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you need three things: innovation,
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Abstract:

Twenty-first century warfare has turned innovation into the true strategic battlefield. From Ukraine to Gaza, modern conflicts show that adapting faster than the adversary can matter more than sheer military power. This text explores how accelerating technology has compressed military innovation cycles to unprecedented speeds. Drones, electronic warfare, and artificial intelligence have made the battlefield transparent and brutally lethal. Ukraine's experience reveals that technological superiority is fragile unless embedded in doctrine, organisation, and industry. Russia, by contrast, relies on mass, industrial scale, and pragmatic adaptation rather than doctrinal transformation. The clash between these two models reshapes the meaning of sustainable military power. We should understand why innovation is no longer optional, but a matter of strategic survival.

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“One of the things that has not changed in combat is that your adversary is going to change. So, you have to understand, you have to have the ability to adapt and integrate it. That will never go away.”

General Christopher Donahue¹

In modern conflicts, victory smiles on those who can quickly turn ideas into viable solutions on the battlefield, from drones and electronic warfare to autonomous platforms and efficient logistics. This, at least, is what Valeriy Zaluzhny, commander-in-chief of the Ukrainian Armed Forces from July 2021 until he was replaced by General Oleksandr Syrskyi in February 2024, claims. He currently holds the position of ambassador to the United Kingdom and in his article published in ZN,UA on 24 September 2025, he states: *"Innovations are the basis of a 'sustainable resistance strategy', which makes war operationally meaningless for Russia"*.² The war in Ukraine, like the war in Gaza, is, among other things, a testing ground for new military technologies. Wars show us how new capabilities can be developed and used. It is in these wars that we can begin to glimpse future developments, both military and political.

Clausewitz overlooked the importance of technology as a variable in his analysis of war. Many of the most critical commentators on the relationship between war and the state have also been skeptical about the importance of technology in this process and have focused instead on the economic aspects of war. The omission is understandable, since, until now, the history of war has been characterised by long phases of technological stagnation interrupted by occasional spasms of revolutionary change caused by a confluence of multiple causes.³

However, the development of military capabilities has always gone hand in hand with technological development. Throughout history, many inventions were, from the outset, related to the battlefield. Weapon systems arising from technological evolution have had a major impact on warfare, especially in the 20th century, when the Industrial Revolution

¹ Since December 2024, General Christopher Donahue has been the head of NATO Land Command and the United States Army Europe and Africa.

² Zaluzhny, V. (2025, September 24). *Innovation as Core of Strategic Resilience: Denying Russia the Power to Dictate Terms Through War*. ZN.ua. <https://zn.ua/eng/innovation-as-core-of-strategic-resilience-denying-russia-the-power-to-dictate-terms-through-war.html>

³ Chin, W. A. (2019). *Technology, war and the state: past, present and future*. *International Affairs*, 95(4), 765–783. <https://doi.org/10.1093/ia/iiz106>. Pag 767.

finally bore fruit, and again in the 21st century with the maturation of the Information Technology Revolution. At the same time, the experience of military history shows that any technological innovation can only be effective if it is successfully integrated into the military organisation. The mere possession of technological superiority does not always produce quick results or win wars. A clear recent example is the conflict in Afghanistan, where the degree of technological difference between the contenders reached levels that will be difficult to match in the future, yet failed to produce the expected results. Ultimately, war remains a war between people, and the human factor will always be decisive, because a weapon, whatever it may be, will always remain a tool in human hands. This is the nature of war, as military history has shown, but it is also the very nature of technological evolution at the present time, including artificial intelligence, quantum computing, directed energy weapons, space technologies and biotechnologies, among others, that makes the future essentially unpredictable.⁴

Fully aware of the terrible difficulties of using history to predict the future, Michel Howard, a prominent expert on military history, pointed out that the purpose of trying to predict the future of war is not so much to be right, but to avoid being terribly wrong⁵. This difficulty in prediction does not absolve us from designing strategies that allow correction when we are more wrong than we expect, and that enable us to equip our armies with the sustainable resilience that Valeriy Zaluzhny points out. Strategic depth is not limited solely to the terrain or geography of a map but also our ability to achieve self-sufficiency in a protracted conflict. This article aims to explore how technological innovation should be part of any military strategy and the possible ways of integrating it to achieve that strategic depth.

The acceleration of technological innovation cycles.

Conflicts, particularly protracted ones, have always been laboratories for experimentation, driven by the need for combatants to adapt their armies and prevail in battle. War produces innovations because it radically alters incentives, creates new markets, generates technical urgencies, attracts new inventors, reorients existing ones, and activates the state as a buyer and financier. In all conflicts, technological,

⁴ Kopõtin, I., Piirimäe, K., & Oll, A. (2025). *Human Factor and Military Technology in Warfare: A Historical Perspective*. En K. Talves & D. Spreen (Eds.), *Artificial Intelligence in Military Technology* (pp. 117–131). Springer, Cham. https://doi.org/10.1007/978-3-031-95578-5_7

⁵ Hernández Calvo, Z. (2011). Ejércitos en combate: Cuando la doctrina importa. *Revista Ejército*, (841), 20.

organisational or procedural solutions have been sought that would provide a window of superiority in which to achieve victory.

As early as 1942, Schumpeter stated that "*the process of Creative Destruction is the essential fact of capitalism. It is the process by which new consumer goods, new technologies, new sources of supply, new types of organisation... incessantly destroy the old.*"⁶ He describes capitalism driven by waves of innovation, generating a continuous renewal of technologies, products and organisational forms. This mechanism would explain the disruptive nature of technological change, but also its tendency to accelerate: each new wave builds on a broader knowledge base, reduces recombination costs and increases competitive pressure to innovate faster.

The 20th century alone produced more technological advances than its entire previous history. From 1945 to the end of the century, an unprecedented intensification of technological innovation occurred. In the field of defence, where competitive advantage depends on anticipating and exploiting technological discontinuities, this wave of renewal intensified to become a structural feature from the late 1970s and the birth of the well-known Revolution in Military Affairs. However, the dominant pattern of innovation in the second half of the 20th century which focused on incremental improvement and cost reduction, is insufficient in the face of the competitive demands of the 21st century, characterised by greater speed, complexity and technological risk. Based on a historical analysis of several centuries of innovation, it can be concluded that "*incremental innovation and cost reduction, so emphasised at the end of the 20th century, will prove inadequate and even counterproductive in the 21st century in achieving the sustained global competitive advantage that radical innovation requires.*"⁷

The technological acceleration of the 21st century responds to a set of structural dynamics that have compressed innovation cycles to unprecedented levels. Massive digitisation has dramatically reduced the costs of design, simulation and testing, allowing technologies to be iterated at a speed that was previously impossible. Global connectivity has multiplied the circulation of knowledge, allowing discoveries, algorithms and prototypes to spread almost instantaneously. Added to this is the convergence between

⁶ Schumpeter, J. A. (2008). *Capitalism, socialism and democracy*. Harper Perennial Modern Thought. (Original work published 1942). Pag. 88.

⁷ Dismukes, J. P., Miller, L. K., & Bers, J. A. (2008). *Accelerated Radical Innovation (ARI) methodology validation*. National Center for Manufacturing Sciences. Pag1.

technological domains—artificial intelligence, robotics, biotechnology, advanced materials, computing—which generates hybrid innovations with exponential effects. Furthermore, strategic competition between technological powers and the growing participation of the private sector in traditionally state-controlled areas have intensified the pressure to innovate faster. Together, these factors have created an environment in which obsolescence is faster, experimentation is cheaper, and the transition between technological generations is shorter, which has a direct impact on the military, where speed of adoption has become a central component of strategic advantage.

*"Never in human history has technology changed so quickly or transformed the lives of so many people in such a short time."*⁸ A direct consequence of this acceleration of innovation cycles, applied to the military sphere, is that armed forces that continue to rely on incremental innovation cycles will see their strategic advantage eroded, because superiority in the 21st century depends on adopting and deploying radical innovation at a much faster pace than the adversary. Wars in the 21st century not only generate innovation, as has historically been the case, but do so in an environment where technology is already evolving rapidly. War accelerates innovation through operational pressure, and the 21st century technological ecosystem accelerates innovation through digitalisation, connectivity and convergence. When both factors combine, military innovation cycles become extremely short, as seen in the conflicts in Ukraine, Israel–Iran, India–Pakistan, Nigeria and Somalia.

The Ukrainian example is a warning to Western armies.

The war in Ukraine has highlighted a phenomenon of enormous significance: the accelerated obsolescence of systems designed for stable technological environments. Precision systems (Excalibur and GMLRS) show a surprising decline in effectiveness due to electronic interference⁹. Designed to operate in scenarios with low electromagnetic response, their effectiveness has been degraded when faced with a battlefield saturated with sensors, drones and electronic warfare. Spectrum density, Russia's GPS jamming

⁸ World Economic Forum & Our World in Data. (2023). *A timeline of technology transformation: How has the pace changed?* [A timeline of technology transformation: How has the pace changed? | World Economic Forum](#)

⁹ Sputnik. (2024, May 11). *Russia's electronic warfare creates problems for US precision weaponry in Ukraine – reports*. GlobalSecurity.org. <https://www.globalsecurity.org/wmd/library/news/ukraine/2024/05/ukraine-240511-sputnik05.htm>

capabilities, and the speed of tactical adaptation have shown that technological advantage can erode in a matter of months or weeks, not decades. The Excalibur precision ammunition used by the Ukrainian Army had a ratio of 1 hit for every 19 shots, raising the cost per hit to nearly \$1.9 million¹⁰. This phenomenon reveals that military innovation no longer guarantees sustained superiority: the operational lifespan of a technology depends less on its intrinsic sophistication than on its resilience against an adversary capable of reacting and innovating cheaply. Accelerated obsolescence forces a rethinking of doctrines based on precision as a strategic multiplier and underscores the need for modular, adaptable and degradation-resistant systems capable of surviving in an environment where innovation is continuous and counter-innovation is immediate.

There are numerous examples of how the evolution of the Ukrainian conflict demonstrates that technological innovation not only introduces new capabilities but completely reconfigures the operating environment. The massive proliferation of drones, sensors and electronic warfare systems has eliminated the possibility of classic manoeuvre and turned the front line into a space of permanent surveillance. As Valeriy Zaluzhny himself forcefully states, *"the battlefield has become completely transparent, rendering manoeuvre completely impossible"*¹¹. This forced transparency means that any concentration of forces, any attempt at a breakthrough, or even simple logistical movements are exposed to immediate detection and rapid destruction by FPV (First Person View) drones, artillery, or loitering munitions. The doctrinal consequence is clear: innovation is not measured solely by the ability to generate firepower, but by the ability to survive, hide and adapt in an environment where visibility is total and lethality is distributed.

One of the latest examples of Russian innovation is the deployment of the Malvina-M unmanned ground vehicle (UGV), an experimental system that mounts TOS-1A thermobaric rocket launchers on an UGV, thus replacing crews that normally have to operate very close to the front line. This adaptation drastically reduces human risk, lowers the cost of using thermobaric ammunition, and allows rockets to be launched from smaller, more mobile, and easier-to-hide positions, reducing vulnerability to Ukrainian

¹⁰ Stewart, C., & Chiu, L. (2024, May 29). *Off Target – Are Kyiv's GPS-Aided Weapons Susceptible to Kremlin EW Jamming?* Kyiv Post. <https://www.kyivpost.com/analysis/33448>

¹¹ Zaluzhny, V. (2025, September 24). Op. Cit.

drones and counter-battery fire. Although the system sacrifices accuracy and targeting capability compared to the original TOS-1A, it offers Russia a cheaper, disposable and less detectable way to employ high-powered weapons on a battlefield where heavy manned vehicles are increasingly vulnerable.¹² The most recent and widely publicised example of Russian innovation has been the use of the Shahed drone. In an adaptation and improvement of the original Iranian models, Russia currently produces this drone, used in swarms to overwhelm Ukrainian air defences. They incorporate advanced cameras, artificial intelligence, jet engines (up to 520 km/h), and interference-resistant systems. They can also launch submunitions and employ thermobaric or cluster munitions. Their psychological and destructive impact has been significant, especially in attacks on cities and civilian populations¹³.

During 2025, Russia has transformed its air campaign through the mass production of these Shahed-type drones, moving from dependence on Iranian imports to manufacturing thousands of units per month on its own territory. This industrialisation has allowed Moscow to launch large-scale night attacks—more than 700 drones in a single night—with the aim of saturating Ukrainian defences and wearing down civilian morale. The key lies not only in technological sophistication, but also in the economics of quantity: cheap drones that force Ukraine to use much more expensive interceptors, creating a strategic imbalance that favours Russia in a war of attrition. Faced with this pressure, Ukraine has had to accelerate its own innovation in drones and anti-drone systems. *"For every technological advance, both sides immediately seek a countermeasure. And the cycle of innovation is so fast that, within two or three weeks, we already see a counter-adaptation to any technological advance."*¹⁴ Ukraine uses FPV to attack Russian positions, develops long-range drones to strike infrastructure within Russia, and experiments with interception systems that are cheaper than traditional anti-aircraft missiles. This dynamic is forcing Ukrainian forces to reorganise their capabilities, integrate drones at all tactical levels, and operate in an environment where survival depends on how quickly new solutions are

¹² Litnarovych, V. (2025, January 24). *Russia mounts thermobaric rockets on ground drone in bid to replace TOS-1A crews*. UNITED24 Media. <https://united24media.com/latest-news/russia-mounts-thermobaric-rockets-on-ground-drone-in-bid-to-replace-tos-1a-crews-15141>

¹³ Nucleo Visual. (2025, julio 5). *Drones Shahed: El arma que redefine la guerra en Ucrania*. Nucleo Visual. <https://nucleovisual.com/drones-shahed-el-arma-que-redefine-la-guerra-en-ucrania>

¹⁴ Lister, T., & Shveda, K. (2024, December 28). *How Russia's drone attacks have reshaped the war in Ukraine: An illustrated guide*. CNN. <https://edition.cnn.com/world/russia-drone-attacks-ukraine-war-intl-vis>

adopted.

The Ukrainian model of innovation.

Ukraine is receiving international recognition for its ability to adapt and innovate. Adaptation in warfare refers to the adjustment of existing military methods in the face of new challenges. Innovation in warfare can be understood as a response to a change in the way conflict unfolds, leading to a new approach to how units operate in the field. Unlike adaptation, innovation would necessarily involve long-term change and the institutionalisation of new practices within organisational knowledge.

The Ukrainian Armed Forces can be divided into three generations, each influenced by different military experiences. Most of the senior leadership was trained during the Soviet era, and although their numbers are dwindling, they are more likely to conceive of military organisations according to a highly centralised and vertical command model. The middle generation may have been influenced by Soviet standards in the early years of their careers, but they were largely trained in an independent Ukraine and, more recently, have been shaped by their experiences in the Donbas war and their participation in international operations in Bosnia, Kosovo, Lebanon, Iraq, Afghanistan, and elsewhere. As a result, this segment has a more diverse cultural background and is more receptive to ideas and reforms inspired by international best practices. The youngest segment has been directly influenced by the current conflict, its hybrid nature, and the integration of volunteer battalions that were created after the conflict began. The experiences of this group have fostered greater openness to innovation and a more critical attitude towards leadership¹⁵.

Since 2022, groups of volunteers, engineers, and operators have created immediate solutions—such as FPV drones, unmanned ground and maritime vehicles, and situational awareness systems—using commercial components and development cycles of weeks rather than years. This *bottom-up* culture is based on identifying urgent problems, maintaining constant communication with units on the front lines, and prioritising speed over perfection. As a result, Ukraine has managed to temporarily counter waves of Shaheds and adapt faster than Russia in multiple technological iterations. But to counter

¹⁵ Osadchuk, I., & Osadchuk, O. (2025). *Lessons learned: Understanding the role of military organisational and adaptation culture for the future of Ukraine's defence* (RAND Report RRA3833-2). RAND Corporation. Pag. 4.

Russia's ability to mass-produce drones systematically, Ukraine needs to transform its culture of innovation into an organised and coherent system capable of generating sustainable capabilities. Although the country stands out for its speed of learning and a feedback cycle between the front line and developers that is probably the fastest in the world, there are structural weaknesses that have had to be addressed: the lack of a single authority for critical missions, the absence of a doctrine to guide capability development, informal mechanisms for learning lessons, and the dispersion of talent among units, companies, and state agencies. To resist effectively, this innovative energy must be channelled into a more integrated architecture: shared centres of excellence, capability directors with cross-cutting authority, and a national rapid development framework. In essence, it must convert its brilliant capacity for improvisation into sustained strategic power to survive Russia's war of attrition.¹⁶

One of Ukraine's most significant adaptations has been to recognise that the development of traditional doctrine — slow, hierarchical and designed for peacetime — is incompatible with an environment where tactics, technologies and threats change every few weeks. Ukraine's transformation after 2014 required abandoning the Soviet model of rigid, prescriptive doctrine and replacing it with a system that rewards initiative, decentralised decision-making, and continuous adaptation under fire.¹⁷ To bridge this gap, Ukraine is moving towards a living doctrine model, a dynamic system that allows procedures, lessons learned, and best practices to be updated in near real time. This approach, described as a "Doctrinal Wiki," seeks to institutionalise innovation without stifling it: an accessible, collaborative, and continuously updated repository that connects combat units, analysis centres, and doctrine makers. The goal is for the experience generated on the front lines, especially in areas such as drones, electronic warfare, and distributed operations—to quickly become organisational knowledge, preventing innovation from becoming trapped in silos or relying exclusively on individual initiatives¹⁸. Autonomous systems, tactical drones, and electronic warfare evolve in such rapid cycles that any static

¹⁶ Lopatin, M., Muravska, J., & Opgenorth, M. (2025, October 22). *From culture to system: A roadmap for turning Ukraine's counterdrone innovation into a capability*. Modern War Institute. <https://mwi.westpoint.edu/from-culture-to-system-a-roadmap-for-turning-ukraines-counterdrone-innovation-into-a-capability/>

¹⁷ Autor desconocido. (2024). *From legacy to resilience: The evolution of Ukraine's military doctrine since 2014*. Lviv Herald. <https://www.lvivherald.com/post/from-legacy-to-resilience-the-evolution-of-ukraine-s-military-doctrine-since-2014>

¹⁸RAND Europe. (2025). *Wartime innovation and adaptation: Supporting Ukraine's digital transformation*. RAND Corporation. <https://www.rand.org/randeurope/research/projects/2025/innovation-adaptation-at-war-cm.html>

doctrine becomes obsolete within weeks. FPV drones, improvised swarms, GPS-jamming-resistant navigation systems and electronic countermeasures are constantly changing, creating an environment where tactics that are successful today may fail tomorrow.¹⁹

To convert its extraordinary tactical innovation into a sustained strategic capability, Ukraine has progressively integrated contributions from four sources into a single system: combat units, the technology industry, analysts, and doctrine centres. To this end, it proposes an organisational architecture in which units provide real-time operational *insights* — including emerging tactics, drone configurations and responses to electronic warfare — while industry and civilian developers provide rapid technical solutions and iterative prototypes. One of the decisive factors in Ukrainian resilience has been the creation of a coordinated industrial ecosystem capable of integrating hundreds of technology companies, volunteer workshops, start-ups and large manufacturers into a unified national effort. Unlike traditional military procurement models, Ukraine has articulated a system where the state—through the Ministry of Digital Transformation and the *Brave1* program²⁰ —acts as an orchestrator, connecting operational needs on the front lines with industrial capabilities in cycles of weeks. This approach has enabled the scaling up of production of FPV drones, electronic warfare systems and autonomous software through a combination of tax incentives, accelerated certification processes and direct channels between operators and developers. The result is an ecosystem that functions as a distributed but coordinated network, where innovation flows from the battlefield to industry and back to the front in the form of iterative prototypes, creating an adaptive advantage that Russia has failed to replicate²¹. This model avoids as much as possible the fragmentation typical of innovation in warfare, creates coherence between units, and allows the distributed creativity of the Ukrainian ecosystem to become an institutionalised cycle of accelerated learning.

¹⁹ Cancian, M., Cancian, M. F., & Lambert, M. (2023). *Lessons from the Ukraine conflict: Modern warfare in the age of autonomy, information, and resilience*. Center for Strategic and International Studies (CSIS).

<https://www.csis.org/analysis/lessons-ukraine-conflict-modern-warfare-age-autonomy-information-and-resilience>

²⁰ BRAVE1 is a Ukrainian state defence innovation platform, established in 2023 to coordinate technology companies, start-ups, military units and government agencies in the accelerated development of unmanned systems, electronic warfare and military software.

²¹ Hakmeh, J. (2025, 5 de marzo). *What Ukraine can teach Europe and the world about innovation in modern warfare*. Chatham House. <https://www.chathamhouse.org/2025/03/what-ukraine-can-teach-europe-and-world-about-innovation-modern-warfare>

The RAND Corporation, in its report "*Wartime innovation and adaptation: Supporting Ukraine's digital transformation*"²², concludes that institutionalising a living doctrine requires three practical lines of action. First, comprehensive mapping of actors to identify which units, laboratories, technology companies, analysts and government agencies generate relevant innovation, and how they connect with each other within the defence ecosystem. Secondly, an access control and governance system that allows for broad contributions but maintains doctrinal consistency through filters, technical validation and centralised oversight. Finally, the need for continuous iteration, where lessons from the front lines, industrial prototypes, and independent analyses are integrated into rapid cycles of doctrinal updating, preventing innovation from becoming outdated in the face of the speed of change in drones, electronic warfare, and autonomous systems. This approach makes innovation a dynamic process rather than a static product, aligned with the demands of contemporary warfare.

The Russian innovation model.

The Russian military innovation process in the war in Ukraine remains deeply conditioned by the Soviet legacy, marked by rigid centralisation and a culture that limits tactical initiative. As RUSI points out, "*Russian adaptation remains constrained by a command culture that discourages initiative at lower levels and requires approval even for minor changes*"²³. Although Russia has introduced incremental improvements in drones, electronic warfare, improvised munitions or artificial intelligence, these tend to emerge in a reactive and fragmented manner, driven by local commanders rather than an *institutionalised system of learning*. The Centre for Naval Analyses (CNA) agrees, stating that Russian innovation tends to be episodic rather than systemic, driven by immediate battlefield needs rather than an established mechanism for doctrinal absorption²⁴. This combination of doctrinal verticality, weak integration between industry and units, and the absence of formal feedback loops slows Russia's ability to transform tactical improvisations into standardised capabilities, contrasted with the more open and

²² RAND Europe. (2025). *Wartime innovation and adaptation: Supporting Ukraine's digital transformation*. RAND Corporation. <https://www.rand.org/randeuropa/research/projects/2025/innovation-adaptation-at-war-cm.html>

²³ Kukkola, J. (2025). *Russia's adaptation in the war against Ukraine (2022–2025)* (Working Papers No. 41). National Defence University – Department of Warfare. https://www.doria.fi/bitstream/handle/10024/193189/Adaptation%20of%20Russian%20Armed%20Forces_Kukkola_web.pdf?sequence=2&isAllowed=y

²⁴ Petersen, M., Schwartz, P., & Rosa-Hernandez, G. I. (2025). *Russian concepts of future warfare based on lessons from the Ukraine war* (CNA Rep.). CNA Corporation. <https://www.cna.org/reports/2025/08/Russian-Concepts-of-Future-Warfare-Based-on-Lessons-from-the-Ukraine-War.pdf>

distributed models observed in Ukraine.

The Russian centralised system also offers advantages in terms of doctrinal coherence and unity of command, elements that derive directly from Soviet organisational culture. This model can implement doctrinal changes more uniformly and disciplinedly than decentralised armies, ensuring that operational guidelines are applied homogeneously across large formations. Similarly, "*the Russian centralised structure reduces tactical variability and ensures the disciplined execution of complex operational plans*"²⁵, facilitating large-scale operations where vertical coordination is essential. Although this rigidity limits bottom-up innovation, it also provides clarity in the chain of command, reduces ambiguities, and enables coordinated responses in scenarios where mass, synchronisation, and discipline are prioritised over tactical creativity. In Ukraine, this doctrinal consistency has allowed Russia to sustain prolonged operations and reorganise forces in a relatively orderly manner despite initial losses.

The Soviet legacy also provides Russia with a remarkable ability to mobilise industrial resources and sustain high production rates in a protracted war. Thus, the Russian system can "*concentrate industrial and logistical capabilities with an efficiency that democracies rarely match*"²⁶, which explains the rapid expansion of production lines for Lancet drones, Shahed drones, electronic warfare systems and artillery ammunition. This capacity for escalation is reinforced by state centralisation, which allows resources to be reallocated and sectors to be prioritised without the friction typical of more decentralised economies. In this way, the Russian model "*can reorient its industrial base toward military objectives with a discipline and uniformity that is difficult to replicate in more open systems*"²⁷. Taken together, these characteristics allow Russia to partially compensate for its tactical innovation deficits through sustained industrial volume, reinforcing a war of attrition approach consistent with its strategic tradition.

In just a few months, Russia went from using improvised FPV drones—assembled by volunteers, individual units, and small workshops with commercial components—to building a mass production system capable of generating thousands of units per month.

²⁵ Grau, L. (2020). *Command and Control in the Russian Armed Forces: Strengths and Weaknesses of Centralization*. *Journal of Slavic Military Studies*, 33(4), 567–589. <https://www.tandfonline.com/loi/fslv20>

²⁶ FOI – Swedish Defence Research Agency. (2019). *The Soviet Legacy: Centralization and Military Effectiveness*. FOI. <https://www.foi.se/en/our-knowledge/security-policy/russia-studies.html>

²⁷ RAND Corporation. (2023). *The Russian Way of Warfare: A Primer*. RAND Corporation. https://www.rand.org/pubs/research_reports/RRA1345-1.html

This leap can be explained by the creation of a hybrid ecosystem that combines formal industry, volunteer networks, and semi-professional workshops, coordinated through direct state support. According to the Trap Aggressor Project, Russia significantly expanded its industrial capacity in drones after the invasion began, integrating Chinese suppliers, standardising designs and centralising procurement and logistics²⁸. At the same time, reports such as *Defense Express* indicate that the Russian industry has managed to launch large-scale serial production of FPV drones, with complete batches sent to the front, thanks to rapid technical iteration based on the experience of operators on the battlefield. The result is a reactive but highly scalable innovation model that converts improvised solutions into sustained industrial capabilities²⁹.

The introduction of UMPK (*Universalny Modul Planirovaniya i Korrektsii*) kits is one of the clearest examples of Russian technological innovation during the war in Ukraine. These modules, designed to convert FAB-250/500 unguided aerial bombs into GLONASS-guided gliding munitions, allow Russian aircraft to attack targets from distances of 40 to 70 km without exposing themselves to Ukrainian air defences. According to analysis by *Defence Express*, UMPKs have enabled Russia to "*employ free-fall bombs as long-range precision weapons using inexpensive, mass-produced kits*"³⁰. This innovation combines technical simplicity, low cost and industrial scalability, which fits with the Russian pattern of transforming pragmatic solutions into sustained capabilities. Furthermore, such adaptations "*have significantly expanded Russia's ability to conduct deep strikes without risking manned platforms*"³¹, cementing UMPKs as a central element of Russia's air campaign since 2023. Russian glide bombs have gone from an initial range of 50–60 km to 90–100 km, and propelled variants capable of reaching up to 300 km are currently under development, transforming cheap bombs into long-range strike weapons³².

On an organisational and doctrinal level, one of the innovations Russia has developed is

²⁸ Trap Aggressor Project. (2023). *Game-changing drones: Who manufactures Russian FPV drones*. Trap Aggressor. [Game-changing drones: who manufactures Russian FPV drones](#)

²⁹ Defense Express. (2023). *Mass production of FPV-drones is apparently taking place in Russia*. Defense Express. [Mass Production of FPV-Drones is Apparently Takes Place in russia, and It's a Bad Sign | Defense Express](#)

³⁰ Defense Express. (2023). *Russia uses UMPK kits to convert unguided bombs into long-range precision weapons*. Defense Express. <https://en.defence-ua.com>

³¹ RAND Corporation. (2023). *The Russian Way of Warfare: A Primer*. RAND Corporation. https://www.rand.org/content/dam/rand/pubs/perspectives/PE200/PE231/RAND_PE231.pdf

³² Defense Express. (2025, 3 de junio). *UMPk-PD: What's known about new Russian glide bomb of 95 km range*. Defence-UA. https://en.defence-ua.com/weapon_and_tech/umpk_pd_what_s_known_about_new_russian_glide_bomb_of_95_km_range-14730.html

the creation of units specialised in locating and neutralising Ukrainian FPV drone operators, a tactical innovation that responds directly to the growing lethality of these systems. These units—informally known as “operator hunters” combine electronic warfare equipment, reconnaissance drones, and precision shooters to triangulate the drone's signal, identify the operator's position, and attack them quickly³³. These units use motorcycles, directional antennas, and their own drones to track and eliminate enemy operators. This innovation demonstrates that, despite its structural rigidity, the Russian system is capable of generating novel organisational solutions when operational pressure demands it.

The common pattern is clear: Russia does not innovate to transform its military model, but to reinforce it. Russian innovation is reactive, pragmatic and volume-oriented, not sophistication-oriented. Its strength lies not in distributed creativity, but in the ability to align industry, doctrine and command to produce cheap, functional and scalable solutions. This explains why Russia has achieved advantages in electronic warfare, FPV drones and gliding munitions, but continues to show limitations in tactical autonomy, multi-domain integration, artificial intelligence and rapid doctrinal cycles. In other words, Russia innovates within the limits of its own system, not against it.

Conclusions.

The war in Ukraine demonstrates that contemporary military innovation does not respond to a single organisational model, but rather to the interaction between two radically different ecosystems that have managed to generate competitive advantages in different domains. Ukraine has built an open, distributed and accelerated innovation model based on collaboration between tactical units, volunteers, technology start-ups and international partners. This bottom-up approach has enabled constant experimentation, rapid iteration of solutions and early adoption of emerging technologies, especially in the field of drones, distributed intelligence and digital battlefield integration.

Russia, on the other hand, has followed a centralised, industrial and volume-oriented

³³ Clover, C., & Deprez, F. (2025, November 13). *The elite Russian military unit hunting Ukraine's drone warriors*. *Australian Financial Review*. <https://www.afr.com/world/europe/the-elite-russian-unit-hunting-ukraine-s-drone-warriors-20251113-p5nfb1>

path, characteristic of its strategic tradition. Its strength lies not in distributed creativity, but in its ability to absorb foreign innovations, standardise them and mass produce them. Examples of the transition from improvised FPVs to industrial production, the proliferation of UMPK kits and the expansion of electronic warfare illustrate a model of reactive but highly scalable innovation. While Ukraine innovates to overcome its structural limitations, Russia innovates to reinforce its own: vertical discipline, industrial mobilisation and the ability to sustain a prolonged conflict.

From a strategic perspective, the comparison reveals that both models are viable, but their advantages and vulnerabilities are different. The Ukrainian model generates disruptive and rapid solutions, but it depends on a social and technological ecosystem that is difficult to sustain in a long war. The Russian model, on the other hand, lacks conceptual agility, but compensates for that rigidity with mass, industrial resilience, and organisational coherence. The war demonstrates that the advantage does not necessarily go to those who innovate the fastest, but to those who manage to convert innovation into sustained combat power. The ability to transition from pure military production to exportable capabilities, talent retention, integration of innovation and market integration will be key in both models once the conflict is over. For Western armed forces, the lesson is twofold: they must preserve their capacity for open innovation but also rebuild an industrial and doctrinal base capable of rapidly scaling simple solutions. Industrial warfare has returned, and with it the need to integrate creativity with volume, agility with discipline, and advanced technology with mass production.

Horowitz reminds us that emerging military technologies—from drones to cyberspace and artificial intelligence—only truly transform international politics when actors have the organisational capacity to integrate them effectively. His central argument is that technology alone does not alter the strategic balance: it is the interaction between innovation, doctrine, and institutional structures that does so. As he explicitly states, *"its effects are mediated by the ability of military organisations to use them effectively on relevant battlefields and in the pursuit of political ends."*³⁴. Therefore, the impact of these technologies depends as much on their dissemination as on organisational adaptation, and the challenge for future research is to connect these advances with classic questions

³⁴ Horowitz, M. C. (2020). *Do emerging military technologies matter for international politics?* Annual Review of Political Science, 23, 385–400. [Do Emerging Military Technologies Matter for International Politics? | Annual Reviews](#)

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about deterrence, escalation and war. Napoleon obviously did not say the phrase that appears in the title of this article, but perhaps if he had commanded armies in the 21st century, he might have shared General Valeriy Zaluzhny's opinion.

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