



Military Resilience Characteristics in Modern Conflict: Lessons from the Aerial Drone Revolution

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MILITARY RESILIENCE CHARACTERISTICS IN MODERN CONFLICT: LESSONS FROM THE AERIAL DRONE REVOLUTION

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Aerial drone conflict advances with exceptional speed, accelerated by recent wars and the affordability of drone technology. All countries face the problem of how best to prepare for future war when rapid change weakens confidence in any technological choice. NATO and its members, though, have a guiding strategy of resilience. This review examines how the quest for resilience informs the search for military-technological capabilities. It stresses lessons from research on recent wars and the approaches of selected major actors in drone warfare. This review supports three recommendations for NATO and its members. One is to invest in procurement capabilities to be able to rapidly acquire the best drone weapons possible and in the military capabilities to operationalize them. Second, design for adaptability, with platforms cheap enough to be painlessly replaced or readily modified. Third, prepare to exploit existing inventories for greatest advantage. Some of the drone and counter-drone weapons that NATO and its members bring to a fight will excel; others will disappoint. Often more important than their design capabilities is how they are imagined and used. Cultivating the mental software of equipment—doctrine and training, especially—is the business of operations research. This review concludes that operations research must become the steady hand guiding drone warfare.

EXECUTIVE SUMMARY

How can NATO members best achieve resilience in their operational capabilities and ability to defend against aerial drones? Which technologies will be the foundation of security? Every NATO member faces the problem of 'getting their defence industries ready to pump out hundreds of thousands of drones or other pieces of armament in case of war, without ending up with warehouses full of obsolete kit.' In essence, these are efforts to ensure military resilience—the ability to deter or withstand a military attack—through technological investment. Military-technological resilience poses especially serious problems in planning for future aerial drone conflict.

NATO elevated resilience as a strategic concept at the 2016 Warsaw Summit, with a commitment to enhance national and collective resilience and civil preparedness. NATO's 2022 Strategic Concept reaffirmed its importance. Resilience fits especially well with efforts to build overlap between civilian and military realms, such as public support for national self-defence.

This overlap offers a framework for dealing with aspects of drone warfare, especially preventing, preparing for and defending against drone attacks. While the United States dominated the emergence of contemporary drones in the early 2000s, events elsewhere played a vital role in shaping current expectations. Wars in the 2020s in Nagorno-Karabakh and Ethiopia, examined here, were the first to demonstrate the full impact of new drone systems. Much smaller, first-person-view (FPV) drones changed the rules of conflict even more in Ukraine, where deployment, in sufficient mass in 2024, broke through a dimly understood threshold.

Massive use in Ukraine beginning in autumn of

that year shifted drones from a supporting role to the central place in armed conflict, from an ancillary to a decisive technology. Previously dominant weapons systems, including artillery and armoured vehicles, suddenly found their utility limited to special circumstances, reduced from a defining role in ground combat to an important but conditional position.

This paper does not try to offer a comprehensive review of aerial drone warfare or strategy. Its purpose is to explore the emergence of the drone challenge, compare the strategies of resilience in selected examples, and briefly evaluate paths to achieve drone military-technological resilience. While every major power is committed to aggressive pursuit of drone capabilities, their approaches and emphasis vary. The examples explored here are representative:

- For China drone resilience comes from redundancy, doing everything, expanding options, the widest spectrum of defensive and offensive options.
- For Europe drone resilience means drone defences, the technology NATO and EU members find it politically most appealing to organize and deploy.
- Russian resilience is indistinguishable from conquest and victory. Russia is the most opportunistic of major drone powers, also stressing drones' role in hybrid warfare.
- For Ukraine resilience remains about tactical stability, a synonym for national defence.

- The United States is following a similar drone strategy to China, and to a lesser degree Russia, doing everything, imitating and innovating, but the US rejects the role of hybridity.

For NATO and its members, the major problem addressed here is a consequence of the lack of global consensus, which acts as a barrier to building military-technological resilience. The drone and counter-drone weapons that NATO and its members bring to a future fight will excel in some ways, and are likely disappoint in others. What matters more than their design capabilities is how they are imagined and used. Led initially by operations research and doctrinal innovation, then by soldiers in the field, drones will become what armed forces make of them.

There are three implications here for the drone and counter drone planning of NATO and its members. One is to stay on the cusp, invest in the procurement capabilities to be able to rapidly

acquire the best drone weapons possible and the military capabilities to operationalize them without delay. Second is design for adaptability, with platforms cheap enough to be painlessly replaced or modified. Third and most complicated, be ready to exploit existing inventories for greatest advantage.

In the short run, NATO countries must expand their development and production capabilities, accelerating production, preparing to produce even more, planning and training to match and surpass visible trends. Caught in technological tides beyond any country's complete controcontrol, NATO designs and doctrines cannot be fixed. What matters more than design capabilities is how drones are imagined and used. The principal conclusion of this review is resilience comes not so much from immediate capabilities, but even more from well-poised potential. Cultivating the mental software of equipment—doctrine and training especially—is the business of operations research.

INTRODUCTION

Denmark had just suffered disastrous military defeat. The British Navy destroyed or captured the entire Danish fleet with attacks on Copenhagen in 1801 and 1807. How to rebuild Denmark's navy? Isolated by the British from its traditional sources of naval oak, on the other side of the Baltic, Denmark responded with imagination, changing the problem. It would become self-sufficient in a key naval technology of the era.

Denmark planted 30,000 hectares of oak, for some 90,000 suitable trees, mostly in Frostrup Forest in Lolland.¹ Almost two hundred years later, a forestry official, with a sense of mischief, notified the Defence Ministry; the oaks were ready. The entire tale could be dismissed as the stuff of legend, except neighbouring Sweden did the same, planting a naval forest of 300,000 oaks.²

Which technologies will be the foundation of security? In an era of accelerating technological change, virtually every country's military history, then and ever since, includes its share of comparable investment failures; costly military technological commitments that went unused, not because they intimidated their enemies nor because political change altered national priorities, but because they just did not matter. Whether they were made of stone, brass, wood, trained men, or more advanced technological revolutions, they were expensive gambles, forgotten when something more decisive came along. Lucky countries had enough money and

flexibility to adapt. Others were forced to accept painful alternatives.

The story would be more ironic if NATO countries could be certain they are not making comparable investments today. There can be no doubt that the combined 2025 NATO military budget of USD 1.588 trillion conceals a forest of virtual oaks, expensive investments never to be feared or used as hoped.³ Much like military procurement planners two-hundred years ago, we struggle today to judge which investments will become stalwarts of defence, potentially instrumental in military triumph, and which will be forgotten. There will be genius and blunders.

This dilemma is on display again as drone warfare transforms military technology—the research problem examined here. While Russia and Ukraine race, others invest—some cautiously, some boldly—but none with great confidence. The challenge is especially severe for militaries and governments heavily invested in older models of national defence, now under pressure to prepare just enough, but not too much. How can they prepare the military technology of tomorrow—without creating another Lolland forest? Every NATO country faces the problem of 'getting their defence industries ready to pump out hundreds of thousands of drones or other pieces of armament in case of war, without ending up with warehouses full of obsolete kit.' In the words of German Defence Minister Boris Pistorius '...it's senseless

¹ Beatrice Heuser alerted me to the Lolland naval forest. Heuser, *Flawed Strategy: Why Smart Leaders Make Bad Decisions*, Cambridge: Polity, 2025, p. 141. For more detail, see Janne Bavnhøj, 'Hr. Krigsminister – egen er klar til levering' [Mr. Minister of War – yours is ready for delivery], *Træ.dk*, 19 January 2005, <https://www.trae.dk/artikel/ps-hr-krigsminister-egen-er-klar-til-levering/>

² Henrik Johansson, 'Visingsö Oak Forest', *Atlas Obscura*, 17 June 2017, <https://www.atlasobscura.com/places/visingso-oak-forest>.

³ Budget total from 'Defence expenditure of NATO countries (2014-2025)', Press Release, Brussels: Nato, August 2025, https://www.nato.int/nato_static_fl2014/assets/pdf/2025/8/pdf/250827-def-exp-2025-en.pdf

today to accumulate drones worth billions of euros that will be obsolete the day after tomorrow.⁵

There is no return to the continuities of the Cold War-era technologies, when platforms lasted for decades with little more than routine maintenance and occasional refits; Instead, a new kind of confidence must be found, using technology, but not based on it. In essence, these are all efforts to ensure military resilience—the ability to deter or withstand a military attack—through technological investment. Their guiding assumptions included specific visions of war and technology. The aim and objective of this review is to show how resilience can guide NATO and its members as they navigate the challenges of drone transformation.

What the Danes were trying in Lolland was much the same as what their successors throughout NATO are trying to do today; to identify and prepare—and to be able to successfully exploit—technologies for victory in case of war. Now, as then, decision-makers applied theories of war, national and Alliance strategy to guide expensive technological choices, absorbing money and talent, precluding other possibilities.

But which technologies? With the sudden switch from a focus on counterterrorism and counterinsurgency to great power war, military planning can seem to have deteriorated into a rush at whatever seems to be working best that moment. Political leaders often yield to the temptation to demand their military commanders explain why they have not bet the farm on the gadget suddenly exciting social media.

This review focuses only on unmanned aerial vehicles, excluding ground and maritime drones for coherence. The focus comes not because aerial drones might make other forms of war obsolete—

we can be certain they won't—but because they stand out as a prominent example of emerging technology.⁶

With a history almost as old as heavier-than-air aviation, aerial drones emerged both gradually and in extraordinary bursts. Their development leapt during the Second World War and the Vietnam War. They won widespread recognition as reconnaissance tools in the 1980s. Their lethal potential was fully demonstrated in 2001, the year of the first counter-terror drone attack. That attack also illustrated the speed of drone evolution, coming just eight months after the first test of an American MQ-9 Reaper, armed with Hellfire missiles.⁷



Initially an American monopoly, highly capable drones gained momentum as global acquisition took off in the 2010s.⁸ Wars in the 2020s in Nagorno-Karabakh and Ethiopia showed the battlefield impact of new drone systems. Turkish-made Bayraktar TB2 drones were used by Ukraine immediately upon Russia's invasion. It was massive introduction of expendable Shahed long-range attack drones and first-person-view (FPV) drones, starting later in 2022, that transformed the character of warfare in Ukraine. By the winter of 2024-25, they fundamentally altered Ukrainian battles.⁹ Not until then had drones so

⁴ Rudy Ruitenberg, 'Europe ponders how to ready industry for war, without being at war', *Defense News*, 2 December 2025, <https://www.defensenews.com/global/europe/2025/12/02/europe-ponders-how-to-ready-industry-for-war-without-being-at-war/>

⁵ Quoted in Peter Carstens, Konrad Schuller, 'Putin macht kein Geheimnis aus seinen imperialen', *Phantasien*, *Frankfurter Allgemeine Zeitung*, 15 November 2025, <https://www.faz.net/aktuell/politik/inland/boris-pistorius-ueber-bedrohung-aus-russland-die-nato-kann-sich-wehren-accg-110781217.html>

⁶ Michael C. Horowitz, Lauren A. Kahn, and Joshua A. Schwartz, 'What drones can—and cannot—do on the battlefield', *Foreign Affairs*, 4 July 2025, <https://www.foreignaffairs.com/united-states/what-drones-can-and-cannot-do-battlefield>

⁷ Sue Baker, 'Predator missile launch test totally successful', *Air Force News Service*, 27 February 2001, <http://madebyfriends.co/drones/sources/predator-missile-launch-test-totally-successful.pdf>; and Stephen Grey, 'U.S. kills al Qaeda leaders by remote control', *Sunday Times*, 18 November 2001, cited in Chris Cole, 'Rise of the Reapers: A brief history of drones', *Drone Wars*, 6 October 2014, <https://dronewars.net/2014/10/06/rise-of-the-reapers-a-brief-history-of-drones/>

⁸ For example, see deployment trends in Africa, see Nate Allen, 'Military drone proliferation marks destabilizing shift in Africa's armed conflicts', *Africa Centre for Strategic Studies*, 21 April 2025, <https://africacenter.org/spotlight/drone-proliferation-africa-destabilizing/>

⁹ The Shahed is a one-way attack and reconnaissance drone developed by Shahed Aviation Industries, based on a West German design by Dornier from the 1980s. 'First Shahed-136 prototype was created in Germany in the 1980s, and it was called DAR', *Defence Express*, 14 November 2023, https://en.defence-ua.com/news/first_shahed_136_prototype_was_created_in_germany_in_the_1980s_and_it_was_called_dar-8560.html

dominated land warfare. What previously seemed a technological adjunct now dominated global attention with unimagined suddenness. It was a leap, from special roles to universal employment; from situational importance to ubiquity; from the periphery of military operations to the centre of warfare.

Much of the most incisive effort to comprehend the impact of drones on warfare comes from appeals to find the most resonant metaphor. Nobody—to the best of my knowledge—has suggested a comparison to oaken ships, but there have been useful comparisons to the Revolution in Military Affairs of the 1990s, to counter-IED efforts of the 2000s and even to contemporary ammunition accountancy.¹⁰ Such comparisons show that we are still searching for the best way to understand the technological challenge and how to address it. Does resilience offer the answers?

More than a metaphor, drone technology stands out for its intrinsic importance. But it would be wise to view it as a harbinger of technological shocks yet to arrive. Predicting these is virtually impossible. Additive manufacturing, artificial intelligence,

autonomous weapons, biological warfare, genetics, hypersonic weapons, infrastructure attacks, open-source intelligence, satellite internet constellations and quantum computing also have been suggested as momentous disrupters.¹¹

Not all emerging technologies will affect the context of warfare equally. Cyberwarfare is an example; a technology once widely feared and still far from contained, but largely accommodated within the fabric of conflict. The importance of cyberwarfare cannot be denied, but it also can be exaggerated.¹² Similarly, drone warfare is a tempting standard for comparison. Whether it can be a model for evaluation of other technologies is unknowable.

Drone debates have been a steady stream for over twenty years, as drone use evolved from a tiny number of expensive weapons to millions of deadly quadcopters. The drone metaphor cannot, on its own, reveal everything we want to know about planning for emerging technologies in conflict and military technological resilience. But it points to essential issues for immediate and longer-term defence planning.

¹⁰ Zachary Griffiths and Jeff Ivas, 'The case for treating drones as ammunition', *War On The Rocks*, 21 November 2025, <https://warontherocks.com/2025/11/the-case-for-treating-drones-as-ammunition/>; Andrew Tenbusch and Trevor Phillips-Levine, 'Ghosts of the road: what the failed war on IEDs means for drones', *War on The Rocks*, 12 November 2025, <https://warontherocks.com/2025/11/ghosts-of-the-road-what-the-failed-war-on-ieds-means-for-drones/>; and James J. Wirtz, 'Colin Gray, the RMA, and the rise of drone warfare', *Military Strategy Magazine*, vol. 10, no. 3, Fall 2025, <https://www.militarystrategymagazine.com/article/colin-gray-the-rma-and-the-rise-of-drone-warfare/>

¹¹ For example, see Tom Sauer, 'The potentially revolutionary impact of emerging and disruptive technologies and strategic conventional weapons on the nuclear deterrence debate', *EU Non-Proliferation and Disarmament Consortium*, December 2024, pp. 4-6, https://www.sipri.org/sites/default/files/2024-11/eunpdc_no_91.pdf

¹² '...policymakers should temper their expectations about the transformative potential of cyber weapons in warfare, incorporating cyber's limitations as well as its potential into simulations, training and war games. War plans should still turn on scale, speed and force concentration at decisive points against the enemy's centre of gravity while treating cyber weapons as niche assets best suited for pre-conflict operations and not as direct means to victory.' Matthew F. Calabria, 'Offensive cyber-attacks and conventional warfare', *Survival*, vol. 67 no. 4, August–September 2025. Also see Jason Healey, 'Is cyber revolutionary or barely relevant in modern warfare?' *War on the Rocks*, 28 February 2025, <https://warontherocks.com/2025/02/is-cyber-revolutionary-or-barely-relevant-in-modern-warfare/>

DEFINING MILITARY RESILIENCE

Resilience is applied here to better understand military technological decision-making. The concept is borrowed from its largely civilian, whole-of-society origins and is used here as a tool for evaluating military technologies. In addition, resilience can help us comprehend the impact of technological change in warfare and guide Alliance military planning. It is used here to examine the forces shaping the salience of military drones, how best to respond, and the outlook for large-scale investment by NATO governments.

There is nothing new about the idea of resilience, but it burst into public policy with a frenzy, and quickly was absorbed into a spectrum of unrelated fields.¹³ Resilience first appeared as an organizing principle in the early 1970s, when experts in ecology and psychology enlisted it to justify greater attention to ways to cope with adverse events.¹⁴ It was used prominently in 1989 to explain an individual's ability to adapt to adversity and failure.¹⁵

In the early 2000s, resilience was adopted by experts in climate change, as an alternative

to policies aimed at reversing climate change, and in disaster management as a principle to guide planning for the failure of prevention and preparation.¹⁶ In both climate sciences and disaster management, resilience justified shifting attention from prevention of pathological change to coping with its consequences. The great advantage of resilience was that it offered an alternative to denial in the face of failure, and a satisfying justification for devoting attention to contingencies that nobody wants to face.

The concept—the language— was quickly absorbed into more and more fields. By 2005, it seemed that everybody was studying resilience, including unrelated fields like art, business and engineering.¹⁷ A Hollywood film released the next year, 'Resilience', exposed it to mass audiences, further accelerating the idea's spread to social affairs and casual conversation.¹⁸ Security policy and security studies were slow to take it up, but gradually accepted its advantages for organizing civilian contributions. Early applications focused on resilience against terrorism and military participation in disaster management.¹⁹ Others

¹³ David E. Alexander, 'Resilience and disaster risk reduction: an etymological journey', *Natural Hazards and Earth System Science*, vol. 13, no. 11 (November 2013), pp. 2707-16, https://www.u-cursos.cl/plataforma/2015/2/VA-01-0268/1/material_docente/bajar

¹⁴ C. S. Holling, 'Resilience and Stability of Ecological Systems', *Annual Review of Ecology and Systematics*, vol. 4 (1973), pp. 1-23, <https://www.jstor.org/stable/2096802>. Especially helpful is the gestational analysis of Corey L. M. Keyes, 'Risk and resilience in human development: an introduction', *Research in Human Development*, vol. 1, no. 4 (December 1974), pp. 223-27, https://www.researchgate.net/publication/241713828_Risk_and_Resilience_in_Human_Development_An_Introduction.

¹⁵ Emmy E. Werner, and Ruth S. Smith, *Vulnerable but Invincible: A Longitudinal Study of Resilient Children and Youth*, New York: McGraw-Hill, 1989.

¹⁶ Carl Folke, et al., 'Resilience and sustainable development: building adaptive capacity in a world of transformations', *Ambio*, vol. 31, no. 5 pp. 437-40, <https://pubmed.ncbi.nlm.nih.gov/12374053/>

¹⁷ For example, Yossi Sheffi, *The Resilient Enterprise: Overcoming Vulnerability for Competitive Enterprise*, Cambridge, Massachusetts: MIT Press, 2005.

¹⁸ Jeannette Catsoulis, 'Lives of deception, revealed in extreme close-up', *New York Times*, 15 December 2006, <https://www.nytimes.com/2006/12/15/movies/15resi.html>

¹⁹ Myriam Dunn Cavelty and Tim Prior, *Resilience in security policy: present and future*, Center for Security Studies, ETH Zurich, October 2013, <https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/CSS-Analysis-142-EN.pdf>

complained it was a buzzword, appealing in security policy exactly because it resists precise definition.²⁰

NATO introduced resilience as a strategic concept at the 2016 Warsaw Summit, where the Alliance made a commitment to enhance national and collective resilience and civil preparedness. The primary goal was to engage civilian audiences across society.²¹ The Summit Communiqué stressed the NATO Baseline Requirements for National Resilience, 'which focus on continuity of government, continuity of essential services, security of critical civilian infrastructure, and support to military forces with civilian means.'²² Resilience emerged as a portmanteau term for the civilian role in Alliance and national security, potentially essential for social preparedness, support and mobilization.

Over time, NATO tried to sharpen the idea. At Warsaw, there was recognition that this required building civilian capacity to withstand attack. The emphasis was on homeland preparations against terrorism, cyber and hybrid attacks, but not at that stage, territorial defence or out-of-area contingencies.²³ Resilience was broadened in 2021, as the ability to 'anticipate and resist strategic shocks or surprises, manage consequences, fight through and ultimately outlast and prevail against adversaries. This requires a layered approach, comprising mutually reinforcing layers of military and civilian resilience.'²⁴

NATO's 2022 Strategic Concept reaffirmed resilience's importance. 'Resilience underpins our efforts to safeguard our nations, societies and shared values', it declared, the 'capacity to prepare for, resist, respond to and quickly recover from strategic shocks and disruptions, and ensure the

continuity of the Alliance's activities.' Specifically, the document called for 'resilience of the space and cyber capabilities upon which we depend for our collective defence and security.'²⁵ It sought concrete action toward more robust, Alliance-wide resilience against military and non-military threats and challenges to provide for continuity of government, the delivery of essential services to Allied populations and civil support to Allied armed forces.²⁶

How resilience applies to actual military preparations is less clear. The 2022 Strategic Concept noted the commonality between resilience and traditional security policy concepts like deterrence and defence.²⁷ But it has also been noted that there is something nebulous here, '...researchers and experts from the defence and security sphere have not yet agreed on a universally accepted theoretical framework that would explain what the application of the concept of resilience means for national and international security.'²⁸

Resilience is especially useful when thinking about problems of hybrid attacks, seemingly arising from within a society. It fits especially well with efforts to strengthen overlap between civilian and military spheres, and build public support for national self-defence.²⁹ And it readily justifies protective measures, like enhancing security against or coping with cyber-attacks, or measures to prevent attacks on civilian infrastructure like data centres, telecom cables, power infrastructure and transportation hubs.

This overlap offers a framework for dealing with aspects of drone warfare, especially preventing, preparing for and defending against drone attacks, as 'an integral part of NATO's deterrence and

²⁰ Michael Hanisch, 'What is resilience? Ambiguities of a key term', Bundesakademie für Sicherheitspolitik, 2016, <https://www.baks.bund.de/en/working-papers/2016/what-is-resilience-ambiguities-of-a-key-term>

²¹ Warsaw Summit Communiqué (2016), Permanent Representation of France to NATO, 2016, <https://otan.delegfrance.org/Warsaw-Summit-Communique-2016>

²² Warsaw Summit Communiqué (2016), *ibid.*, ¶ 73.

²³ Warsaw Summit Communiqué (2016), *ibid.*, ¶ 8, 71, 123.

²⁴ NATO Warfighting Capstone Concept, Norfolk: North Atlantic Treaty Organization, 2021, p. 15, <https://www.act.nato.int/our-work/nato-warfighting-capstone-concept/>

²⁵ NATO 2022 Strategic Concept, Brussels: North Atlantic Treaty Organization, 2023, pp. 1, 7, 25, 26, <https://www.nato.int/content/dam/nato/webready/documents/publications-and-reports/strategic-concepts/2022/290622-strategic-concept.pdf>

²⁶ Resilience Reference Curriculum. Brussels: NATO Headquarters, 21 February 2025, p. 9, <https://www.nato.int/en/news-and-events/articles/news/2025/02/21/nato-launches-the-resilience-reference-curriculum>

²⁷ Resilience Reference Curriculum, *ibid.*, p. 8.

²⁸ Resilience Reference Curriculum, *ibid.*

²⁹ Roderick Parkes, Not Withstanding? An Upbeat Perspective on Societies' Will to Fight. Rome: NATO Defence College, 29 July 2025, <https://www.ndc.nato.int/not-withstanding-an-upbeat-perspective-on-societies-will-to-fight/>; and Florence Gaub and Roderick Parkes, 'Is Europe too soft to fight?' War on the Rocks, 28 October 2025, <https://warontherocks.com/2025/10/is-europe-too-soft-to-fight/>

³⁰ 'Deterrence and defence', Brussels: North Atlantic Treaty Organization, 10 December 2025, <https://www.nato.int/en/what-we-do/deterrence-and-defence/deterrence-and-defence>

defence posture', it can also help guide societies facing the possibility of attack.³⁰ If it is accepted as a synonym for deterrence and homeland defence, resilience can provide helpful counter-drone guidance.

Resilience, as the ability to withstand and recover from stress or disruption, has a highly reactive and defensive taste. This makes it invaluable to national security, but far from sufficient. Preparing civilians for a coming drone onslaught may reduce shock and suffering. It may strengthen public resolve, though that is not certain. And there is much more to deterring and fighting drone attacks than just the ability to absorb punishment.

With its focus on resilience, this paper does not attempt a comprehensive review of contemporary military drone programmes or their use in armed conflict. The ubiquity of aerial drone technology makes this lack of clarity likely to worsen. Although there may be important exceptions, it increasingly

seems that drones are becoming synonymous with armed conflict, much like automatic rifles or grenade launchers. As of 2024, the Uppsala Conflict Data Program recorded 61 active conflicts involving at least one state.³¹ There is no reliable, comprehensive data, but it can confidently be said that most of these conflicts involve aerial drones of some type.

Similarly, the total number of drones in the inventories of the world's militaries and security agencies can no longer be estimated. In a few countries—most prominently Ukraine—total numbers are a topic for public and official discussion. In most others, led by China and Russia, totals can only be estimated. Even the United States only publicizes the scale of specific programs.³² Instead of a global picture, this review focuses on strategies of resilience and examples of paths chosen by selected actors as they navigate the Scylla and Charybdis of aerial drone opportunities and dangers.

³⁰ 'Deterrence and defence', Brussels: North Atlantic Treaty Organization, 10 December 2025, <https://www.nato.int/en/what-we-do/deterrence-and-defence/deterrence-and-defence>

³¹ 'UCDP: Sharp increase in conflicts and wars', Pressmeddelande, Uppsala Conflict Data Program, Uppsala University, 11 June 2025, <https://www.uu.se/en/press/press-releases/2025/2025-06-11-ucdp-sharp-increase-in-conflicts-and-wars>

³² For example, the Pentagon's Drone Dominance Program is intended to field more than 340,000 small drones by the end of 2027. Steve Trimble, 'U.S. Army Drone Dominance Vision Meets Reality In Training Exercises', Aviation Week, 26 February 2026, <https://aviationweek.com/defense/budget-policy-operations/us-army-drone-dominance-vision-meets-reality-training-exercises>

EMERGENCE OF THE DRONE CHALLENGE

With aerial drones, the past is prologue. It is the story of a long era of efforts to create autonomous aircraft, free of the physical constraints, physiological limits and moral awkwardness of crewed flights. Historically, successful operations had to be tailored to specific circumstances. Unmanned weapons could be autonomous but not accurate; navigable but inflexible; destructive but not affordable. It was only in the 2000s that advances in sensor and navigation performance, and in engine and control technology, solved the drone equation: autonomous, accurate, navigable, flexible, destructive, and depending on the mission, reusable.

The advantages of autonomous weapons were fully understood long before they could be made satisfactory. There still are valuable lessons to be drawn from Germany's V1 pilotless cruise missile, the buzz-bomb campaign of 1944-45, the first to feature pilotless aircraft—difficult to intercept and shocking on impact, though not exceptionally destructive. Armaments Minister Albert Speer later confessed it was a waste of resources.³³ That was partly because it could not be deployed on the scale imagined, and partly because of poor accuracy. Even so, 30,000 were built and 9,251 launched at Britain. Of those, 2,515 reached London, killing 6,184 and injuring 17,981.³⁴ As British leaders recognized at the

time, the losses were sustainable over a period of eight months. Attacks by V weapons failed more fundamentally because they actually strengthened British resilience, above all strengthening public solidarity.³⁵

It was better guidance and control that made drones reliable weapons. In the Vietnam War, the United States employed Ryan jet-powered drones with general success, made possible partly by technical advances and partly by the limited requirements of its reconnaissance mission. Ryan drones also introduced reusability. Contemporary efforts to weaponize cruise missiles and glide bombs were generally successful, but the results were expensive and hard to reproduce. American laser-guided bombs proved effective in raids such as the Thanh Hoa bridge attack in 1972. None of those systems were reusable.

It was conventionally armed Tomahawk cruise missiles, debuted in combat against Iraq in 1991, that showed how an unpowered aircraft could be used against a variety of targets. In use to this day, the Tomahawk is limited largely by cost. Even after its original inertial and terrain-matching guidance was replaced with GPS, it remains a fire-and-forget weapon. Today it can be retargeted in flight, with some of the flexibility of a multi-use drone.³⁶

³³ Albert Speer, *Inside the Third Reich*, Richard and Clara Winston, trans. New York: Simon and Schuster, 1970, pp. 365-66.

³⁴ Rick Atkinson, *The Guns at Last Light: the War in Western Europe, 1944-1945*. New York: Henry Holt, 2013, pp. 107, 110; and Sebastien Roblin, 'The Nazis built 30,000 V-1 'Buzz Bombs' to terrorize London into submission', *National Interest*, 8 December 2019, <https://nationalinterest.org/blog/buzz/nazis-built-30000-v-1-buzz-bombs-terrorize-london-submission-it-didnt-work-out-way>

³⁵ R. V. Jones, *Most Secret War: British Scientific Intelligence 1939-1945*. London: Hamish Hamilton, 1978, ch. 44. Jones was more impressed with the buzzbomb than Speer, writing 'As it was, an analysis of the economics of the campaign showed a large balance in the German favour: the cost of our countermeasures, especially in bombing the sites, exceeded the estimated cost of the campaign to the Germans.'

³⁶ Tamir Eshel, 'Tomahawk Cruise Missiles to become dual mission, assume anti-ship role', *Defence Update*, 17 January 2017, https://defense-update.com/20170117_tomahawk-2.html

MQ-9 Reaper drone, introduced in 2001, combined the accuracy and range of previous cruise missiles with opportunistic retargeting and in-flight control. Unlike cruise missiles, it carried pylon-mounted munitions, typically Hellfire missiles, making it reusable. As the United States reduced its ground combat in Afghanistan, Iraq, Somalia, and Syria, and elsewhere in the Middle East and North Africa, Reapers carried more of the burden of counter-terrorism operations.

With limited technical resilience, the key to drones' contribution is uncontested airspace. Against enemies with almost any high-altitude air defence, Reaper-type drones and their technological brothers are vulnerable to interception. In Houthi-controlled northern Yemen, the United States lost roughly twenty Reapers in 2023-25, illustrating the seriousness of the air defence problem. They probably were shot down by Iranian-type Barq-1 and -2 SAMs, based on the Soviet SA-6 (2K12 Kub), a design from the early 1960s, adapted and probably supplied by Iran.³⁷ Neither the Houthis nor the United States displayed great sensitivity to their losses in the confrontation, which were significant without being decisive. The American losses did not end foreign interest in the Reaper and its relatives. Countermeasures have improved, and long-duration drone missions remain important. Buyers continue to procure medium-altitude long-endurance unmanned aerial vehicles (MALEs),³⁸ but their use now is limited to situations where air dominance is more assured.

While the United States led the emergence of contemporary drones, events elsewhere played an equally vital role in shaping expectations. American employment inspired a global appetite, but Washington's strategic hesitance to sell Reapers created opportunities for less inhibited exporters. Many countries moved to fill the export gap, led by China, Iran, Israel, Türkiye and the UAE. Already in 2019, roughly 100 countries deployed some kind of military drone. Even at that point, just before what turned out to be a global pivot, an estimated 30,000 or more unmanned military aerial vehicles were in service worldwide. The vast majority were smaller, cheaper models for monitoring and intelligence collection.³⁹ Even then, such estimates were confusing at best, equating large, fully weaponized MALE platforms and tiny commercial adaptations.

The pivot originated in Türkiye, where Bayraktar TB2 drones were instrumental in battlefield success in Syria. In the same class of weapons systems as the American Reaper, it is smaller, but has many of the same capabilities, for roughly one-fifth the cost.⁴⁰ Small commercial drones had previously been used in the region, adapted for use by Daesh/ISIL, albeit indecisively. They were outclassed by the Turkish Air Force in operations against PKK terrorists. Early operations were not easy. The Bayraktar TB2 was effective but initially did not stand out in a growing drone market. Several were shot down.⁴¹



³⁷ Joseph Trevithick, 'What air defences do the Houthis in Yemen actually have?' War Zone, 23 April, 2025, <https://www.twz.com/news-features/what-air-defenses-do-the-houthis-in-yemen-actually-have>

³⁸ Agnes Helou, 'Saudi Arabia in talks to buy as many as 200 MQ-9 drones, General Atomics says', Breaking Defence, 21 May 2025, <https://breakingdefense.com/2025/05/saudi-arabia-in-talks-to-buy-as-many-as-200-mq-9-drones-general-atomics-says/>; and Jaroslaw Adamowski, 'Poland buys Sky Guardian drones as it readies to launch 'Drone Force'', Defence News, 13 December 2024, <https://www.defensenews.com/global/europe/2024/12/13/poland-buys-sky-guardian-drones-as-it-readies-to-launch-drone-force/>

³⁹ Warren P. Strobel, 'Military drones now common to nearly 100 nations, report finds', Wall Street Journal, 25 September 2019.

⁴⁰ Mustafa Enes Esen, Engin Büker and Yüksel Akkale, 'The proliferation of Bayraktar TB2 drones and their risks', Institute for Diplomacy and Economy, 7 April 2023, <https://www.institute.org/analysis/the-proliferation-of-bayraktar-tb2-drones-and-their-risks>

⁴¹ Frank Christian Sprengel, Drones in hybrid warfare: Lessons from current Battlefields, The European Centre of Excellence for Countering Hybrid Threats, June 2021, pp. 16-17, 23, <https://www.hybridcoe.fi/publications/hybrid-coe-working-paper-10-drones-in-hybrid-warfare-lessons-from-current-battlefields/>

Perceptions changed after the starring role in Azerbaijan's offensive against Armenia in the Second Nagorno-Karabakh War, September–November 2020. Azerbaijan had several strategic advantages. It was better financed and prepared; it initiated the war and took Armenian defenders by surprise. Azerbaijan was better armed generally and enjoyed more dependable support from foreign arms suppliers. Among its most important imports were Bayraktar TB2 and operational support services.⁴²

The Bayraktar TB2s emerged as the decisive weapons of the Second Nagorno-Karabakh War, initially used to destroy Armenian air defences, then turned against Armenian armour and artillery, with great success. Operating assistance from Türkiye was an important contributor, and possibly from Israel too.⁴³ Of greatest relevance here was the number of drones involved. Estimates vary, but none report Azerbaijan had more than twelve Bayraktar TB2s.⁴⁴ With an investment of roughly USD 60 million, Azerbaijan achieved battlefield dominance. Armenia lacked comparable weapons and found itself paralysed by punishing losses of its major weapon systems, unable to respond except by retreating.

The war was widely seen as a window on conflicts to come, with medium-altitude, long-endurance drones in the foreground. It triggered a global rush to comparable systems.⁴⁵ Among the sudden buyers was Ethiopia, which deployed Bayraktar TB2s with great effect in its civil war with Tigrayan rebels.

In the first stage of the war, the Tigray People's Liberation Forces advanced within 200 kilometres of Addis Ababa. The Ethiopian National Defence Forces responded with a counter-offensive,

supported by drones led with drones from China, Iran, UAE and most famously from Türkiye. The Tigrayans, well equipped except for lack of their own drone force or substantial air defences, were unable to respond resiliently.⁴⁶ The victor's euphoria was captured by Ethiopian army chief field-marshal Birhanu Jula, who exclaimed, 'Drones were made for war! We purchased them for battle, not to parade them in the media...If we find groups of extremists, we will strike them!'⁴⁷

Of greatest relevance here, again, is the number of drones involved in Ethiopia. Estimates of the total number of Bayraktar TB2s operated by the Ethiopian National Defence Forces during the war range from three to four.⁴⁸ In retrospect, the scale Azerbaijani and Ethiopian drone forces seems comical. But there is no denying their decisiveness.

Defeat of Armenia and Tigrayan separatists taught profound lessons about drone technology and military technological resilience. There are other examples, such as Houthi-controlled Yemen's apparent mastery of the production of Iranian-style long-range attack drones, and its apparent imperviousness to counterattacks.

For pure economy, the examples of Azerbaijan and Ethiopia are especially revealing. In the proportion of results for their investment, their drones were the equal of battleships one hundred years earlier, arguably as decisive as tactical nuclear weapons are imagined to be. There is no comparison to the historical cost of battleships or the availability of tactical nuclear weapons. The cost and acquisition barriers for MALE drones are of a different—and far smaller—order of magnitude, with no serious forces limiting their proliferation. These two conflicts sent lessons about the transformation of air power, clear for every military planner to see.

⁴² Dan Sabbagh, 'UK wants new drones in wake of Azerbaijan military success', *Guardian*, 29 December 2020, <https://www.theguardian.com/world/2020/dec/29/uk-defence-secretary-hails-azerbaijans-use-of-drones-in-conflict>

⁴³ The Azerbaijan–Armenia conflict hints at the future of war', *The Economist*, 8 October 2020, <https://www.economist.com/europe/2020/10/08/the-azerbaijan-armenia-conflict-hints-at-the-future-of-war>

⁴⁴ According to the International Institute for Strategic Studies, Azerbaijan had at least six Bayraktar TB2s. SIPRI records twelve. See *The Military Balance 2025*, London and Abingdon: International Institute for Strategic Studies and Routledge, 2025, p. 171; and SIPRI Arms Trade Database, Stockholm: Stockholm International Peace Research Institute, 2025, <https://armstransfers.sipri.org/ArmsTransfer/TransferData/>

⁴⁵ Sabbagh, 'UK wants', *op. cit.*

⁴⁶ Zecharias Zelalem, 'Deadly skies: drone warfare in Ethiopia and the future of conflict in Africa,' Policy Brief, European Council on Foreign Relations, February 2025, <https://ecfr.eu/publication/deadly-skies-drone-warfare-in-ethiopia-and-the-future-of-conflict-in-africa/>

⁴⁷ Zelalem, 'Deadly skies', *op. cit.* Also see 'Africa's scary new age of high-tech warfare', *The Economist*, 19 June 2025, <https://www.economist.com/middle-east-and-africa/2025/06/19/africas-scary-new-age-of-high-tech-warfare>

⁴⁸ According to the International Institute for Strategic Studies, Ethiopia had three Bayraktar TB2s. SIPRI records four delivered in 2021. See *The Military Balance 2025*, London and Abingdon: International Institute for Strategic Studies and Routledge, 2025, p. 473; and SIPRI Arms Trade Database, Stockholm: Stockholm International Peace Research Institute, 2025, <https://armstransfers.sipri.org/ArmsTransfer/TransferData/>. But there is a picture of five TB2s in Ethiopia in Zelalem, 'Deadly skies', *op. cit.*

YEAR OF THE DRONE PANIC

Ukraine's early use of a dozen Bayraktar TB2 aerial drones was not so much a break with the past as a continuation of trends seen since Afghanistan in 2001, reaffirmed in Nagorno-Karabakh and Ethiopia.⁴⁹ Early impressions were mixed. In the days and months after the Russian invasion, the hottest military commodity in the world was not drones, but 152mm and 155mm artillery rounds.⁵⁰

The drones of February 2022 were a straightforward alternative to conventional artillery and air-to-ground capabilities, doing an old job with greater precision. Even Russia's much larger use of Iranian Shahed drones (designated Geran-2 in Russia), hugely destructive against Ukrainian cities, did not greatly alter older employment doctrines. These drones were used for specific roles, under specific

circumstances. Like Tomahawk cruise missiles, they add range and accuracy to the battlefield and promise assured conventional destruction, but they did not challenge older tactical thinking about manoeuvre or attrition. They even have many of the same vulnerabilities as older systems.⁵¹

Ironically, it wasn't big drones that changed the rules in Ukraine, but little ones. Much smaller, first-person-view (FPV) drones had been present there since 2022, but were deployed in sufficient mass only in 2024, breaking through a dimly understood threshold. Mass use by Ukraine in autumn of that year shifted drones from a supporting role to the central place in armed conflict, from an ancillary to the decisive technology.



⁴⁹ At the time of the Russian invasion, Ukraine had approximately twelve Bayraktar TB2 drones. SIPRI Arms Trade Database, Stockholm: Stockholm International Peace Research Institute, n.d., <https://armstransfers.sipri.org/ArmsTransfer/TransferData/>

⁵⁰ Sam Skove, 'In race to make artillery shells, US, EU see different results', *Breaking Defence*, 27 November 2023, <https://www.defenseone.com/business/2023/11/race-make-artillery-shells-us-eu-see-different-results/392288/>

⁵¹ Elisabeth Gosselin-Malo, 'Are the once-vaunted Bayraktar drones losing their shine in Ukraine?' *Defense News*, 31 October 2023, <https://www.defensenews.com/global/europe/2023/10/31/are-the-once-vaunted-bayraktar-drones-losing-their-shine-in-ukraine/>

Previously dominant weapons systems, including artillery and armoured vehicles, suddenly found their utility limited to special circumstances, reduced from a defining role in ground combat to an important, but ancillary position. C.J. Chivers noted that 'no previous conflict had involved drones used so extensively by two sides, in so many forms or in so many roles... 90 per cent of the Russian equipment that was destroyed by Ukraine was destroyed by drones.'⁵² According to a Ukrainian parliamentary leader, 'Drones, not the big, heavy artillery that the war was once known for, inflict about 70 per cent of all Russian and Ukrainian casualties... In some battles, they cause even more.'⁵³ Ukraine's national survival, it was widely accepted, had come to depend on drones, in part to compensate for its smaller numbers of soldiers. But drones also caused most of its suffering.

In October 2024, President Zelensky announced that Ukraine had built one million small FPV drones within eight months, albeit relying almost entirely on parts imported from China.⁵⁴ Ukraine also produced 25 times more artillery and mortar ammunition during this period than in the entire year of 2022, but nobody cared as much about that anymore. It was the drone goal, soon rising to a planned four million drones annually, that got global attention.⁵⁵ That implies that over half of Ukraine's drones are now sourced domestically. Ukrainian procurement could go above 10 million annually, if it has the funds. Then Ukraine would outproduce China to become the world's largest drone maker.⁵⁶ For the first time since the JDAM was introduced in Kosovo in 1999, the Reaper in Afghanistan in 2001, and IEDs in Iraq in 2003, a newly decisive weapon is at work.⁵⁷

Rising awareness in 2024 created its own global social momentum. The result was an international drone frenzy. In November-December 2024, for example, unexplained drone sightings were reported in at least seven American states, often at airports, military bases, nuclear power stations or other restricted airspace.⁵⁸ It soon became apparent the phenomenon was partly due to overexcitement. Sometimes drones were indeed present, albeit for official or otherwise approved purposes. The reports reflected the kind of hysteria associated with UFO sightings.⁵⁹ The events do not appear to have been hybrid warfare.

Even if the specific incidents are exaggerated, events the following year showed that heightened concern is justified. Drone smuggling emerged as a major tactic for surprise attacks. First came the Ukrainian 'Spiderweb' attacks on 1 June 2025, targeting Russian strategic and long-range aviation, destroying at least ten strategic aircraft in bases as far as 4,500 km from Ukraine. On 12 June 2025, Israel appears to have used drone smuggling to launch attacks on leadership targets in Iran.⁶⁰

For NATO members, the most alarming events came on 9 September 2025, when roughly twenty Russian drones overflew Ukraine into Poland, forcing the closure of four Polish airports. NATO fighter planes from the Netherlands were scrambled. Several drones were shot down. The rest crashed across Poland, scattering debris.⁶¹ These were Shahed reconnaissance or decoy drones with a maximum range of roughly 2,500 km (1,550 miles). That the Russian drones were unarmed is the strongest indication that they were not strays bound for Ukraine, but intelligence

⁵² C. J. Chivers, 'How suicide drones transformed the front lines in Ukraine', *New York Times*, 31 December 2025, <https://www.nytimes.com/2024/12/31/magazine/drones-weapons-ukraine-war.html>

⁵³ Marc Santora, et al., 'A thousand snipers in the sky: the new war in Ukraine', *New York Times*, 3 March 2025, <https://www.nytimes.com/interactive/2025/03/03/world/europe/ukraine-russia-war-drones-deaths.html>

⁵⁴ Chivers, *op.cit.*

⁵⁵ Volodymyr Zelenskyy, 'Thanks to its defence industries, Ukraine is set to become one of the key global contributors to security – Volodymyr Zelenskyy', *President of Ukraine*, 1 October 2024, <https://www.president.gov.ua/en/news/zavdyaki-oboronnim-industriyam-ukrayina-maye-stati-odnim-iz-93617>

⁵⁶ Gillian Tett, 'How drones have changed the nature of war', *Financial Times*, 20 September 2025, <https://ft.pressreader.com/v99e/20250920/281724095709627>

⁵⁷ The JDAM dominated Kosovo battlefields and featured in the mistaken attack on the Chinese Embassy in Belgrade. On the impact of JDAM in Kosovo and Serbia, Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operation Assessment*. Santa Monica: RAND Corporation, 2001, pp. 91-98, 144-47, https://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1365/RAND_MR1365.pdf

⁵⁸ Ariana Baio, 'Mapped: all the locations of mass drone sightings in the last week', *Independent*, 16 December 2024, <https://www.independent.co.uk/news/world/americas/drone-sightings-map-new-jersey-b2666334.html>

⁵⁹ Dave Collins and Mike Catalini, 'Drone detectors in New Jersey have found 'little or no evidence' of wrongdoing, Governor says', *Associated Press*, 17 December 2024, <https://apnews.com/article/drones-mystery-new-jersey-york-b37fda04755803392178b1f39b76ccd8>

⁶⁰ Lara Jakes, 'First Ukraine, now Israel: drone smuggling is potent new war weapon', *New York Times*, 14 June 2025, <https://www.nytimes.com/2025/06/14/world/middleeast/drones-smuggled-israel-iran-ukraine-russia.html>

platforms or classic warning shots. Even unarmed, the mere fact of the incursion would prove catalytic for European security planning. Poland called a NATO Article Four meeting of the North Atlantic Council, for official consultation, and a meeting of the UN Security Council.⁶²

A smaller but comparable drone incident was the launch of a drone targeted at the French aircraft carrier, the Charles de Gaulle, while it was docked in the southern Swedish port of Malmö on 25 February 2026. The flight from a Russian intelligence-gathering ship triggered countermeasures from a Swedish navy ship nearby.⁶³ The incident stood out for its relative clarity.

More typical were the mysterious drone sightings in October 2025, reported across Central and Western Europe. Multiple incidents were reported in Belgium, Denmark, France, Germany and Poland, and less frequently in Bulgaria, Czechia, Estonia, Finland, Lithuania, Moldova, Norway and Sweden. The identity of those responsible, and the launch sites of most of these drones, remains unknown. There have been no verified public reports of these drones being captured or destroyed. This makes their origins unknowable, as intended. Depending on their size, they could have been launched domestically, from Belarus, from Russian Kaliningrad or even from contiguous Russia.⁶⁴

Belgian Defence Minister Theo Francken confirmed in November 2025 that unidentified drones were observed flying near the Kleine-Brogel airbase, believed to host US nuclear weapons.⁶⁵ In December 2025, at least five unidentified drones flew over France's Ile Longue submarine base in Brest, harbour of the country's strategic nuclear missile submarine fleet, as confirmed by the Gendarmerie Nationale. Citing lack of evidence, Defence Minister Catherine Vautrin refused to attribute responsibility for the intrusions.⁶⁶

Greatly complicating assessment in NATO members is the problem of Russian hybrid attacks, designed for ambiguity and deniability, intended to affect public attitudes by undermining confidence of national security institutions.⁶⁷ In the words of Blaise Metreweli, Chief of the United Kingdom's Secret Intelligence Service (MI6), 'Russia is testing us in the grey zone with tactics that are just below the threshold of war. It's important to understand their attempts to bully, fearmonger and manipulate, because it affects us all.' She went on to explicitly note 'Drones buzzing airports and bases', among various Russian organized provocations.⁶⁸ In many cases—such as in Belgium and France—we have specific confirmation from national officials; the drone overflights occurred and were not authorized by state security agencies. But were they the work of pranksters or political activists, or were they organized by Russia or a Russian ally? In all likelihood, the uncertainty is the point.

⁶¹ Maciej Miłosz, 'Rosyjskich dronów było ponad 20. Strzelały głównie holenderskie F-35 [There were over 20 Russian drones. The shots were fired mainly by Dutch F-35s]', *Rzeczpospolita*, 10 September 2025, <https://radar.rp.pl/przemysl-obronny/art42986931-rosyjskich-dronow-bylo-ponad-20-strzelały-głównie-holenderskie-f-35>

⁶² 'Poland moves to invoke NATO Article 4 after airspace violation', *The Chancellery of the Prime Minister, Republic of Poland*, 10 September 2025, <https://www.gov.pl/web/primeminister/poland-moves-to-invoke-nato-article-4-after-airspace-violation> ; 'Emergency briefing on drone incursion into Poland', *Security Council Report*, 12 September 2025, <https://www.securitycouncilreport.org/whatsinblue/2025/09/emergency-briefing-on-drone-incursion-into-poland.php>

⁶³ 'Sweden says it intercepted Russian drone during visit by French aircraft carrier', *Associated Press*, 27 February 2026, <https://apnews.com/article/sweden-france-aircraft-carrier-drone-russia-c8905513cb9ade27176a88ef642411b7>

⁶⁴ Frank Gardner, 'Mysterious drones have been spotted at night at airports across Europe. How worried should we be?' *BBC News*, 17 November 2025, <https://www.bbc.com/news/articles/crkl3d6pegpo>

⁶⁵ Shaghayegh Chris Rostampour, 'Drone incursions in Belgium spark probes, NATO-EU response', *Arms Control Today*, December 2025, <https://www.armscontrol.org/act/2025-12/news/drone-incursions-belgium-spark-probes-nato-eu-response>

⁶⁶ Rudy Ruitenberg, 'Drones fly over French strategic nuclear submarine base, media report', *Defense News*, 5 December 2025, <https://www.defensenews.com/global/europe/2025/12/05/drones-fly-over-french-strategic-nuclear-submarine-base-media-report/> ; and Chloé Hoorman and Elise Vincent, 'France opts for discretion after drones spotted above naval base', *Le Monde*, 6 December 2025, https://www.lemonde.fr/en/international/article/2025/12/06/france-opts-for-discretion-after-drones-spotted-above-naval-base_6748219_4.html

⁶⁷ Sam Jones, 'Russia's escalating hybrid warfare', *Financial Times*, 9 December 2025, <https://ft.pressreader.com/v99e/20251209/281758455610365>

⁶⁸ 'Speech by Blaise Metreweli, Chief of SIS', *Gov.UK*, 15 December 2025, <https://www.gov.uk/government/speeches/speech-by-blaise-metreweli-chief-of-sis-15-december-2025>

WHICH DRONE WAR?

Technological resilience is fundamentally about coping: about choices that technology itself will not make for us. Although technology is often portrayed as an inhuman force that makes us powerless victims—able only to adapt to trends beyond our control—scholars are adamant in rejecting such technological determinism.⁶⁹

Civilian processes, seemingly driven by markets, taste and regulation, can help guide military expectations. But regardless of today's commonplace reliance on civilian technology, armed conflict follows different rules from civilian business. It is only through deliberate choice that military technological prioritization happens: national strategy, warfighting doctrine, official specifications and procurement decisions.

It would be much easier if the technologies could do the prioritizing for us. But technological change—even the most abrupt—almost never takes us neatly from one environment to another. The shock of the new does not clean away the old. Military technologies rarely become obsolete or useless. Even the hoariest relic keeps its virtues and has some advantages over any potential replacement. Under the right circumstances, even the oldest piece of hardware can be revived.

Spotting the reemergence of battlefield antiques is a minor sport for soldiers and journalists. The bayonet remains an ultimate metaphor of military timelessness, but it is far from unique. In Afghanistan, NATO soldiers faced Taliban marksmen shooting Lee-Enfield bolt-action rifles, the kind introduced in 1895.⁷⁰ American and Russian strategic bombers designed in the 1950s are still operating, updated—stunning in their permanence. In 2020 and 2022, China and India fought battles for border control with maces. In 2024, an Israeli unit rediscovered the utility of the trebuchet.⁷¹

Gramsci wasn't thinking about lethal technology, but he understood the general problem: 'The old world is dying, and the new world struggles to be born: now is the time of monsters.'⁷² He meant political systems, but any observer of contemporary battlefields will recognize his words. The old order remains important enough that we must give it our full attention, even as we watch something unprecedented emerge.

Perhaps the greatest lesson of recent wars for NATO members, trying to make sense of battlefields littered with old and new, is the problem of multiplication. Old technology rarely becomes obsolete, but only a fool would disregard what

⁶⁹ For example, George Raudzens, 'War winning weapons: the measurement of technological determinism in military history', *Journal of Military History*, vol. 54, no. 4 (October 1990), pp. 403-34, <https://www.jstor.org/stable/i307992>

⁷⁰ Steve Johnson, 'Enfield rifles again finding favour in Afghanistan', *The Firearms Blog*, 26 January 2009, <https://www.thefirearmblog.com/blog/2009/01/26/enfield-rifles-again-finding-favor-in-afghanistan/>

⁷¹ 'Galwan Valley: image appears to show nail-studded rods used in India-China brawl', *BBC News*, 18 June 2020, <https://www.bbc.com/news/world-asia-india-53089037>; Seth J. Frantzman, 'Why a unit in Israel's IDF purportedly used a medieval trebuchet against Hezbollah', *Breaking Defence*, 13 June 2024, <https://breakingdefense.com/2024/06/why-a-unit-in-israels-idf-purportedly-used-a-medieval-trebuchet-against-hezbollah/>

⁷² Slavoj Žižek, 'How the left misread Gramsci', *New Statesman*, 26 November 2025, <https://www.newstatesman.com/ideas/2025/11/how-the-left-misread-gramsci>

is newest and most lethal. Strategy requires a sense of priorities to be coherent, not necessarily expressed in simple policy choices, but at least in terms of preferences, however hedged. In this disorder, military technological resilience emerges not as a redoubt for those fleeing mistakes, but as a guardian of careful risk-takers. A review of how China, Europe and Russia are adapting to drones reveals that more countries are navigating the drone transition through a combination of hedging and experimentation.

China's full spectrum

Nobody would suggest that China is typical of anything, but the obscurity of its aerial-drone program is not exceptional. This is partly due to official obfuscation, but it also reflects a common avoidance of prioritization. Rich, with little incentive to choose, China's drone and counter-drone programmes are broad. Its priorities are elusive, probably because they have yet to be made. President Xi Jinping's campaign against military corruption helps keep policy debates quiet. Instead, it is the products themselves that are most revealing.

In 2019, President Xi called on the People's Liberation Army to 'accelerate its drone warfare research and training.' Soon after, the PRC National People's Congress released its Fourteenth Five-Year Plan, covering 2021-25. This stated that 'future wars will be uncrewed and intelligent'. The plan called for 'steadily advancing 'national defence and military construction' to meet this need. Drone development became a priority for research institutes, business and state-owned enterprises. One 2023 industry report estimated that Chinese military spending on UAVs rose 67 per cent following the release of the Fourteenth Five-Year Plan. It argued that 'increased domestic demand for military drones is driven by policy.'⁷³

The effects of official policy and market opportunity are readily seen. China is said to be responsible for eighty per cent of global production

of smaller, first-person-view drones.⁷⁴ Those come overwhelmingly from a single civilian firm. The Chinese manufacturer DJI is said to control ninety per cent of the global consumer drone market. That statistic is more often repeated than analysed, but the general point is irresistible. The Shenzhen-based company's FPV drones were created for hobbyists and businesses and now serve both sides in the Russia-Ukraine war for reconnaissance and attack.⁷⁵

Chinese dominance of the commercial market makes its militarily role central, to the point that many countries are struggling to reduce their dependence. While Russia seems comfortable relying on drone imports from its close ally, Ukraine is racing to become 'China-free', a major motive in its campaign to build perhaps twenty million annually.⁷⁶ If it succeeds, it would almost certainly be the first major buyer to do so.

The most publicized Chinese programs focus on larger vehicles. A prominent example is China's CH-7, a large, high-altitude, high-speed reconnaissance drone with a stealthy flying-wing configuration.⁷⁷ Large drones featured prominently in the 80th anniversary Victory Day Parade in Beijing on 3 September 2025, celebrating the defeat of Japan in 1945. Among the examples on display were the Hongdu GJ-11 Sharp Sword stealth unmanned combat aerial vehicle (UCAV), the CAIG Wing Loong II medium-altitude long-endurance unmanned combat aerial vehicle, and several stealthy flying-wing and less stealthy air-combat drones.⁷⁸

China also appears highly active in counter-drone weaponry. It's defence marketplace reportedly features more than 3,000 manufacturers producing anti-drone equipment in various form, highlighting the strategic importance placed on this domain. Recent procurement data also reveal a steady rise in contracts for counter-drone systems. The PLA is investing across the spectrum, from AI-based detection, and decision-making, to laser and microwave interception. The number

⁷³ Timothy Ditter, 'China readies drone swarms for future war', Centre for Naval Analyses, 24 September 2025, <https://www.cna.org/our-media/indepth/2025/09/china-readies-drone-swarms-for-future-war>

⁷⁴ Gillian Tett, 'How drones have changed the nature of war', Financial Times, 20 September 2025, <https://ft.pressreader.com/v99e/20250920/281724095709627>

⁷⁵ Zeyi Yeng, 'Why China's dominance in commercial drones has become a global security matter', MIT Technology Review, 26 June 2024, <https://www.technologyreview.com/2024/06/26/1094249/china-commercial-drone-dji-security/>

⁷⁶ Tett, 'How drones have changed', op.cit.

⁷⁷ Liu Xuanzun and Ma Jun, 'China's CH-7 high-altitude, high-speed drone makes maiden flight', Global Times, 15 December 2025, <https://www.globaltimes.cn/page/202512/1350559.shtml>

⁷⁸ '2025 China Victory Day Parade', Wikipedia, n.d., https://en.wikipedia.org/wiki/2025_China_Victory_Day_Parade#

of procurement notices, requests for proposals, has risen from 87 in 2022 to 205 in 2024.⁷⁹ The Parade also featured examples of the OW5, a laser weapon designed to intercept low-altitude, slow-moving targets, the FK-3000 short-range air defence system, and the Hurricane 3000, a high-power microwave air defence system.⁸⁰

While the products are readily seen, the goals of China's military investment are obscure. Is China striving to enhance the resilience of its cities; to strengthen its ground forces' ability to manoeuvre offensively; or to achieve an export breakthrough? The technology alone doesn't answer these questions. Foreign audiences, and Chinese leaders themselves may fully appreciate what these programmes achieve only as their deployment matures.

China's intentions maybe hazy, but its potential is crystal clear. Perhaps most impressive is the breadth of China's development programmes. Chinese leadership in commercial drone making is absolute. If one looks only at military unmanned aircraft programs—a dubious shortcut—direct comparison shows China and the United States working at comparable levels. Both sponsor comparable high-end drone programs, including reconnaissance, transport, air-superiority and combat strike models.⁸¹ China appears to lead the world in construction of prototypes for counter-drone warfare, although this area remains exceptionally dynamic.

Europe's resilient defence

One day after Russia's drone incursion into Poland, European Commission President Ursula von der Leyen spoke in favour of a massive system

of networked drone defences. In a previously scheduled speech, that was quickly tweaked, she said 'We must heed the call of our Baltic friends and build a drone wall... Europe will defend every inch of its territory.'⁸²

As von der Leyen said, the proposal for a counter-aerial drone barrier was not new, but the resolve was sudden. The initiative for a defensive belt from the Baltic to the Black Sea is an ideal packaging of military technological resilience. Few could doubt the scale of the problem or the need for action. European countries already were investing heavily in defensive systems. These would have to be integrated and built up into a multi-layered system: radars, sonic and optical sensors to detect and track incoming drones, with electronic countermeasures and interceptors to incapacitate or destroy them.

But questions came fast. Western Europeans worried that the proposal overlooked their own vulnerabilities. France, Germany, Italy and Spain resisted efforts by the EU Commission to lead on the issue. Their initial response was an almost perfect regression to the mean of European defence politics; demand clarification, slow the pace of collective action and preserve national control over defence projects.⁸³ Other observers heard only the word 'wall' and reflexed with Maginot clichés.⁸⁴ Von der Leyen struggled to defend her proposal, later reassuring, 'This anti-drone system will be a shield for our entire Union.'⁸⁵ It was only somewhat helpful when the European Commission rebranded the proposed drone wall the *European Drone Defence Initiative*.⁸⁶ Commission Vice President Kaja Kallas proposed that the system be 'fully operational by the end of 2027.' She reassured that 'This will be done, of course, in close cooperation with NATO.'⁸⁷

⁷⁹ Tye Graham and Peter W. Singer, 'China's counter-UAV efforts reveal more than technological advancement', *Defense One*, 2 May 2025, <https://www.defenseone.com/technology/2025/05/chinas-counter-uav-efforts-reveal-more-technological-advancement/405031/>

⁸⁰ '2025 China Victory Day Parade', Wikipedia, op.cit.

⁸¹ Jason French, Josh Chin, Jemal R. Brinson and Liza Lin, 'How American and Chinese drone arsenals stack up', *Wall Street Journal*, 14 November 2025.

⁸² Ursula von der Leyen, '2025 State of the Union Address by President von der Leyen', European Commission, 10 September 2025, https://ec.europa.eu/commission/presscorner/detail/en/speech_25_2053

⁸³ Haye Kesteloo, 'EU's anti-drone defence plan stalls as France and Germany Block 'Drone Wall' initiative despite Russian incursions', *DroneXL*, 15 October 2025, <https://dronexl.co/2025/10/15/eu-anti-drone-defence-france-germany-block-drone-wall/>

⁸⁴ Chris Lunday, Laura Kayali and Jacopo Barigazzi, 'Von der Leyen's 'drone wall' plan crashes into EU reality', *Politico*, 3 October 2025, <https://www.politico.eu/article/ursula-von-der-leyen-drone-wall-plan-crash-eu-reality/>

⁸⁵ Ursula von der Leyen, 'Speech by President von der Leyen at the European Parliament plenary debate on a united response to recent Russian violations of the EU Member States' airspace and critical infrastructure', *Delegation of the European Union to Ukraine*, 8 October 2025, https://www.eeas.europa.eu/delegations/ukraine/speech-president-von-der-leyen-european-parliament-plenary-debate-united-response-recent-russian_en?s=232

⁸⁶ Alexandra Brzozowski, 'Don't call it 'drone wall' - how Europe wrangles over proposals to protect its skies', *Kyiv Independent*, 16 October 2025, <https://kyivindependent.com/dont-call-it-drone-wall-how-europe-wrangles-over-proposals-to-protect-its-skies/>

⁸⁷ 'Defence Readiness Roadmap: press remarks by High Representative/Vice-President Kaja Kallas at the press conference', *European External Action*, 16 October 2025, https://www.eeas.europa.eu/eeas/defence-readiness-roadmap-press-remarks-high-representativevice-president-kaja-kallas-press_en Kallas was widely misreported saying the system will be fully operational in 2027.

Getting lucky for once, Europe already was investing in the most important part of counter drone infrastructure; the monitoring system to make drones visible to civilian and military authorities, and potentially to all observers. This is U-space, an EU initiative from 2018, ideal for enhancing counter-drone resilience, that now seems visionary.⁸⁸ Completion of U-space remains distant. Much depends on execution, which still has far to go, requiring standardization of exactly the kind that bedevils European cooperation, 'sharing technical standards, having standardized and secure communications between Allies and platforms and systems, and running joint exercises.'⁸⁹

The difficulties of drone and counter-drone choices are shared by all European NATO members, all racing to adapt. Poland is especially revealing, illustrating many European trends. To be sure, it is exceptional in important respects. With the highest rate of defence spending in the Alliance—4.48 per cent of GDP in 2025—and its proximity to Ukraine and bordering Russia, Poland is poised to lead.⁹⁰ But like other European countries, Poland arrives at the current situation imperfectly prepared. Investment in traditional major weapon systems, especially for ground forces, still dominates its defence procurement.⁹¹ Its drone policy, by comparison, seems more tentative and reactive.

Poland has a recent history of experimentation with drone operations, culminating in a significant investment in Bayraktar TB2s in 2021.⁹² But only after the rise of drone war in Ukraine did Poland commit to large-scale drone mobilization.⁹³ One

major response was to build on earlier investments by expanding medium-altitude, long-endurance drone forces. In December 2024, Poland contracted with the United States for MQ-9 drones. The deal, worth USD 310 million, provides Poland with major capability and cultivates diplomatic relations with Washington. Like many other NATO countries, Poland's domestic aerial-drone industrial goals are served primarily through contracts for smaller FPV drones, prioritizing domestic start-ups.⁹⁴

Managing this investment is no less important. Many countries are reorganizing for better drone exploitation and defence. In 2024, influenced by organizational reform in Ukraine, Poland's Ministry of National Defence announced a separate new Drone Forces organization, to accelerate integration of drone technologies into all services.⁹⁵ Creation of the Drone Forces was a sign of high-level frustration, to overcome institutional hesitancy of its traditional armed services, ensuring drones get aggressive organizational advocacy and integration.

Poland's emphasis shifted further after the 10 September 2025 incursion, suddenly focusing more on defences. As with other drone initiatives, Polish defensive planning tries to balance immediate military requirements with pressure to buy local, to enhance self-sufficiency and promote domestic industry.⁹⁶ Currently, national survival worries are winning over sovereign autarky, most spectacularly in Poland's decision to import massive quantities—the actual numbers remain obscure—of FPV drones from Taiwan.⁹⁷ An investment in Turkish counter-drone electronics

⁸⁸ 'Keeping drones safe, secure and green: Commission launches the European Network of U-space demonstrators', European Commission, 19 October 2018, https://transport.ec.europa.eu/news-events/news/keeping-drones-safe-secure-and-green-commission-launches-european-network-u-space-demonstrators-2018-10-19_en

⁸⁹ Anjana Ahuj, 'Can a drone wall really work?' *Financial Times*, 26 November 2025, <https://ft.pressreader.com/v99e/20251126/281749865649306>; and Philip Butterworth-Hayes, 'Europe's U-space logjam: the dangers of, and remedies to, slow progress', *Unmanned Airspace*, 3 July 2025, <https://www.unmannedairspace.info/uncategorized/europes-u-space-logjam-the-dangers-of-and-remedies-to-slow-progress/>

⁹⁰ 'Defence expenditure of NATO countries (2014-2025)', Brussels: Nato, August 2025, p. 4, https://www.nato.int/nato_static_fl2014/assets/pdf/2025/8/pdf/250827-def-exp-2025-en.pdf

⁹¹ Krystyna Marcinek and Scott Boston, *Polish Armed Forces Modernization*. Santa Monica: RAND Corporation, 29 May 2025, pp. 20-33, https://www.rand.org/pubs/research_reports/RRA2971-1.html

⁹² 'The first sets of Bayraktar drones were delivered to the Mirosławiec Base', Republic of Poland, Ministry of National Defence, 28 October 2022, <https://www.gov.pl/web/national-defence/the-first-sets-of-bayraktar-drones-were-delivered-to-the-miroslawiec-base>

⁹³ Adamowski, 'Poland buys Sky Guardian', *op.cit.*

⁹⁴ Jarosław Adamowski, 'Poland, Romania lead a drone bonanza in Eastern Europe', *Defence News*, 26 May 2025, <https://www.defensenews.com/global/europe/2025/05/23/poland-romania-lead-a-drone-bonanza-in-eastern-europe/>

⁹⁵ 'Poland aerospace and defence military Drone Force established', International Trade Administration, U.S. Department of Commerce, 27 January 2025, <https://www.trade.gov/market-intelligence/poland-aerospace-and-defense-military-drone-force-established>

⁹⁶ Haye Kesteloo, 'Poland won't wait for EU's stalled Drone Wall, Launches Independent Counter-Drone System After Russian Incursions', *Medium*, 4 November 2025, <https://medium.com/@hayekesteloo/poland-wont-wait-for-eu-s-stalled-drone-wall-launches-independent-counter-drone-system-after-3ee4d2d819e4>

⁹⁷ Konrad Szatters, 'Why Poland Is world's leading buyer of Taiwanese drones', *China Observers in Central and Eastern Europe*, 17 December 2025, <https://chinaobservers.eu/why-poland-is-worlds-leading-buyer-of-taiwanese-drones/>

worth USD 410 million shows Poland rushing for military technological resilience.⁹⁸ Balancing military security and strategic autarky is certain to remain an acute policy issue.

Russian lessons

At the heart of Russia's approach to aerial drones is a combination of imitation and innovation. Although it initiated the war against Ukraine with foolish self-confidence, Russian leaders quickly showed they could learn and adapt. Four years later, the result is an extreme multiplication of old and new battlefield tactics. These range from human wave assaults similar to Russian and Soviet methods from the first half of the twentieth century, to ideas and equipment borrowed from allies and enemies, and important examples of outright novelty. Rather than resilience, the approach stresses offensive advantage. None of this has achieved President Putin's grandest goals. Ukraine continues to fight Russia on nearly equal terms. But Russia's slight offensive advantage is enough for gradual territorial gains.

The scale of Russian FPV drone procurement is too poorly reported for reliable judgment but looks to be much lower than Ukraine's. Russian Minister of Defence Andrei Belousov told Russian soldiers in July 2024 that Russia was launching 4,000 drones every day, equal to almost 1.5 million per year.⁹⁹ More cautious Ukrainian reporting from suggested that 'In March and April 2024, they [Russia] were using about 250 FPV drones per day. By October 2025, they were launching 1,000 to 1,200 per day, sometimes even more... In August, they set a record: around 30,000 FPVs used in a single month.'¹⁰⁰ That was at least five times more than a year earlier, equal to an annual rate of 360,000, but less than one-third Ukraine's rate of annual procurement at that time. Others think Russia will reach one-half Ukraine's rate of procurement, 'around two million per year.'¹⁰¹

Numbers alone, though, are not the only source of Russian battlefield drone strength.

Rather, Russia's emphasis on rapid imitation and innovation is what helps it most. The approach came directly from political-military hybridity, especially from methods associated with what is often called Gerasimov Doctrine, first seen clearly in the deployment of the 'little green men' in the Donbas and Crimea in 2014. These were guerrilla combat concepts adapted for state-to-state warfare, borrowing ideas and equipment promiscuously, evaluating them exclusively for their immediate military and political effects, with no concern for origins or broader implications.¹⁰²

Reliance on imitation often is sufficient due to Russia's superior factor endowments. As always, Russia's large size allows advantages to endure defeat and recover. Greater population and infrastructure, wealth and territory, make it easier to field larger numbers of all kinds of drones, and assign more people to operate them. The length of the war helped Russia recover from its early blundering, and to benefit from systematic adaptation of technologies proven elsewhere.

Russia's most visible act of imitation is mass deployment of Shahed drones, originally from Iran's Shahed Aviation Industries. Instead of relying on large reusable drones to launch stand-off weapons, in October 2022 Russia introduced this mid-sized fire-and-forget reconnaissance and attack drone. The weapon lacks the flexibility for decisive battlefield use—it is not designed to hit moving targets—but it is ideal for counter-city and infrastructure attacks.¹⁰³ Initially Russia relied on Iranian-supplied drones. Continuous expansion of industrial capabilities made Russia increasingly self-sufficient, while imports from China and Iran fill component gaps. By the mid-2026, Russia could launch roughly 263 per day, over 8,000 Shahed drones per month, or some 96,000 annually.¹⁰⁴

⁹⁸ 'Poland chooses Türkiye's ASELSAN in \$410m pact for electronic warfare and counter-drone shielding', *Army Recognition*, 20 December 2025, <https://www.armyrecognition.com/news/army-news/2025/poland-chooses-tuerkiyes-aselsan-in-410m-pact-for-electronic-warfare-and-counter-drone-shielding>

⁹⁹ Olivia Savage, 'Ukraine conflict: Russia producing 4,000 FPV UAVs per day, minister claims', *Jane's*, 31 July 2024, <https://www.janes.com/osint-insights/defence-news/air/ukraine-conflict-russia-producing-4000-fpv-uavs-per-day-minister-claims>

¹⁰⁰ Stanislav Storozhenko, 'Russian low-cost drones are changing the face of its war in Ukraine', *Moscow Times*, 10 October 2025, <https://www.themoscowtimes.com/2025/10/10/russian-low-cost-drones-are-changing-the-face-of-its-war-in-ukraine-a90779>

¹⁰¹ Theodore Bunzel and Tom Donilon, 'How to secure the sky: America needs a defence against drones', *Foreign Policy*, 26 December 2025, <https://www.foreignaffairs.com/united-states/how-secure-sky>

¹⁰² Benjamin Jensen and Yasir Atalan, 'Drone saturation: Russia's Shahed campaign', *Centre for Strategic and International Studies*, 13 May 2025, <https://www.csis.org/analysis/drone-saturation-russias-shahed-campaign>

¹⁰³ Asami Terajima, 'Russia launches first-ever kamikaze drone attack on Kyiv, kills', *Kyiv Independent*, 17 October 2022, <https://kyivindependent.com/russia-launches-first-ever-kamikaze-drone-attack-on-kyiv/>

¹⁰⁴ Igor Anokhin, 'June 2026 updated analysis of Russian Shahed-type drones deployed against Ukraine', *Institute for Science and International Security*, 1 June 2026, <https://isis-online.org/isis-reports/monthly-analysis-of-russian-shahed-136-deployment-against-ukraine>

Russia's Shahed campaign shows not just attention to saturation, but a willingness to adapt. Individual attacks gradually were replaced to improve penetration with swarming and decoyed attacks, changing attack altitudes, flight paths and trajectories. Ukraine has shown creativity and persistence intercepting Shahed drones and other counter-city weapons. In one night in September 2025, for example, Russia sent a record 810 attack drones and decoys into Ukraine. Kyiv claimed to have knocked down 92 per cent. That still meant 63 got through.¹⁰⁵

Shahed drones, along with attacks by ballistic missiles and glide bombs (comparable to the American JDAM) extended the war to Ukrainian civilians. But the strategic accomplishments remain few. The Shahed drone campaign is the most obvious example of an imported tactic that caused enormous destruction, but little else. A compelling case can be made that Russia's counter-city campaign is the second greatest tactical blunder of the war, after its failed initial effort to take Kyiv. The counterproductive performance of Russia's Shahed campaign adds to the mystery of the newest imitator; the United States, which also is adopting the Shahed design.¹⁰⁶



¹⁰⁵ Paul Sonne and Kim Barker, 'Russia made drone production a supreme priority. Now it swarms the skies', *New York Times*, 14 September 2025, <https://www.nytimes.com/2025/09/14/world/europe/russia-ukraine-drone-attacks-production.html>

¹⁰⁶ Joseph Trevithick and Howard Altman, 'U.S. deploys Shahed-136 clones To Middle East as a warning to Iran', *War Zone*, 3 December 2025, <https://www.twz.com/air/u-s-deploys-shahed-136-clones-to-middle-east-as-a-warning-to-iran>

In the first two years of the war, drone learning on both sides was decentralized and ad hoc, as individual units experimented and ideas were shared. Ukraine was first to centralize drone combat, establishing a new armed service in early 2024, the Unmanned Systems Forces (USF).

The Russian Ministry of Defence copied this in August 2024, creating a separate, centralized branch for unmanned systems, the Rubikon Centre for Prospective Unmanned Technologies. Informal drone organizations were disbanded and their personnel shifted to the new organization. President Putin confirmed the establishment of this separate branch for unmanned systems within the Russian Armed Forces in November 2024.¹⁰⁷ Assessments noted that 'Russia has slowly but surely improved its institutional and tactical learning systems over time.'¹⁰⁸

Russia also has shown it can lead outright innovation in drone warfare. By encouraging bottom-up innovation—not a traditional Russian strength—Russia gradually improved its combat ability with drones. Early innovations included GPS jamming, fibre-optic control, and tactical

innovations like sending FPV drones across the front lines to hit Ukrainian targets from behind.¹⁰⁹

In the constant search for advantage, Russia has advantages in the resilience of its society, which since May 2025 endured mobile internet shutdowns, an average of 2,000 a month, more than the rest of the world combined. The official reason is that shutdowns are needed to hinder Ukrainian drones, which depend on cell towers for navigation. Russia introduced a block on new SIM cards to stop Ukrainian drones that use SIM cards for navigation.¹¹⁰

Rubikon may be the most important long-term element in this innovative process. It caused initial chaos and battlefield reverses for Russia when it was imposed and fighting formations lost indigenous drone capabilities.¹¹¹ But a year later it had restored the initiative, developing into a creative force in drone war. Best known for targeting attacks on Ukrainian drone command and control, Rubikon became an equalizer for Russia, ending its chronic inferiority in drone engagements and giving a modest but meaningful degree of drone superiority.¹¹²

¹⁰⁷ Kateryna Stepanenko, 'Russian efforts to centralize drone units may degrade Russian drone operations', *Institute for the Study of War*, 13 December 2024, <https://understandingwar.org/research/russia-ukraine/russian-efforts-to-centralize-drone-units-may-degrade-russian-drone-operations-2/>

¹⁰⁸ Mick Ryan, 'Seven contemporary insights on the state of the Ukraine War', *Centre for Strategic and International Studies*, 17 November 2025, <https://www.csis.org/analysis/seven-contemporary-insights-state-ukraine-war#h2-1-drone-issues-saturation-and-russian-evolution>

¹⁰⁹ For example, 'The latest in the battle of jamming with electronic beams', *The Economist*, 3 July 2023, <https://www.economist.com/special-report/2023/07/03/the-latest-in-the-battle-of-jamming-with-electronic-beams>

¹¹⁰ Maria Kolomychenko, 'How far will the Kremlin take its internet crackdown?' *Carnegie Politika*, 16 December 2025, <https://carnegieendowment.org/russia-eurasia/politika/2025/12/russia-internet-restrictions>

¹¹¹ Stepanenko, 'Russian efforts', *ibid.*

¹¹² Charles Clover and Fabrice Deprez, 'Elite Russian unit hunts down Kyiv's drone warriors in battlefield reversal', *Financial Times*, 15 November 2025, <https://ft.pressreader.com/v99e/20251115/281586656870304>; and Ian Lovett, Marcus Walker and Nikita Nikolaienko, 'Russia gains upper hand in drone battle', *Wall Street Journal*, 1 December 2025.

RECOMMENDATIONS FOR NATO

The scale of the aerial-drone revolution is all but unchallenged. Few deny that ‘Drones are no longer the future of war. They’re now a defining weapon in Ukraine, Iran, Lebanon, Sudan and beyond—altering the course of conflicts and reshuffling the balance of military power.’¹¹³ Traditional weapons platforms have their partisans, but they seem more sentimental than visionary.¹¹⁴ There may still be a role for tanks, for example, but can they again be the battlefield stars they long were? Older technologies will remain situationally valuable, and many emerging ones may disappoint. But the conventional wisdom seems unanimous.

If only it was that simple. The drone revolution requires a change in emphasis, not a simple switch. It forces NATO and its members to re-evaluate the balance of defence technological development and industrial production. There is still a role for the historic defence-technological paradigm, encouraging gradual accumulation of major platforms, kept in service for decades with regular upgrades. There always will be important roles for traditional defence procurement. Modernizing the best of the past without overshadowing the new is itself a challenge.

Preserving established European and North American defence industries and their capabilities is of highest importance. But they also must adapt. It is impossible to tell if they can meet the demands

of today’s rapid development and production cycle, and the improvisational nature of FPV drones and their battlefield cousins. If they cannot keep up, traditional defence industries will become part of the problem.

Protecting industry, a major goal throughout NATO, need not be militarily harmful. Eliciting the best from established firms, while cultivating new competitors, is a tough but feasible goal for NATO procurement systems. But it is far from a sufficient to the challenge.

Demands for faster and more agile military procurement are endless now.¹¹⁵ But they skip the hard questions. What should be produced? How can relevance be ensured? How can useless or suboptimal kit be avoided? Such demands also simplify military competitiveness to a single, easy marker.

Matching the industrial productivity of enemies is vital, but military resilience requires more. A rival theme is the value of systematic national drone policies.¹¹⁶ That might be attainable. If not, a more practical recommendation is to stress the ability to exploit existing capabilities, constantly planning how best to use what they have.

Drone-war resilience requires both productive capability and rapid adaptability. Committing

¹¹³ Steve Feldstein and Jon Bateman, ‘Every War Is Now a Drone War’, *Carnegie Endowment for International Peace*, 9 January 2026, <https://www.youtube.com/watch?v=49sgua4Cs-4>

¹¹⁴ Scott Rutter and Matthew C. Paul, ‘Why mechanized warfare will still be decisive in the next land war’, *War on the Rocks*, 2 January 2026, <https://warontherocks.com/2026/01/why-mechanized-warfare-will-still-be-decisive-in-the-next-land-war/>

¹¹⁵ For example, Mariano-Florentino Cuéllar, Robert Doar, William C. Greenwalt, Dara Massicot and Kori Schake, ‘Battlefield lessons from Ukraine: rethinking defense production’, *Carnegie Endowment for International Peace and American Enterprise Institute*, 7 January 2026, <https://www.youtube.com/watch?v=0EaDm45zDm8>

¹¹⁶ Bunzel and Donilon, ‘How to secure the sky’, *op.cit.*

to mass production is easy, if agility is ignored. Adaptability is the natural suppressant of mass production. Balancing those conflicting goals will be the greatest military-industrial challenge of the drone war era. For NATO and its members, in this highly competitive environment, racing for particular technologies is a poor way.

Tech giants want to mass produce hardware, because that is the easiest job. But will huge production orders generate war winners? Their greatest value of technical innovation comes, rather, from creating and sustaining the potential to stay at or near the cutting edge. Equipment matters, both in sophistication and mass, but the

keys to victory are more likely to lie elsewhere: in the ability to exploit it.

Investing in quantity and quality is essential, but it guarantees nothing. This amounts to gambling on the unlikely ability to make the largest quantities of the most advanced equipment. Instead, European and North American militaries are more likely to ensure national resilience by cultivating their exploitation capability, the ability to use drones and related technologies better than anybody else. Exploitative capability requires reimagining the fulcrum of resilient defence. Not just industry, but operations research and doctrinal commands also must be at the centre of drone-warfare planning.

CONCLUSIONS

To return to the question first posed in this review, which technologies will be the foundation of security? While every major power is committed to aggressive pursuit of aerial drone capabilities, the quality of their interest, their level of commitment, varies, as does their programme emphasis. Each has an interpretation of the drone resilience theme. This review suggests that there are as many paths to military-technological resilience as there are major drone powers:

- For China, drone resilience comes from redundancy, doing everything, expanding options, the widest spectrum of defensive and offensive options. Diversification is the most visible principle, not by picking technological champions, but cultivating the ability to overwhelm any foe.¹¹⁷
- For Europe, resilience means drone defences, the kind of technology NATO members and EU members find it politically easiest to organize collectively. There is growing interest in long range strike capability, pre-emption through interdiction, but this remains a distinctly national, and largely undeveloped, option.¹¹⁸
- Russian resilience is indistinguishable from conquest and victory. One senses that Russia is the most opportunistic of major drone powers, pursuing drones for immediate tactical goals. Russian military resilience depends not on its conventional capabilities but on weapons of mass destruction, largely unchanged from Putin's 2018 and subsequent statements on nuclear weapons.¹¹⁹
- For Ukraine, resilience continues to mean tactical stability, a synonym for national defence. Keeping society and front lines together requires keeping up and leading in the dominant technology. Currently this means drones and defences. But drone dominance does not seem to be a matter of Ukrainian national identity. Should new technologies emerge, expect Ukraine to adapt quickly.
- The United States appears to be following a similar drone strategy to China, and to a lesser degree Russia, doing everything, combining conventional deterrence and defence with offensive options, imitating and innovating. Like China, the US is experimenting heavily but remains essentially uncommitted to any technological path. An important difference is that China experiments with hybridity, where drones could have a role, but hybridity remains alien to the American way of war.

¹¹⁷ Chen Chuanren, 'Chinese Victory Day Parade spotlights new weapon priorities', *Aviation Week*, 1 September 2025, <https://aviationweek.com/defense/missile-defense-weapons/chinese-victory-day-parade-spotlights-new-weapon-priorities>

¹¹⁸ Robert Wall and Tony Osborne, 'Long-range strike becomes Europe's new obsession', *Aviation Week*, 24 July 2025, <https://aviationweek.com/defense/missile-defense-weapons/long-range-strike-becomes-europes-new-obsession>

¹¹⁹ Neil MacFarquhar and David E. Sanger, 'Putin's 'invincible' missile is aimed at U.S. vulnerabilities', *New York Times*, 1 March 2018, <https://www.nytimes.com/2018/03/01/world/europe/russia-putin-speech.html>

For NATO and its members, the lack of global consensus is a barrier to building military-technological resilience. Getting ahead of the global curve of technological adaptation seems a formidable task for the Alliance. With a defensive orientation, spontaneity is not its strength. In fairness, attention to preparation can work well. It was NATO-mandated fighters that shot down Russian Shahed drones over Poland.¹²⁰ But it was the EU that hatched the drone wall, seemingly before the staff prepping the North Atlantic Council meeting could set out the water bottles.

Caught in a vast technological experiment, everybody must grope. The lack of global consensus is revealing and unsurprising. Drone technology is changing as fast as possible, propelled by the deadly competitiveness of the Ukraine war and wars in the Middle East. Yet even these inspire others to an even faster pace. Around the world, hesitancy to spend has yielded to undisguised hunger for testing and capability expansion. Military units now complain they are drowning in new gear. 'The number of systems and different assets that we've had is just insane', confesses an American commander.¹²¹ And we know there will be much more.

This environment makes prediction impossible. Previous military-technological prediction always relied on standpoint. 'The most accurate assessments of war in the near future are informed by the present', a respected assessment said, concluding that 'By advancing a theory of what will be new in the operating environment, one can lose sight of continuities.'¹²² But the distant horizons that guided that expectation now press upon us urgently. There can be no doubt that old gear will keep troops busy in any future conflict. But will it be decisive? Having witnessed a break in continuity, nobody can be sure. The foundations of military-technical resilience must be sought elsewhere.

When lost in military ambiguity, security scholars can be excused for burying their noses in Clausewitz. In his search for the permanent nature of war, Clausewitz was cautious in handling

technology, which he saw as part of war's passing characteristics. One of his contemporary students agrees, noting that 'there is no doubt that drones are both a multifaceted opportunity and a dynamic problem that manifests at the blistering pace of wartime innovation.' Concluding that this makes prediction impossible, Jim Wirtz warns against the false comfort of emulating recent lessons.¹²³ In the same spirit, Colin Gray channelled Clausewitz to warn against the hype, 'War, in common with sport, has the characteristic that what worked yesterday might not work tomorrow, precisely because it worked yesterday.'¹²⁴

The kindest part of the drone transition is its relative affordability. Mistakes need not to be punishing. It is possible to walk away from disappointment. But there is one concession that must be accepted. When everybody is racing, leadership cannot be enduring. The principal conclusion of this review is resilience comes not so much from immediate capabilities, but even more from well-poised potential.

There are vital implications here for the drone and counter drone planning of NATO and its members, summarized as three principles. One is to stay on the cusp: to invest in procurement capabilities; and to be able to acquire the best drone weapons possible and the military capabilities rapidly to operationalize them without delay. Second is to design for adaptability, with platforms cheap enough to be painlessly replaced, or modified to serve rapidly evolving needs. Neither of these is as easy as they might seem. Adaptability comes at a cost. Engineers naturally design to maximize performance at the moment, though this can limit what a product can do in the future. Ensuring cusp capabilities and adaptability requires deliberate planning and difficult trade-offs.

The third and most complicated implication is to be ready to exploit existing inventories for greatest advantage. Donald Rumsfeld was mistaken when he quipped, 'You go to war with the Army you have, not the Army you might want or wish to have at a later time.'¹²⁵ What matters most is not what you

¹²⁰ 'Statement by NATO Secretary General Mark Rutte on the violation of Polish airspace by Russian drones', North Atlantic Treaty Organization, 10 September 2025, <https://www.nato.int/en/news-and-events/events/transcripts/2025/09/10/statement>

¹²¹ Niharika Mandhana, 'Army changes its look in Pacific', *Wall Street Journal*, 12-13 December 2025.

¹²² Robert A. Johnson, 'Predicting future war', *Parameters*, vol. 44, no. 1, Spring 2014, pp. 67, 71.

¹²³ Wirtz, 'Colin Gray', *op. cit.*

¹²⁴ Colin S. Gray, 'The changing nature of warfare?' *Naval War College Review*, vol. 49, no. 2, (Spring 1996), p. 14, <https://digital-commons.usnwc.edu/nwc-review/vol49/iss2/3/>

¹²⁵ Helmut Sonnenfeldt and Ron Nessen, 'You go to war with the press you have', *Brookings Institution*, 30 December 2004, <https://www.brookings.edu/articles/you-go-to-war-with-the-press-you-have/>

have, but how you prepare to use it. This was the great lesson of operations research, developed not so much to justify buying new equipment as to maximize the effectiveness of existing hardware. Most famously, the United Kingdom won the Battle of the Atlantic in large part with slightly older weaponry, reimagined and adapted through processes of mathematical reassessment.¹²⁶

Because future war will have to be reimagined, only so much can be gleaned from recent examples. Respect China's full-spectrum drone investment, learn from it, but do not try to copy it. It conceals a forest of mistakes. Russia's Rubikon Centre offers an intriguing example of what can be accomplished without a huge investment in new equipment. It deserves respect. But it will not be equally useful as the gravity of conflict shifts, which

it must. Admire Ukrainian drone and counter-drone technology and tactics, be informed by them, but do not rely on them when trying to look over the horizon. Only so much can be borrowed in a dynamic environment.

Some of the drone and counter-drone weapons that NATO and its members bring to a fight will excel; others will disappoint. Such is the nature of engineering. What matters more than their design capabilities is how they are imagined and used. Cultivating the mental software of equipment—doctrine and training, especially—is the business of operations research.¹²⁷ It can be the steady hand guiding drone warfare. Led initially by operations research and doctrinal innovation, then by soldiers in the field, NATO's drones will become what its armed forces make of them.



¹²⁶ An outstanding explanation of this thesis, sometimes puffed up as 'mathematicians won World War Two', is P. M. S. Blackett, 'Evan James Williams. 1903-1945', *Obituary Notices of Fellows of the Royal Society*, vol. 5, no. 15 (February 1947), pp. 386-406, <http://www.jstor.org/stable/769090>

¹²⁷ Kjell Hausken, 'Fifty years of operations research in defence', *European Journal of Operational Research*, vol. 318, no. 2 (16 October 2024), <https://www.sciencedirect.com/science/article/pii/S0377221723009694>

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