of drone footage, integrated with other sources of information (e.g., satellite data, intelligence, military reports, etc.). This is where algorithms and computer networks are applied. How, then, is the production of this overarching gaze on warfare developments constituted through an algorithmic vision?

Geographer Denis Cosgrove argues that the "meanings of the photographed earth" were "anticipated long before the photographs themselves were taken". In his view, "for all its radical newness, actually witnessing the globe culminates a long genealogy of imagining and reflecting upon the possibility of doing so".[10] Similarly, drone videos and datasets integrated into a larger algorithmic structure are

8 Caren Kaplan, *Aerial Aftermaths: Wartime from Above*, Durham, NC: Duke University Press, 2017, 13.

9 *WikiLegalAid*, "Poryadok vykorystanny tsyvilnykh povitryanykh droniv (bezpilotnykiv)" ("The Procedure for the Use of Civilian Drones (UAV)"), https://tvl.ink/zTzMu [accessed: 10.03.2023].

10 Denis Cosgrove, *Apollo's Eye: A Cartographic Genealogy of the Earth in the Western Imagination*, Baltimore: Johns Hopkins University Press, 2001, 9.

seen today as a promise that is supposed to offer the all-encompassing panorama of complex, large-scale processes, like frontline developments in the Russo–Ukrainian War. This anticipation consists of its own genealogy of imagination and reflection. The idea of seeing something beyond the limitation of the humanlike point of view by using computers is also not new. Its trajectory starts in the mid-20th century in the post–World War II context, when cybernetics became one of the key attempts to comprehend and govern complex structures and processes in which a single person is only a part of something larger.

Coined by the American mathematician Norbert Wiener, this discipline proposes the idea of managing complex systems on the principles of control and communication in the animal and the machine.[11] This idea gained considerable popularity worldwide with the beginning of electronic computing and discussions about its application in society. Moreover, due to a high degree of abstraction when it comes to governing large-scale systems, it was closely connected to the concept of visuality – computers and algorithms should show us what the human eye cannot see on its own. Soviet scientist Victor Glushkov explicitly used the metaphors of 'film' and 'visuality' to explain this idea.[12]

In the Soviet Union, cybernetics gained widespread popularity with the beginning of Khrushchev's reforms. Projects using computers and algorithms were launched first in the military and later in civilian spheres. One of the most notable scholars in this field was Glushkov. While focusing on civilian computer networks, his theoretical thinking and research infrastructure were involved in a broad spectrum of cybernetic projects in the Soviet Union. He founded his research centre in Kyiv in the early 1960s, which still exists today, called the Institute of Cybernetics. His name is usually associated with the concept of the all-state automated system of management (better known as OGAS), a nationwide computer network often called the 'Soviet Internet' in the literature. Glushkov was convinced that complex processes and systems can be comprehended primarily through building networks of computers to collect multiple sources of information and to calculate and process them with algorithms, which was supposed to improve the efficiency of the Soviet Union's planned economy.[13]

In his view, various pieces of information about our current reality are fed to the 'electronic brain' (Glushkov's metaphor for a computer), where those are integrated

11 Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society*, Cambridge, MA: Riverside Press, 1950.

12 Victor Glushkov, Gennadiy Dobrov, and Valeriy Tereschenko, *Besedy ob upravlenii* (*Conversations on Governance*), Moscow: Nauka, 1974, 36 .

13 The history of OGAS and the context of Soviet cybernetics is explained in: Benjamin Peters, *How Not to Network a Nation: The Uneasy History of the Soviet Internet*, Cambridge, MA: MIT Press, 2017; and Slava Gerovitch, *From Newspeak to Cyberspeak: A History of Soviet Cybernetics*, Cambridge, MA: MIT Press, 2002.

into a larger sequence to show our complex reality. In the example of a factory, he stresses how the information (or 'data', as one would put it today) about production is more important for an algorithmic vision than the production itself: "It is possible to imagine that a certain strange film is born in the electronic brain of the factory, where not the external, visible shell of the production process, but its internal, informational essence is recorded. Watching the film, the brain advises how to make the process optimal".[14] Computers not only visualise the complexity of the current situation but also prospectively project potential scenarios, therefore affecting the decision-making process. Computing serves as an intermediary between contemporary reality and the eventuality of the future. It is supposed to create a 'film' that is projective in nature – a 'film' representing potential developments. Even though Glushkov's metaphor refers to manufacturing production as an example, in his view, this principle of collecting and structuring the data to manage large-scale and complex processes is applicable to basically any sphere of social life. This metaphor does not reflect the factual, objective reality of using technology back at the time. It illustrates instead a way of thinking about technology, anticipating its universality for extending human comprehension. It is an imaginary that promotes the use of computer technology for social, economic, and military governance. With this metaphor, Glushkov introduced the term ASU – automated management system.[15] Such systems were actively created in nearly every sphere of late Soviet society, with varying levels of both complexity and efficiency. The term ASU is still used, including in a military context, which suggests that, directly and indirectly, this imaginary is, to an extent, still present today.

If we follow this metaphor of 'an electronic brain watching a film', we can try to trace how the anticipation of extending human comprehension with technology is present in the Russian war in Ukraine. It leads to another visuality of this war created by drone vision, data production, computational algorithms, and ASUs used on the battlefield. What films do drones watch in this war? What modes of visuality (and reality) do the 'electronic brains' of automated control systems offer to humans?

This is a 'film' done by and for the military. It begins with technical infrastructure, logistics, and people's expertise on the ground supplying drone footage of a specific 'scene' or 'episode' of the war. Once aggregated from dozens of other drones and integrated by algorithms with other reconnaissance datasets via specific apps, the military develops a certain 'film sequence' providing 'situational awareness' for still fragmented but nevertheless larger areas and broader time frames. Processed and analysed on a higher level of abstraction via ASUs, 'sequences' are eventually 'edited' into a 'film'. This 'film' is supposed to provide an all-encompassing overview of the front line, which affects the decision-making process of higher command.

14 Glushkov, Dobrov, and Tereschenko, *Besedy ob upravlenii*, 36.

15 Ibid.

In the following sections, I will trace, through illustrative examples, some key infrastructural elements facilitating the algorithmic vision used by the military in this war.

On the Ground

Military drone visuality is generated through sweat and blood. Their maintenance is hard work. The use of drones in the war has reached an unprecedented level of intensity. According to Ukrainian military estimates, 500 drones can be in the sky simultaneously during combat operations.[16] This is evidence of their relentless necessity on the battlefield. At the same time, their vulnerability to adversaries' weapons makes them expendable. According to analysts, a quadcopter, such as a commonly used series of compact drones called Mavic, operates for an average of three flights; a fixed-wing drone (e.g., Bayraktar, PD-2, Leleka, Valkyrie), for six. A third of the flights are successful. In the first six months of the war, Ukraine lost 90 per cent of its drones.[17] This is another indication of which infrastructure and logistics solutions on the ground are required to get the view from above.

"Mavic 3 is something we always need", says a soldier who has been a drone operator since 2019.[18] The interview with his group was filmed in a field on the line of contact during a combat mission. During the full-scale invasion, he killed about 500 soldiers by dropping grenades from civilian drones. According to this soldier, drones are constantly involved in repelling offensives or capturing prisoners. At the same time, he admits that they lose drones regularly.[19] The drones are shot down, their batteries run out, and communication is lost due to signal jamming. They try to find them after they are lost[20] or to evacuate them from the front line.[21]

16 Sam Schechner and Daniel Michaels, "Ukraine Has Digitized Its Fighting Forces on a Shoestring", *Wall Street Journal*, 03 January 2023, https://www.wsj.com/articles/ukraine-has-digitized-its-fighting-forces-on-a-shoestring-11672741405 [accessed: 10.03.2023].

17 Mykhaylo Zabrodskyi, Jack Watling, Oleksandr V. Danylyuk, and Nick Reynolds, "Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022", Royal United Services Institute, 30 November 2022, https://rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-conventional-warfighting-russias-invasion-ukraine-february-july-2022 [accessed: 10.03.2023].

18 Butusov Plus, "'Ya osobysto zrobyv minus 500 okupantiv'", 06:41–06:43 [author's trans.].

19 Ibid., 10:31–11:03.

20 Babylon13ua, "Poryatunok ryadovoho drona" ("Saving Private Drone"), YouTube video, 11:36, 02 February 2023, https://www.youtube.com/watch?v=8fDZUDLjbII [accessed: 10.03.2023].

21 @yigal_levin, "Bespilotnik 93-iey brigady VSU evakuiruyet…" ("A drone from the 93rd brigade of the AFU evacuates…"), Telegram post, 22 December 2022, https://t.me/yigal_levin/37706 [accessed: 10.03.2023].

This soldier is one of many who are on the other side of average drone footage, who travel to the line of contact with the necessary equipment to get the drone into the air. This takes place under fire, in the open field, in trenches and dugouts, or in unprotected territory, as well as in different weather conditions, which affect both people and drones. Drone operators are trained in flying, technical characteristics, remote control, targeting, and registering drones in systems to distinguish them from civilians or to feed intelligence. Because this drone view requires significant resources and energy, a certain personal relationship is formed between drones and their operators. They euphemistically call drones 'birds', 'eyes', and so on. They even jokingly 'bury' them, as if the drones were live beings that require respectable burial and mourning for the loss.[22]

Both the government and volunteer organisations work to supply military units with drones. The government and businesses allocate funds. Volunteers also organise crowdfunding campaigns, and not only in Ukraine, which has included raising millions of dollars for Bayraktars (long-endurance combat drones) and multiple small-scale allocations for Mavic 3s for individual military units.[23]

Blood and flesh, in peace or under fire, in cold or heat – maintaining the infrastructure is essential to keep drones in the air. This is how the cuts for the 'film' are collected. The first level of algorithmic vision takes place here as machines are tied to human bodies through designing repeatable collective routines of setting up hundreds of drones in the sky over the front line.[24] Fragments of footage from such drones are what civilians usually see. These are actual hostilities with actual people and machinery that can be easily understood without additional context. The further level of abstraction in an algorithmic 'film' takes place in the next stages.

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22 @lastwarriorr, "Chas dla zboru hroshey nastav!…" ("The time to raise money is now!…"), Telegram post, 07 December 2022, https://t.me/lastwarriorr/19266 [accessed: 10.03.2023] [author's trans.].

23 For more on the governmental programmes of fundraising for and the import and production of drones, see: Joe Tidy, "Ukraine rapidly expanding its 'Army of Drones' for front line", *BBC*, 26 April 2023, https://www.bbc.com/news/technology-65389215 [accessed: 10.03.2023]. See also about the crowdfunding campaign in Lithuania to buy a military drone: *Euronews*, "Lithuania Shows off 'Crowdfunded' Military Drone It's Giving to Ukraine", 07 July 2022, https://www.euronews.com/2022/07/07/lithuania-shows-off-crowdfunded-military-drone-its-giving-to-ukraine [accessed: 10.03.2023].

24 The broader use of the term 'algorithmic' as a tie between machines and human bodies is discussed by Jussi Parikka in: Jussi Parikka, "Operational Images: Between Light and Data", *e-flux Journal* 133, February 2023, https://www.e-flux.com/journal/133/515812/operational-images-between-light-and-data [accessed: 10.03.2023].

Scene

"Drones don't see, they scope", Australian artist Kathryn Brimblecombe-Fox emphasises through her series *Dronescapes*.[25] Images transmitted by drones have one key characteristic. First of all, they provide an overhead view from a distance of several hundred metres to several kilometres, a picture of landscapes destroyed by the fighting – trenches, craters, burnt houses, and mangled trees. Sometimes this visualisation is transmitted from the infrared spectrum through thermal imagers. Sometimes this visualisation is blurred, shaded, or clouded. As the war has lasted more than a year, all four climatic seasons are visible in this footage. The landscape, however, inherently remains only a background in these images. The key focus is the military: positions and numbers, precise coordinates or distances from the target, and movement directions and speed, among other things. Eventually, this visuality must be transformed into information for the 'electronic brain'. Images are quantified and measured to become 'operational' and therefore eligible for processing, analysis, and synthesis.[26] At this stage, it is not the captured visual footage itself that becomes more important but the quantified data extracted from it, as well as the way it is combined and visualised with other datasets.

Drone footage usually does not exist autonomously. It is integrated into a wider network. "It's like a taxi – whoever responds to the order the fastest is the best", says a member of the special unit "Birds of Madyar" about the work of an unmanned aerial vehicle reconnaissance pilot and drone integration into the ASU.[27] One of the most popular Android-based systems is ASU Kropyva (Nettles), developed by volunteers after the beginning of the war in 2014. According to them, the app is used by over 90 per cent of artillery units.[28]

With this application, drones, artillery units, and local commands are connected to a network. The command and artillery units can monitor updates of enemy targets, receive their coordinates, and automatically calculate the direction of fire and

25 Federica Caso, "Visualising the Drone: War Art as Embodied Resistance", *E-International Relations*, 16 May 2018, https://www.e-ir.info/2018/05/16/visualising-the-drone-war-art-as-embodied-resistance/ [accessed: 10.03.2023].

26 Parikka, "Operational Images: Between Light and Data".

27 5 kanal, "Schoyno! Madyar pokazav, yak robytsya BABAKH na holovy okupantiv" ("Now! Madyar showed how to make a BOOM on the heads of the occupiers"), YouTube video, 03:58, here 01:49–01:54, 22 February 2023, https://www.youtube.com/watch?v=HyNlY0Z8r9g [accessed: 10.03.2023] [author's trans.].

28 Yura Fedorenko, "Na rivni tekhnologiy u nas vse ye'. Volonter 'Armiya SOS' – pro peredchuttya peremohy, steky technolohiy v armiyskykh proyektah i naypopulyarnishi ukrainski BPLA" "'In Terms of Technology, We Have Everything': Army SOS Volunteer Talks about the Anticipation of Victory, Technology Stacks in Army Projects, and the Most Popular Ukrainian UAVs") *DOU*, https://dou.ua/lenta/articles/army-sos/ [accessed: 10.03.2023] [author's trans.].

distance from the target. The units with the most favourable position promptly hit the target and then update the status or correct the data in the app. Data from rangefinders, sniper devices, and weather stations supplement the information from drones.

According to the developers, the Kropyva system has made it possible to significantly reduce the average time to deploy artillery, the time to hit an unplanned target, and the time to open fire in response to adversary strikes. Drones, along with this app, do not just register a combat operation – they take part in it. The war in Ukraine is far from a war of only machines; human soldiers on the ground play the key military role. However, drones, algorithms, and telecommunications have changed combat and deeply mediatised it. Kostiantyn Polishchuk, a photojournalist that now serves in the Ukrainian Armed Forces, notes: "This war is not about small arms; it is a war of drones and artillery. Many people who have directly taken part in battles confirm that they never fired at the enemy and have not fought face to face".[29] This war has therefore become a combination of cybernetic tools and kinetic weaponry. Their uses have crossed over each other to the extent that division between these types of military combat is no longer clear.[30]

Operational communication between all elements of this network is provided by local radios and satellite internet connection is provided by Starlink. Some clever units even came up with a solution to mount the satellite terminals on a drone and fly it into the air for better coverage.[31] The supply of Starlink satellite stations was a game changer for communications on the front line, as it provided communications that were virtually invulnerable to Russian electronic warfare. Before that, Ukrainian satellite terminals were either jammed or cyberattacked by the Russians. At the same time, this made the Armed Forces of Ukraine vulnerable to the decisions of the private company SpaceX, such as the restriction of its use near the front line in early February 2023.[32]

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29 Kateryna Iakovlenko, "Images at War: Interview with Ukrainian Photographer Kostiantyn Polishchuk", *e-flux*, December 2022, https://www.e-flux.com/notes/508561/images-at-war-interview-with-ukrainian-photographer-kostiantyn-polishchuk [accessed: 10.03.2023].

30 Cyberwar discourse and practices are analysed in: Nick Dyer-Witherford and Svitlana Matviyenko, *Cyberwar and Revolution: Digital Subterfuge in Global Capitalism*, Ann Arbor: University of Minnesota Press, 2019. How weaponry and media are merging is discussed from a media theory perspective in: Jeremy Packer and Joshua Reeves, *Killer Apps: War, Media, Machine*, Durham, NC: Duke University Press, 2020.

31 Tom Cooper, "Ukraine War, 10 February 2023", Medium post, 10 February 2023, https://medium.com/@x_TomCooper_x/ukraine-war-10-february-2023-df851175ef7b [accessed: 10.03.2023].

32 Micah Maidenberg, "SpaceX Limits Ukraine's Military Use of Starlink Satellite Business", *The Wall Street Journal*, 08 February 2023, https://www.wsj.com/articles/spacex-to-limit-ukraines-military-use-of-starlink-satellite-business-11675894401 [accessed: 10.03.2023].

Thus, the Kropyva map is continuously used to exchange data updates on the progress of combat operations in real time for a particular area of the front line. Its use is apparent in many stories about these scenes from certain parts of the battlefield. But that kind of imagery is rare in the public sphere, as the key screen here is an application that is not accessible to civilians.

However, this is still not the 'film' that Glushkov envisioned in his metaphor. In military parlance, Kropyva serves at the tactical level, meaning that it shows only one of the scenes of this 'film' from a particular area of several hundred metres to dozens of kilometres. These scenes are arranged in a sequence in the next stage.

Sequence

It was unexpected for the operator of the Neptune antiship missile system to see a large object on his radar in the Black Sea, 120 kilometres away from the Ukrainian coastline, on 13 April 2022. By its size, it could only be the flagship of the Russian Black Sea Fleet, the cruiser *Moskva*, which came notably within range of the Neptune missiles. While the Russians on their side failed to notice the missile launch, the ship was damaged and soon sank.[33] According to the Ukrainian military, the ASU Delta, an automated management system, was also used for communication and data exchange between all those involved in this combat operation.[34] But not only during this one.

Employees of nine situational centres along the front line use Delta to collect and analyse photos and streams from drones, data from dozens of Ukrainian and third countries' satellites, and information from NATO intelligence. The system also manages in what area which reconnaissance drones operate. It also indicates tasks and provides a report on the results. Such views from above are complemented by data from intercepted radio signals or posts by the Russian military on social media.

In addition to drones and reconnaissance, the situation behind enemy lines is monitored with the help of guerrillas and civilians. The Telegram chatbot eVoroh

33 Iryna Balachuk and Roman Romaniuk, "It became known how exactly Russian cruiser Moskva was discovered and sunk: details and photos", *Ukrainska Pravda* (*Ukrainian Truth*), 13 December 2022, https://www.pravda.com.ua/eng/news/2022/12/13/7380515 [accessed: 10.03.2023].

34 Tayisa Melnyk, "Viyskovyi soft DELTA teper ofitsiyno v ZSU. Vin dopomahav u vsikh velykykh operatsiyakh – vid potoplennya 'Moskvy' do zvilnennya Zmiinoho. Chomu z nym voyuvaty shvydshe" ("Delta Military Software Is Now Officially in the Ukrainian Armed Forces. It Helped in All Major Operations – From the Sinking of the Moskva to the Liberation of Zmiine. Why It Is Faster to Fight with It"), *Forbes.ua*, 04 February 2023, https://forbes.ua/innovations/twitter-dlya-zsu-viyskoviy-soft-delta-dopomagav-u-vsikh-velikikh-operatsiyakh-vid-potoplennya-moskvi-do-zvilnennya-zmiinogo-chomu-z-nim-zsu-voyuyut-shvidshe-07122022-10318 [accessed: 10.03.2023] .

(єBopor, or eEnemy), developed by the Ukrainian Ministry of Digital Transformation, is integrated into the Delta system. With its help, civilians can quickly inform the Armed Forces of the presence of the Russian military or its equipment. Over the first year of the full-scale invasion, 462,000 users have registered with the chatbot.[35] In previously occupied Kherson, a local partisan placed surveillance cameras in apartments in different parts of the city to monitor the movements of Russians. The footage was transmitted to the Armed Forces of Ukraine.[36]

The idea for Delta came from volunteers back in 2015, during the fighting in eastern Ukraine, and in 2016 the navy began using it. With the start of the full-scale invasion, it was already being actively used by other units. In February 2023, the Armed Forces of Ukraine officially incorporated it and allowed it to be deployed in the cloud outside of Ukraine for better protection against missiles and cyberattacks.[37]

All collected information is organised into catalogues and mapped according to frontline sectors covering dozens and hundreds of kilometres. This allows military commanders to register in the system and subscribe to updates from the area they need. In this way, the military can improve their 'situational awareness' of the enemy in a certain area and make decisions about further actions and the placement of their own forces. The system also helps monitor and adjust attacks on enemy positions. This way, Delta serves as a hub, integrating drone and other inputs into a sequence, as in a film, depicting an episode taking place in a certain area and time.

Delta is accessible only to a limited number of military personnel and is kept as classified as possible from prying eyes, both their own and those of adversaries. In the autumn of 2022, the Russians managed to gain access to the system through a phishing attack. Although the data they obtained was only fragmentary and quickly

35 Mintsyfra (Ministry of Digital Transformation of Ukraine), "Yak Ukrayintsi dopomahaly v borotbi z vorohom" ("How Ukrainians helped in the fight against the enemy"), Telegram post, 23 February 2023, https://t.me/mintsyfra/3842 [accessed: 10.03.2023] .

36 Hanna Mamonova and Kateryna Kobernyk, "U Khersonskyh pidlitkiv operatyvnoho dosvidu bilshe, nizh u deyakykh spivrobitnykiv spetsluzhb. Yak misto chynylo opir rosiyanam – rozkazuye pidpilnyk i mayzhe spetsahent" ("The Kherson Teenagers Have More Operational Experience than Some Intelligence Officers: How the City Resisted the Russians – An Underground Member and Almost Special Agent Tells Us"), *Babel.ua*, 07 December 2022, https://babel.ua/texts/87954-u-hersonskih-pidlitkiv-operativnogo-dosvidu-bilshe-nizh-u-deyakih-spivrobitnikiv-specsluzhb-yak-misto-chinilo-opir-rosiyanam-rozkazuye-pidpilnik-i-mayzhe-specagent [accessed: 10.03.2023] .

37 Ministry of Defence of Ukraine, "Za podannyam ministra oborony Oleksiya Reznikova Uryad pryinyav rishennya schodo zaprovadzhennya systemy Delta v Sylakh oborony, Ministerstvo oborony Ukrainy" ("Following a Proposal by Defence Minister Oleksiy Reznikov, the Government Has Decided to Introduce the Delta System in the Defence Forces, the Ministry of Defence of Ukraine"), 04 February 2023, https://www.mil.gov.ua/news/2023/02/04/oleksiya-reznikova-uryad-prijnyav-rishennya-shhodo-zaprovadzhennya-sistemi-delta-v-silah-oboroni/ [accessed: 10.03.2023].

outdated, it showed both the value and vulnerability of the sequences that are formed at this level.[38]

Film

When the Armed Forces of Ukraine began preparing an offensive in southern Ukraine in the summer of 2022, the universal gaze on the war was extremely important for decision-making. For Ukrainian commanders, it became apparent that the enemy had begun to move its forces southwards, thereby weakening the front in the Kharkiv region. The commander of the ground forces, General Oleksandr Syrsky, noticed this dynamic and eventually organised and successfully conducted an operation in this direction.

However, it was not only the panoramic view that was important but also the modelling of potential scenarios. In July, a meeting was held in Germany between the Ukrainian, American, and British militaries to conduct a wargaming session, taking into account available resources and possible attack options. This was how they planned the offensive in southern Ukraine. The plans were broader than those that were implemented. In particular, in the Zaporizhzhia region, it was planned to reach Crimea and cut the 'land corridor' between Russia and the peninsula. But after the simulations conducted during this session, it became clear that there would not be enough forces for such an operation. In the end, the Ukrainian military decided to concentrate on Kherson.[39]

In fact, the general public does not know much about the ASUs that were applied by the Ukrainian command to see opportunities and plan offensives in Kharkiv and Kherson. But it seems that systems like Dzvin-AS were designed precisely with such an idea in mind – modelling and planning large-scale military operations by analysing datasets aggregated from lower levels. The Armed Forces of Ukraine requested Dzvin-AS's development in 2016 and incorporated it in December 2022, a few weeks before the start of the invasion.[40]

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38 Yevhen Pylypenko, "Rosiya zapustyla feyk pro khakerskyi zlom Delta – unikalnoho boyovoho softu ZSU" ("Russia Launched a Fake about Hacking Delta, a Unique Combat Software of the Ukrainian Armed Forces. What Really Happened"), *LIGA.net*, 01 November 2022, https://news.liga.net/ua/politics/news/rf-zapustila-feyk-o-vzlome-delta-unikalnogo-boevogo-softa-vsu-chto-bylo-na-samom-dele [accessed: 10.03.2023] [author's trans.].

39 Isabelle Khurshudyan, Paul Sonne, Serhiy Morgunov, and Kamila Hrabchuk, "Inside the Ukrainian Counteroffensive That Shocked Putin and Reshaped the War", *The Washington Post*, 29 December 2022, https://www.washingtonpost.com/world/2022/12/29/ukraine-offensive-kharkiv-kherson-donetsk [accessed: 10.03.2023].

40 *Defense Express*, "V Ukraini pryinyato na ozbroyennya avtomatyzovanu system upravlinnya: Dzvin-AS" ("The Automated Control System Dzvin-AS Was Adopted in Ukraine"), 08 Decem-

The metaphorical 'film' that Glushkov discussed is supposed to be projected at the level where Dzvin-AS is. This is the level of strategic and operational decisions. While at the level of drone footage, one would have a top-down view of the recognisable landscape; with each zoom-out level, the picture becomes more abstract, requiring a legend to read markings; the image of the landscape turns into a topographic map, and the data increasingly turns into schematic visualisations and dashboards. The reconnaissance image is accompanied by, for example, data on troops, supply stockpiles, types and quantities of ammunition, and the logistics chain. In addition, such a system is supposed to collect combat-relevant data from civilian structures. The images become quantified into data. In high-intensity battles on a front line stretching over 1,500 kilometres,[41] the sources of information are so disparate, large-scale, and complex that they require automation tools and algorithms like Dzvin-AS to generate combat management documents, create and track maps, obtain comprehensive data on their own troops and intelligence data on enemy forces and their current and potential supply lines, and suggest the optimal use of this data in different scenarios.

The system is designed in such a way that it only aggregates data and transmits it to the level of high-ranking military commanders. This 'film' is accessible only for a limited circle. Therefore, civilians can only guess how informative and helpful it is. However, this 'film' was conceived to be projected – to construct a 'script' of potential events. In this sense, projection is something that implies future eventuality, to 'project' as a way to 'see' the future. Because it is classified, the broader public cannot see this projection and thus cannot 'see' the 'film' about the future eventuality. The only possibility for the public is to follow the post-facto results of what was projected and what decisions were accordingly made by military commanders.

The time distance between potential scenario calculations and actual events defines the essence of ASUs. According to Glushkov's concept, the shorter the time distance, the more efficient the system.[42] This is exactly the goal that the military set for such systems – quick data exchange and analysis as a way to calculate future developments and establish an advantage over the adversary. This was emphasised by the Armed Forces of Ukraine Commander-in-Chief General Valeriy Zaluzhnyi in his comments in 2020, two years before the start of the full-scale war, when one of

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ber 2022, https://defence-ua.com/news/v_ukrajini_prijnjato_na_ozbrojennja_avtomatizovanu_sistemu_upravlinnja_dzvin_as-9905.html [accessed: 10.03.2023].

41 CinCAFU (Valeriy Zaluzhnyi), "Zbroiny syly Ukrainy zvilnyly 40% zakhoplenykh pislya 24 lyutoho terytoriy…", ("Ukrainian armed forces liberate 40% of territories seized after 24 February…"), Facebook post, 02 January 2024, https://www.facebook.com/photo/?fbid=478660831096074&set=a.225687776393382 [accessed: 10.03.2023].

42 Glushkov, Dobrov, and Tereschenko, *Besedy ob upravlenii*, 36.

these systems was tested in an exercise: this was about the possibility for high commanders to receive reports on the developments of hostilities, not with a four- to six-hour lag but in nearly real time.[43] The fact that the system is perceived as a possibility for algorithmic predictive modelling is also evident in some of the comments made by the military: "If the core is made right, then even artificial intelligence can be installed on it, which will play back [or play forward?] possible solutions to the commander in this situation, I don't think it will be a problem", says Pavlo Pavlenko, Head of Operational Situation Monitoring and Automated Control Systems of the Armed Forces of Ukraine.[44] The Ukrainian Minister of Defence, Rustem Umerov, is similarly convinced that "technology will win the war".[45]

As the scale gets larger, not only does the image become more abstract and schematic. It complicates the infrastructure to combine all these modes of visuality into a comprehensive whole. The Ukrainian Army's need to develop 'eyes' became critical with the outbreak of hostilities in 2014. First, a number of volunteer solutions and then official assignments appeared at various levels to build an infrastructure of 'seeing' the adversary. In addition to Kropyva, Delta, and Dzvin-AS, the army uses about a dozen similar applications and systems at various levels: from maps and artillery calculations at the tactical group level to monitoring situational awareness and controlling combat operations at the brigade or command level – on land, at sea, and in airspace.[46] Some of these systems were created by volunteers, some were commissioned by the government, and some were developed by foreign partners. In some cases, the systems are equivalent and even compete with each other. In other cases, they complement each other or create opportunities for interoperability.

43 Defense Express, "Tsyfrova revolutsiya dlya ZSU: Na scho zdatnyi Hermes-C2 vid UaDefense" ("Digital Revolution for the Armed Forces of Ukraine: What Hermes-C2 from UaDefense is Capable of"), YouTube video, 10:44, 01 October 2020, https://www.youtube.com/watch?v=NKPs2cm_k9I [accessed: 10.03.2023].

44 Defense Express, "Avtomatyzovana systema upravlinnya viyskamy: tsyfrovyi 'Dzvin' dlya ZSU" ("Automated Troop Management System: Digital 'Bell' for the Armed Forces of Ukraine"), YouTube video, 10:43, 16 December 2019, https://www.youtube.com/watch?v=43FwNYTBlYQ, 08:41–08:49 [accessed: 10.03.2023] [author's trans.].

45 *Radio Liberty*, "'Viynu vyhrayut tekhnolohii' – ministr oborony Ukrayiny" ("'Technology Wins the war' – the Minister of Defence of Ukraine"), 29 November 2023, https://www.radiosvoboda.org/a/news-umerov-tekhnologiyi-viyna/32706700.html [accessed: 11.12.2023] [author's trans.]

46 Tayisa Melnyk, "IT-khaos na sluzhbi ZSU. Sotni tysyach viyskovykh korystuyutsya riznym softom, yakyi rozrobyly volontery. Chy nebezpechna taka detsentralisatsiya" ("IT Chaos in the Service of the Armed Forces. Hundreds of Thousands of Military Personnel Use Various Software Developed by Volunteers. Is Such Decentralisation Dangerous?"), *Forbes.ua*, 14 November 2022, https://forbes.ua/innovations/it-khaos-na-sluzhbi-zsu-sotni-tisyach-viyskovikh-koristuyutsya-riznim-softom-yakiy-rozrobili-volonteri-chi-nebezpechna-taka-detsentralizatsiya-14112022–9700 [accessed: 11.12.2023].

Some systems are only at the stage of testing, while others have already had dozens of updates, releases, and compatibility tests with NATO systems. However, steps towards universal integration for practical use at all levels are actually taking place in the process of combat.

Many of the above-mentioned systems involve specialists who are, in one way or another, connected to the cybernetics infrastructure in Ukraine. For example, the developers of the Dzvin-AS software partly originate from the aforementioned Institute of Cybernetics, founded by Glushkov.[47] This is one of the instances where Glushkov's legacy and the legacy of other Soviet cyberneticians are still present in not only the theoretical framing of how computational technology could be used in society but also the research and education infrastructures that were shaped in Ukraine since the 1960–70s by Soviet cybernetics. Therefore, the algorithms in service of the Armed Forces of Ukraine illustrate a combination of global technologies, local IT expertise with its origins in the Soviet cybernetic heritage, and the experience of military operations since 2014, when the Russian aggression in Ukraine started.

Glushkov's metaphor implies that the input data is calculated into a structured sequence of events. But one can question to what extent the 'film' projected by 'an electronic brain' will actually take place on the ground. Algorithms write a 'script' based on collected data and develop a projection of how the 'film' is supposed to evolve. But the reality on the ground does not necessarily follow the inscribed eventuality. Moreover, do the 'scripts' themselves possess the ontological capability and sufficient datasets to project future events?

Despite these efforts, this 'film' cannot provide a complete picture and take into account the complexity of the war – it cannot collect and consider everything. There will always be elements that are invisible to the system. First and foremost, this is data that intelligence has not noticed or that has changed since it was generated. Apparently, at different levels of running the system, it faces a number of difficulties that are simply impossible for outsiders to learn about – the data may be incomplete, inaccurate, or generated with errors. It is also unclear what non-military aspects of wartime reality are incorporated into the data (such as civilian casualties or infrastructure destruction).

Conclusions

As examples in this essay show, the Ukrainian military imagines and practises network-centric war strategies during the Russian invasion, with the intention of

47 Softline, "History", https://softline.company/en/about-us/history.html [accessed: 10.03.2023].

gaining an advantage based on a real-time and all-encompassing 'view from above'. Drones and algorithmic vision seem to be among the priorities at all military levels – from regular drone reconnaissance by local military units to strategic decisions by high-ranking military commanders. Despite various imperfections of the current systems, their value is rather unquestionable and anticipated as the ultimate means to gain an advantage on the battlefield.

The 'film', as Glushkov conceptualised it in his metaphor in the 1960–1970s, is supposed to show the potential course of the war. Such a metaphor distinctively enables a thinking tool to explore the imagination and infrastructure behind the algorithmic vision used in this war. In the same way as the value of aerial photography of Earth was much anticipated and imagined even before it became possible, Glushkov inspired reflections on the potential use of algorithms and computer networks for governing large-scale complex structures. In addition to the Soviet cybernetic theoretical legacy, its research and infrastructural legacy also influenced the way contemporary technologies are applied in Ukraine and who is involved in the development of multiple ASUs for the military.

These ASUs are used to aggregate drone footage as 'scenes' from particular parts of the front line, coordinate action between military units, collect reconnaissance data on adversary troops, and arrange ammunition supply logistics. Algorithmic vision, in this case, varies from images of a landscape and scoping military targets on the level of 'scenes' and 'sequences' to more abstract forms of maps or graph visualisations at the level where the raw imagery is processed and analysed into a metaphorical 'film'. Its production is a continuous process of simultaneous military action and data aggregation mixed together. Data production becomes both the result and the goal of hostilities.

Writing a 'script' for this 'film' would not mean developing a definitive storyline of the warfare but creating algorithms to collect drone footage and other sensory media input, process them, and model future eventualities in anticipation that they will project the final scene of the victory by real people on the ground and closing credits reading "The End".

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