
THE KESTREL PAPERS
A SELECTION OF ESSAYS ON AIR POWER
2024
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AIR AND SPACE
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The Kestrel Papers

A selection of essays on air power

2024

Edited by

Murray Simons

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Foreword

The *Kestrel Papers* series is one of several publications produced by the Air and Space Power Centre (ASPC). While the others include monographs and academic papers, the *Kestrel Papers* hold a special place by offering an opportunity for emerging scholars to explore contemporary topics. ASPC also offers a number of other less formal outlets where opinions and ideas can be discussed by anyone at any time.

While I commend the efforts of those whose papers have been selected for publication here, I also want to acknowledge everyone who has had the courage to write on air and space power issues. Progressing our collective understanding of the profession of arms starts with individuals. If you have never put your ideas out in the public domain, then now is a great time. Short blog pieces are an easy way to start and are relatively quick to write. Be bold, start now.

Consume, contest, contribute and collaborate.

Group Captain Michael Sleeman
Director, Air and Space Power Centre

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Introduction

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If you don't like change, you're going to hate irrelevancy.

As the conflict in Ukraine rages on, military professionals around the world are reconsidering the value of entrenched doctrine. It is not just new technologies, but the way they are being exploited by ingenious innovators on one side and a behemoth military that seems incapable of adapting on the other. Change is a constant, but adapting faster than one's adversary is essential.

While the greatest military thinkers study warfare—rather than wars—the rate of change in this current conflict is so rapid that there is merit in examining the paradigm shifts in just the first 12 months. The following collection of lessons from Ukraine are offered as conversation starters rather than definitive conclusions. Remarkably, they are the observations of the Australian Defence Force's newest members—midshipmen and officer cadets from the Australian Defence Force Academy. These observations are based purely on the opening 12 months and predate the conflict's developments from mid-2023 onwards.

While the *2024 Kestrel Papers* appear as standalone observations centred on specific aspects of the conflict, an underlying theme permeates them all. In particular, there appears to be a paradigm shift from legacy thinking around individual domain supremacy to not just integrated warfare but national power. And while innovation has a long history on the battlefield, it is often limited to isolated technological breakthroughs rather than systemic mindset shifts. While one side of the Ukrainian war is

fighting a *war of choice*, the other has its backs against the wall in a *war of national survival*. In the first 12 months, at least, one side demonstrated unwavering deference to legacy doctrine, while the other had no choice but to *adapt or die*.

Critical examination of any conflict is always important. This involves not just considering what is said and done but what is not. For example, while most Western cultures draw dots between the stars, many Australian Aboriginal cultures recognise the *Dark Emu* in the space between stars (Pascoe, 2014). The Ukraine conflict, therefore, should be acknowledged as partially *sui generis*, and thus, not every lesson is transferrable. Sometimes, it is necessary to *turn the map around* and consider what is not done—and why. Either way, Ukraine offers important lessons for other middle power countries who foresee regional instability from an aspiring hegemon.

1.1 Innovation Mindsets

Air power is arguably the most dynamic of the visible military power domains. Yet, it must never cease in its relentless pursuit of disruptive innovation to outmanoeuvre adversaries. Indeed, the characteristics of air power are often entangled with those of the other domains (Australian Defence Force, 2022). Since its emergence, however, air power has challenged traditional paradigms. The earliest form of any combat can be traced through the lens of the land domain, where prowess and success were measured by the resources acquired through seizing and holding ground. This two-dimensional mindset of shifting the *zero line* seems to permeate to this day, with lines on a map designating success or failure. Meanwhile, the Senior Service has long shared similar concepts of geographic control—albeit at sea. The notions of controlling choke points or maintaining sea lines of communication still seem to be central to the Navy's *rasion d'etre* and the nautical chart remains its central reference point.

Geographical mindsets reflect the folly of tangible metrics. While some Services continue to be seduced by quantitative measures (Leonard, 2022), air power practitioners tend to revere quality and impact over Excel spreadsheets. There are no leaderboards for the most push-ups inside aircraft hangars, nor are the attritional warfare metrics of rounds expended or *body counts* (Nunn, 2017) considered valid measures of air power's success. Aviators are inextricably linked through a manoeuvrist mindset—a cognitive freedom that was born simultaneously with the irreverence to of lines on a map—*the slipping of the surly bonds of earth* (Magee, 1941).

The birth of air power changed warfare forever. While the physical presence of flying machines overhead in itself represented a revolution of military affairs (RMA)—whereby the enemy was forced to either adapt rapidly or else face complete annihilation—this alone was not unique (Adamsky, 2010). Both the maritime and land domains have enjoyed RMAs (Hill, 2015) in the form of *ships of the line*, submarines, machine guns and tanks, to name a few. Technological superiority has often been

cause for decisive military victory (Schmid, 2022), so the advent of aircraft themselves was arguably just another innovative adaptation. Air power, however, ushered in a different seismic shift in the history of warfare.

Air power's arrival saw a fundamental mindset shift away from two-dimensional thinking. Lines on a map and radiating concentric circles still played a part, but something even more fundamental emerged. The notion of strategic targeting deep into the enemy's heartland was more than just an incremental increase in range for naval gunfire support (NGS) or indirect fire; it shifted warfare away from the long-held linear paradigm of tactical engagement to one where victory could be achieved by a single act.

Among the earliest air power theorists, Guillot Douhet (1921/2019) ambitiously foreshadowed this mindset shift. While technology lagged behind his ideas, the subsequent decades saw more pragmatic doctrine emerge of strategic bombing and conceptual targeting systems—such as *Warden's Rings* (Warden, 2011) and John Boyd's (1996) cognitive *Observe Orientate Decide and Act* (OODA) Loop. Creeping barrages gave way to holistic thinking about an enemy's entire system through *parallel warfare* (Chun, 2008). Today, this paradigm shift is captured in the modern concept of *air mindedness* (Australian Defence Force, 2022).

From the outset, the pioneers of military aviation were mavericks. They were the daring ones who not only stared death in the face aloft but also dared to challenge traditional thinking (Matheson, 2007). Such larrikins were subjected to disparaging remarks by the conservative traditionalists; indeed, such interservice banter around supposed ill-discipline continues today. This combined physical and cognitive risk-taking became immortalised in the adventurous reputation of United States (US) aviators of World War II. Unsurprisingly then, Malcolm Gladwell's (2021) book, *The Bomber Mafia*, dedicates an entire chapter to this very premise. Yet, there is something oxymoronic problem with this culture.

Aircraft are incredibly technical and inherently dangerous, so flouting rules and extreme risk-taking sound like a dangerous mix (Kern, 2009). The real art of airmindedness, therefore, is knowing when and which boundaries can be pushed (Jordan,et al., 2021). Even today, air power is renowned for its relentless pursuit of faster, higher, better.

Air power is defined by its exceptional ability to *see, move,* and *influence*. Airborne platforms afford military planners incredible reach in terms of sense-making. The notion of Volatile, Uncertain, Complex, Ambiguous, and Novel (VUCAN) is no longer something to fear—it is now something to exploit onto adversaries. Meanwhile, exquisite air assets (such as the E7 Wedgetail) help provide clarity to what would otherwise be our adversary's attempt to discombobulate our decision-makers (Owen, 2023), and, therefore, allow us to exploit *dilemma flipping* (Johansen &

Euchner, 2013) back on them. As Winston Churchill reputedly quipped—*never waste a good crisis*.

Similarly, air power's ability to move personnel and materiel to anywhere in the world at incredible speed further disrupts potential adversaries from conducting tactical action with time to secure gains. While sea and land transport obviously excel in volume, the value of speed during the halt phase can be strategically decisive as both a response and deterrence (Riggins & Snodgrass, 1999). Influence—kinetic or otherwise—is another characteristic that is shared with the land and maritime domain, but range, speed, and agility mean air power offers strategic targeting options beyond conventional forces in the other domains.

Air power's fundamental mindset and targeting shifts have given rise to even more powerful options. The emergence of the military Space domain has obviously expanded the *see* role of air power to global proportions, while the contribution of space to navigation and communications has also exponentially improved all facets of military activities. But the paradigm breaking has not stopped there; Space significantly facilitates the military's newest domain.

Cyber warfare has redefined mental models even further. While air power challenges the linear, two-dimensional mindset, cyber does not even know it exists. The near instantaneous ability to reach out and either enhance or deny the *see, move, and influence* trinity almost anywhere in the world has necessitated a commensurate scramble to defend against such interference—by those who can. The integrated power of all five domains working harmoniously together has further reinforced the importance of mental paradigm shifts. Despite the legacy doctrine in some areas, the need to push boundaries is critical when facing off against equally innovative adversaries.

1.2 Holistic National Power

Land and sea power doctrines were both forged in an era when commanders had absolute control over their conduct of operations. For centuries, Fleet Commodores would sail over the horizon before opening a sealed envelope containing their overarching mission, but beyond that, how they achieved the mission was up to them. Communication back to the homeland was sporadic and slow (Lavery, 2020). Thus, the notion of a ship being a floating piece of sovereign territory was intertwined with the captain being authorised to independently engage in international relations on behalf of their government—including accepting peace treaties. Similarly, on land, the transliterated quotation of German Chancellor von Bethmann-Hollweg (1914), 'When diplomacy ends, the iron dice roll', emphasises that early warfare was considered separate from the other instruments of national power. Land commanders felt empowered to make all the decisions on how, why and when to engage the enemy—often regardless of any

non-military consequences. To them, all war was total war. Even today, such absolute Machiavellianism would be a prized empowerment for any ground commander focussed solely on military victory. Yet modern technologies now enable whole-of-government input into military action.

Air, space and cyber domains all emerged after the technological advances of global communication. Colloquially known today as the *6,000-mile screwdriver* (Miller, 2012), the notion of government, coalition, or even international bodies dictating the conduct of war still irks those who were raised on a diet of absolute autonomy. With the exception of insurgencies and weak state militaries, modern-day conflicts are both planned and executed with significant input from all government agencies. The current war in Ukraine, for example, means both sides are critically reliant on their respective allies for materiel, as well as intelligence, diplomatic, and economic support. What happens on the zero line can reverberate through to not just types of donated weapons but grain supplies to Africa (Balma et al., 2022), voting for new members of alliances (Alberque & Schreer, 2023) and, of course, economic sanctions for third-party support (Bown, 2023).

Arguably, much of what is being witnessed in Ukraine has been brewing for some time, but it has now become much more explicit. Live feeds on social media from soldiers in the trenches (Ciuriak, 2022) are now entangled with mainstream media coverage of NATO summits and South Africa's dilemma over an International Criminal Court arrest warrant for Russian President Vladimir Putin.

The general public is becoming increasingly aware of the role economic sanctions and diplomatic negotiations have on what might otherwise be considered just another localised border dispute. Thus, while still early days, the conflict is well worth examining for not just the technological innovations and mindset shifts but the manoeuvres on the world stage. Ukraine is not just about resource scarcity and one man's greed; it is about a fundamental threat to the Rules Based Global Order (RBGO).

1.3 2024 Kestrel Papers

Russia's 2022 invasion of Ukraine heralded a seismic shift in conflict. Not only was a numerically and technologically superior military humiliated by their smaller neighbour in the opening days, but their lack of adaptability was exposed by a passionate nation that exploited innovative thinking. Although the war still rages on at the time of writing, the first 12 months of the conflict saw a number of early lessons worth considering. In years to come, as details become declassified and the fog of propaganda warfare dissipates, more will be revealed. But for now, preliminary observations remain important.

The following collection of papers begins with the surprising failure of Russian air power in the opening days of the invasion. It then considers more holistic questions

about the apparent ongoing absence of traditional air power before delving into specific systems. For example, the role of modern ground-based air defence systems (GBAD) in neutralising air power has demonstrated the challenge of technological parity. Similarly, lessons emerge from the contribution of both exploiting sea power innovations and neutralising traditional capabilities. Meanwhile, the potential impact of autonomous weapons on the zero line highlights the inextricable link between what might seem like an ingenious tactical innovation and something that could evaporate all diplomatic efforts for international support.

Due to the ongoing and highly political and controversial nature of this conflict, it is important to recognise that active information operations are almost certainly impacting the quantity and legitimacy of information available regarding this topic. Out of necessity, some sources used throughout this paper extend beyond verified academic publications and should be evaluated in concert with alternative perspectives.

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2
Russian air power's failure to secure swift victory in Ukraine

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Soon after Russian troops were mobilised in Ukraine in February 2022, many military commentators were adamant that the stronger Russian forces would secure a triumphant victory (Wetzel, 2022). One year later, the conflict between the two countries persisted. The utilisation of Russian air power in this conflict should have been a decisive factor leading to a seamless victory over Ukraine. Instead, the failure of Russian air power prolonged the outcome of the war. This paper examines the factors that led to Russian air power failing to secure swift victory in Ukraine, with reference to the effective deployment of Ukrainian air defence systems, Russian logistic errors and lack of support for ground forces.

2.1 Air Defence

Ukrainian air defence systems have been essential to eliminating Russian threats to Ukrainian security. Early assessments of a Russia–Ukraine conflict suggested that the capability possessed by Russia would far outperform that of the Ukrainian arsenal (Bronk, 2022a). In the commentary surrounding the invasion, there was much pessimism regarding whether Ukrainian air defence systems actually possessed any advantage to successfully defend against the Russian forces (Bronk, 2022b). This was an assumption echoed by Professor Justin Bronk, who noted the suite of modern Russian aircraft, air defence and offensive strike capabilities would outperform Ukraine's 'few good air defence options' (Bronk, 2022b). Despite the advanced Russian capabilities,

the growing effectiveness of Ukrainian air defence systems has continued to impact crucial Russian capabilities.

Located throughout Ukraine is an intricate system of air defence technologies. Early warning systems on Ukraine's borders and a vast network of additional radar systems allow for primary defence capabilities—namely, surface-to-air missiles (SAMs)—to anticipate incoming threats and intercept them accordingly (Boyd, 2023). In the early stages of the conflict, it was predicted by many Western military experts that Russian forces would 'try and immediately destroy Ukraine's air force and air defences' (Stewart & Ali, 2023). However, these Russian strike campaigns were unsuccessful in causing significant damage to Ukrainian air defence systems, with the failure of these strikes being of great detriment to the conduct of Russian operations (Bronk et al., 2022). Due to the majority of Ukrainian radar-guided missile systems remaining operational, Russian pilots have been forced to fly at low levels into Ukrainian air space to avoid detection. This tactic, while effective in avoiding radar detection, brought Russian aircraft into target range of Ukrainian man-portable air defence systems (MANPADS), leading to numerous aircraft losses (Bronk et al., 2022).

Ukrainian air defence has been successful in intercepting deployed Russian missiles. According to the Australian Strategic Policy Institute (ASPI), Russia launched over 2,000 missiles at Ukrainian air defence systems in the first three months of the conflict (Bermant & Tentler, 2023). In March and April alone, Ukrainian defence systems successfully intercepted an estimated 20–30% of Russian missiles launched. By mid-June, these interception rates had climbed to approximately 50–60% (Bronk et al., 2022). Ukraine claims that this statistic has yet again increased, with an estimated 90% of Russian missiles launched over Ukraine being intercepted. Further, by November 2022, Ukrainian forces successfully shot down 200 Russian aircraft (Axe, 2022a). These interception rates demonstrate the growing strength and accuracy of Ukrainian air defence systems to ensure national security while denying Russian attempts at securing victory.

Ukrainian air defence systems are proven to be incredibly resilient. At the beginning of the conflict, Ukraine had an estimated 100 active air defence systems; some weeks later, Russia had destroyed over 20 of these (Axe, 2022a). Despite these losses, Ukrainian forces successfully sustained their air defence systems to continue the fight against Russia. As suggested by a US policy advisor, the resilience of Ukrainian air defence can be attributed not only to the tactics employed by Ukrainian forces to redeploy their defensive systems but also to the considerable support provided to Ukraine by their allies (Stewart & Ali, 2023). Notably, the US has provided Ukraine with over 1,000 Stinger air defence systems and two National Advanced Surface-to-Air Missile Systems (NASAMS), along with a fleet of Avenger air defence systems (Garamone, 2022). Similarly, countries such as Spain, Sweden, Germany and Poland have also provided crucial support to maintain Ukrainian capabilities (Garamone, 2022).

Ukrainian air defence capability continues to be bolstered by allied support, further enhancing Ukrainian ability to deny effective utilisation of Russian air power and preventing Russian victory.

2.2 Logistic challenges

Further, a myriad of logistic challenges prevented Russian air power capabilities from operating effectively, in turn stalling a swift Russian victory. First, depleted long-range precision-guided missile stocks led to Russian forces borrowing rockets and missile munitions from their ground forces. Not only did this impact the efficient operation of Russian ground-based forces, but it also left Russian air capabilities utilising systems far less adequate for the conduct of air-based operations. Second, the Russian domestic arms industry struggled to replenish a number of Russian unmanned aerial vehicle (UAV) capabilities, such as the Orlan-20, Eleron-3 and Forpost—which the lethality of Russian air power operations relies heavily on (Jones, 2022). Third, as a consequence of Western sanctions against Russia, the supply of integral parts to Russian air power capabilities was made increasingly complex. The 9M729 cruise missile and 9M949 rocket—two of Russia's most technologically advanced capabilities—rely on core parts manufactured by companies in the US (Jones, 2022). Similarly, the TOR-M2 defence system operated by Russian forces can only be operated with components from manufacturers in the United Kingdom. The political roadblock created by state sanctions has made the development and sustainment of crucial Russian air power systems incredibly difficult. The combination of these logistic shortcomings has undermined the conduct of Russian air power operations, thus affecting their ability to achieve victory.

2.3 Ground support

Additionally, lack of ground support has had unfavourable effects on the conduct of Russian aerial operations. The ability of air power assets to provide close air support to a ground war is of crucial importance; this conflict is no exception. However, Russia has been hesitant to amply utilise its air power capability. As such, their ground forces were left struggling to defend their positions. As suggested by the Ukrainian Air Force commander, shortcomings of Russian air support operations have resulted in 'a deceleration and subsequently a complete paralysis of the ground offensive' (Oleshuk, Shamko & Antonov, 2023, p.22). In particular, the exceptional air defence systems deployed by Ukraine have created a serious level of deterrence for Russian air power capabilities. Russia is 'not necessarily willing to take high risks with their own aircraft and their own pilots' (Suciu, 2022).

The deterrence level created by Ukrainian air defence systems has resulted in Russian air power assets' reluctance to provide essential ground support to their ground forces.

This failure of a core air power function has further contributed to the failure of Russian air power to secure a swift victory over Ukraine.

2.4 Summary

The conflict between Russia and Ukraine continued to develop since its outbreak in early 2022. Military experts had predicted a conclusive, overbearing Russian victory. The Russian invasion of Ukraine should have brought about an easy victory for Russia. Their superior assets, especially in the air power realm, should have quickly eliminated any countermeasure posed by the smaller Ukrainian force (Wetzel, 2022). However, much to the surprise of many, the war in Ukraine has endured—in large part due to the failure of air power. The failure of Russian air power operations to destroy and counter Ukrainian air defence systems had a tremendous impact on their overall conduct. In particular, the impressive deployment and sustainment of Ukrainian air defence systems resulted in significant losses to Russian capability. Additionally, Russian air power struggled with a multitude of logistic errors that had calamitous effects on the overall operation of Russian forces. Namely, depleting Russian munition stocks, a struggling domestic arms capability to promptly produce crucial capabilities, as well as sanctions preventing part imports have interrupted Russian efforts to achieve victory. Further, the absence of Russian ground support from the air—mostly due to the excellent Ukrainian air defence network—brought Russian ground operations to a deadlock. Overall, this paper has analysed the factors contributing to the failure of Russian air power to secure an easy victory in Ukraine.

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3
Why Russia failed to gain air superiority

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The Russia–Ukraine War continued well beyond an entire calendar year despite the West assuming Ukraine would be overrun in weeks. This conflict is perhaps a demonstration of arguably near-peer competitors unable to establish air superiority because of the difficulties of effectively using the potential of air power. Russia failed to meet Western expectations because their understanding and use of air power is different at all levels and stages of the conflict. Despite Russia's military, economic and manpower advantages, it never established air superiority. This paper considers three main discussion topics—Western expectations of an air campaign and how this differed in Ukraine, Russia and Ukraine as near-peers, and, finally, regional lessons for Australia.

3.1 Western expectations

The West understands air power is capable of manoeuvrable, scalable and capable operations as in most modern conflicts. For example, in the Gulf War, the decisive capacity of air power was fully realised for several key reasons. Air power is dependent on a system of systems to support its battlefield effects. Operation Desert Storm quickly secured air superiority because of effective US coalition with leadership, training, materiel support, and targeting facilities. Obtaining this air superiority was a crucial element in the broader Coalition's effort to end Iraq's occupation of Kuwait (Department of the Air Force, 1991). The Air Force flew over 65,000 sorties using F-15s and had a 92% success rate, demonstrating the breadth and potential that air power has to influence a conflict when employed to meet Western expectations (Department of the Air Force, 1991). The system of systems, including maintenance teams, electron-

ic-warfare planes, refuelling aircraft and airborne radar planes, enabled these fighter sorties. Thus, hundreds of aircraft and thousands of highly trained people were involved in one successful precision air strike for maximum effect. This is the doctrine behind Western air power, valuing precision through intelligence, surveillance and reconnaissance (ISR) and ultimately leading to robust, repeatable outcomes. Thus, the Western expectation of air power is that it is potentially decisive in a conflict yet difficult to support and execute effectively. Why, then, has Russia's military strength not achieved this level of coordination and effect in Ukraine?

3.2 Russian actions

Despite its numerical advantage, Russian air power failed to achieve decisive strategic results because its doctrine is based on supporting ground troops. Its history of conflict has shaped its conception that land power is the most important military facet, leading to a less developed understanding and use of air assets. Throughout World War II, Russia successfully defended its territory through numerical superiority, as evidenced by the total size of the Red Army and its casualties—accounting for 75–80% of the losses on both the Western and Eastern fronts combined (Krivosheev, 2001). Yet, its modern logistics and combined arms operations exist in chaos where friendly soldiers and aircraft are shot down, as seen in the 2008 Chechnyan and Georgian wars (Solovyov, 2009). Thus, the West expects Russia to use its military budget, accounting for 4.1% of the Russian GDP (double the international standard), to conduct a strategic air campaign as outlined in the previous paragraph but does not understand the limited role air power has in the Russian military, deferring to privileged land forces (World Bank, 2023).

Western analysts thought Ukraine would fall within one month based on Russia's capacity for air superiority, but only if used in the Western way. Russian pilots are given limited flexibility to take out opportune targets and, when attacking specified ones, rely on unguided munitions and vague intelligence. As such, they are most proficient in close air support roles with more available intelligence and practice in this exercise, although accidents still occur despite the more favourable situation. Overall, Russia uses its air power with poor army–air force coordination and little appreciation of the potential strategic air strikes, which the West did not foresee because of its own expectations.

3.3 Applicable differences and their importance

The differences between Western expectations and Russian actions in Ukraine underline the resistance Ukrainian forces have increasingly mustered. Given both combatants started the conflict with similar post-Soviet arsenals and land-centric strategic planning, the difference is how they conceive of and employ these forces (String-

er, 2023). Ukraine relies upon dispersed SAMs, MANPADS and fighters to counter Russian aircraft, inflicting losses and forcing them to fly low to avoid detection (Sankaran, 2023). Ukrainian efforts are the most important reasons for the failure of Russian air power, exploiting already weak opponents through dispersion tactics and decentralised command rather than concentrating forces under the controlled missions Russia employs.

Further, Ukraine's integration of new technology has outstripped Russia's, which has failed to arm its SU-34 bomber fleet for a close air support strategy. Ukraine has incorporated US weapons, including Javelins in 2018, Stingers (MANPADS Ukraine operates currently) artillery in 2022 and main battle tanks in 2023 (Vox, 2023). These US shipments and those followed up by European countries have controlled the pace of the conflict, dictating the range and intensity at which Ukrainian forces can operate, as the West does not want to engender an escalation and invasion of Russian territory, lest it supports Ukraine in violating internationally recognised borders. Hence, despite Ukraine's disadvantages and similar starting arsenal, its ability to incorporate new technology into a dispersed strategy is the most important reason why the conflict is at a stalemate. This difference in focus between the two combatants has resulted in the current state of the conflict, with Ukraine tailoring Western advice and equipment to counter Russian efforts effectively, yet it is still limited to self-defence.

3.4 Near-peer conflict

The Russia–Ukraine conflict stalled because each combatant had a different strategic situation, requiring differing levels of military engagement to manage. Russia had diverse interests and could not commit all its national resources. Ukraine, however, is in a war for national survival and has a singular objective: expel Russian forces. Russia also has the longest borders in the world and covers 11 time zones, with critical interests across these. It is also still heavily involved in the Syrian civil war, draining logistics and manpower resources (Syrian Observatory for Human Rights, 2023). Further, under the original pretext of the conflict, Russia's 'special military operation' cannot economically, socially or politically gear the country for total war (UN Security Council, 2022). In contrast, Ukraine is a smaller country with its northern and eastern borders under threat, yet is engaged in a total war of national survival and is on track to become a NATO member, receiving US$75 billion of support from the US alone (Harding & Koshiw, 2022). Thus, Ukraine can concentrate all national resources and more on this single objective, whereas Russia must divide its forces, increasing the resources and coordination needed to achieve the same effect Ukraine has, but without the same level of international support. While Russia may be able to pool resources from other areas, logistic weaknesses, air power doctrine and politics hamper these efforts. Additionally, the 'unlimited' Chinese–Russian friendship may provide materiel support to the Russian military, but both countries face significant economic

pressure and sanctions (Power, 2022). Thus, for China to provide an equal level of support to Russia that NATO does to Ukraine, it will face its own domestic and strategic challenges, further degrading the support Russia will receive. The conflict's early stalemate was evidence of Russia and Ukraine being near-peer competitors, despite Western expectations, as measurements of a nation's total power are mere predictions of what it can achieve.

3.5 Relevance to Australia

This demonstration of Russian air power is not optimal according to Western expectations; however, it is relevant for Australia in assessing its own strategic situation. China and Taiwan have a similar strategic situation to Russia and Ukraine, and this has demonstrated that a full-scale invasion of a neighbouring state is possible in 2022. Beijing has never renounced the right to use force to bring its 'renegade province' under control, and this resembles Russia's pretext for conflict. Similarly, Taiwan is a smaller nation with the backing of Western nations and military organisations, neighbouring an anti-Western military/economic juggernaut. Thus, while the status quo in Southeast Asia has remained for several decades, it is not proof it cannot change, as open conflict is possible in 2022 in Europe.

Further, the Russia–Ukraine conflict demonstrates the importance of effective use of air power in one's objectives, whatever they may be. Russia failed to coherently optimise its air power strategy in support of land forces. Therefore, China may also hold significant economic influence and military assets, but until tested in open conflict, one cannot assume China's opponents (Australia) would fall quickly under pressure or make policy decisions based on this flawed assumption. Overall, the Russia–Ukraine conflict provides lessons in modern conflict and air power that are important to Australia because of the similarities of the situation. Australia must not expect China to use air power in the same way it does and must be open to adapting its use of air power to China's own weaknesses.

3.6 Summary

This paper explored the differences between Western and Russian use of air power and the lessons drawn from this distinction. The West conceives of air superiority as necessary and will consequently use a system of systems and many resources to deliver maximum effect via air power. This has shaped their expectation of how Russia would use air power in the Ukrainian conflict, leaving many experts mistaken, as Russia instead employs it as support for land objectives, yet it still suffers from organisational weaknesses despite national advantages.

Ukraine exploited the difference in air power conception, preying on Russian weak-

nesses and tailoring Western advice. Further, this near-peer conflict demonstrates a change in the nature of warfare and the place air power has in it today. Australia should draw relevant lessons from this conflict to inform its strategic situation, with the China–Taiwan conflict closely mirroring Russia–Ukraine. Perhaps the best lesson it can take away is air power has the potential to be decisive in any conflict but must be employed with organisational support towards key national objectives. Further study could examine what air power lessons China should draw from the Russia–Ukraine conflict with consideration of the seas between it and Taiwan, focusing on how the US and Australia could exploit its additional maritime logistics difficulties to protect Taiwan.

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4
Ground-based air defence systems in the Ukrainian conflict

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The Russian invasion of Ukraine in February 2022 saw operations in the air domain play a prominent role. One of the key aspects of the air domain during the invasion has been the use of ground-based air defence (GBAD) systems by both sides. In this paper, GBAD systems are defined as any weapon system that primarily serves an anti-air capability, such as anti-missile and anti-aircraft launchers. Hence, in this paper, small arms or anti-armour weapons are not considered GBAD, even though they can still operate in an anti-air capacity.

So far, GBAD has played an influential role in both sides' air operations to defend infrastructure and resources, prevent casualties and destroy enemy air assets. Without GBAD, Russian air superiority could have enabled their early victory, and it is clear that GBAD has had a proportionately higher benefit for the Ukrainians by helping to negate this Russian dominance. This paper builds on the previous paper by outlining the role GBAD played in the first 12 months of the invasion before arguing why this role has been important. It concludes with an exploration of how the role of GBAD is likely to change as the conflict continues as one of attrition.

4.1 Destroying aircraft

GBAD systems have had a significant impact on destroying aircraft during the invasion so far. As of 6 March 2023, the total number of Russian aircraft shot down by both integrated air and missile defence in the invasion was over 70 (Gordon, 2023).

The Ukrainian inventory includes over 200 S-300 mobile SAMs systems, over 75 2K12 Kub systems, as well as two American NASAMS air defence systems delivered in November 2022 through the Ukraine Security Assistance Initiative (Ismay, 2022). Despite a portion of Russia's anti-aircraft systems being placed in Russian territory from the border to Moscow to defend crucial facilities, the Russians have still shot down considerable numbers of Ukrainian aircraft (Starchak, 2023). Accurate statistics are hard to source, but at the time of writing, US estimates are placed at around 60 planes downed by Russian GBAD systems. These statistics highlight the importance and destructiveness of GBADs so far in the invasion against enemy aircraft alone.

The effect of GBAD systems on enemy aircraft is important because it weakens the other side's ability to conduct aerial operations and their resolve to fight in the air domain. A loss of aircraft is obviously a damaging blow to capability, as they are very expensive and take time to replace. A problem facing the Russian Air Force is that they entered the war with few experienced pilots. On top of this, their decision to send the majority of pilot instructors to Ukraine as combat pilots has meant that future Russian pilots will have worse training and less experienced mentors (Peck, 2023). As Russian aircraft losses continue to rise from GBAD systems or other means, the level of replacement pilot competency will continue to drop. This could have a significant impact on the Russian war effort and in the air domain. Due to Ukraine's numerically smaller aircraft force, Russian GBAD has been and will continue to be a dangerous threat to Ukraine's ongoing and competitive presence in the air. This highlights the significant role of GBADs in changing the battlespace and influencing the invasion and its future course.

4.2 Protecting military and industrial infrastructure

Along with other anti-aircraft capabilities, GBAD systems have also been utilised in the invasion to defend important infrastructure and facilities on the ground. The opening days of the invasion instantly highlighted the need for well-placed GBADs in Ukraine, as the Russians widely employed cruise and short-range ballistic missile strikes to great effect in these first days. Since October, Russia has launched mass missile and drone attacks on Ukraine's energy infrastructure, which cast some cities into cold and darkness for the winter. Due to GBADs' ability to prevent such attacks, there has been a larger Ukrainian emphasis placed on their ongoing operation, as well as getting more of them from military allies. On the Russian side, Ukraine has begun to target locations on Russian soil, with reports of fires, drone attacks and shelling. After a year on the offensive, President Putin will now need to also prioritise GBAD systems on neighbouring territory and not just on the front and around Moscow. Thus, the urgency and role of GBADs in defending infrastructure in the invasion is clear.

The influence of GBAD systems on protecting vital infrastructure and capabilities is important, as it has the ability to maintain and protect combat essential units

and, ultimately, the war effort. When discussing GBAD systems, the Chief of Staff of Ukraine's President, Andriy Yermak, said that 'we need these weapons to win' (Schwartz & Miller, 2022). In the lead up to the 2022–23 winter, Russia's attacks on energy infrastructure left cities in darkness and cold. This not only prompted more support from Ukraine's foreign allies but showed the vulnerability of vital locations without sufficient GBAD systems. Russia has also been targeting military bases and airfields with their missile strikes, which further increases Ukrainian casualties and capability loss. The urgent importance of GBADs in the invasion in protecting ground targets is clear and ongoing.

4.3 Protecting civilian infrastructure

GBAD systems have also been employed by Ukraine to defend cities and population centres from Russian attacks during the invasion. The S-300 has been the predominant GBAD system used to repel missile attacks on urban centres throughout the invasion, but its results have been mixed. Many Russian missiles still penetrate Ukraine's defences, such as on 14 January 2023, when a residential building was struck in the city of Dnipro, killing five and wounding 60 civilians (Marsi & Stepansky, 2023). Attacks like this one can often be part of larger missile barrages, such as on 15 November 2022, when more than 100 missiles targeted cities and towns around the country (Leicester, 2022). It is for this reason that, in the last six months, Ukraine has reached out and received advanced GBAD systems from international allies, such as the previously mentioned NASAMS. The prior, continuing and crucial role of GBAD systems in protecting Ukrainian civilians is of utmost importance as the invasion enters its fourteenth month.

The employment of GBADs to protect urban centres and civilians is the most important factor in preserving Ukrainian morale and resolve in the face of the Russian invasion. As previously mentioned, Russian missile strikes on Ukrainian towns and cities have killed thousands of people, injured many more and caused catastrophic property damage. In March 2022, an attack on a theatre in the eastern city of Mariupol killed around 300 people, with the majority of these being children (Bachega, 2022). This terrible attack highlights not only the critical need for more GBAD systems in urban centres where the Russians are striking relentlessly but also the civilian death toll that has been rising ever since the beginning of the invasion. Had GBADs been on or around the theatre in Mariupol, the missile would probably have been neutralised before impact. Despite strong Ukrainian resistance and their refusal to surrender amid terrible suffering, this is an area that needs to be given more attention. Air power can significantly influence a nation's capacity to wage war, and escalated civilian targeting can bring a side to its knees. Thus, the Ukrainians need to improvise and balance the deployment of GBAD systems to defend both civilian infrastructure and military locations as best as possible.

4.4 Future operations

As the conflict continues, GBAD systems will become more important to Ukraine. Fierce resistance has halted Russian forces at Bakhmut, and there is talk of a Ukrainian spring counteroffensive on the back of increased support from Western allies. Despite help and support from allies, the availability of defences and capability remains Ukraine's biggest constraint (Gressel, 2023). Its Soviet-era GBADs, such as the S-300 and combat aircraft, remain behind the level of modern Russian technology and jets. Due to the size of the Russian Air Force and its numerical superiority in almost all aspects of capability, an increase in foreign support for Ukraine is needed if it is to win the war (Jones et al., 2023). When it comes to GBADs, the US NASAMS and Patriot systems are a step on the right path to achieving victory for Ukraine.

Despite the war's continued ferocity, the tempo in the air domain has slowed down, and this is going to affect the role of GBADs in two main ways. It cannot be known how the war will end, but it is clear that it is now a war of attrition, with no clear path to victory for either side (Bristow, 2023). As such, this has had an effect on all aspects of both Ukrainian and Russian capability. For GBAD systems in Ukraine, this first means a realignment from mostly defending one's own infrastructure and civilians, as previously covered, to strategically wearing down the enemy's force as a war of attrition demands. If this means relocating some GBADs from urban centres to the front where the fighting is most heavily concentrated, then that is what is needed. Second, this means that Ukraine must innovate and experiment with the GBADs that it currently has to ensure they are doing everything possible to destroy as much Russian capability as required to end the conflict. This innovation may not be enough, and so Ukraine must hope that the West will support a protracted war and that ongoing support is maintained during this attrition race (Jones et al., 2023). As it is, therefore, clear that the role of GBADs, among other capabilities in the air domain, will change as the war continues and that this change is most profound for the Ukrainian defending force.

4.5 Summary

As the invasion of Ukraine continues, the role and need for GBAD systems by both sides will increase in importance, as the war recently became one of attrition. GBAD systems have been important in destroying aircraft during the invasion and thus weakening air capability. They have also been utilised heavily in protecting important ground assets such as energy infrastructure and military bases that protect combat-essential units and the enemy war effort. Further, their use in protecting cities and civilian life has also been important in maintaining Ukrainian morale and resolve. As the war has now changed to a war of attrition and risks becoming a drawn-out, protracted conflict, GBADs must be prioritised by both sides to destroy enemy military capability, not domestic targets.

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5
Air power projection through targeting and targeting through air power

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Russia's invasion of Ukraine created a catastrophic warzone in which the world bears witness to active, high-intensity warfare involving highly sophisticated and modern technology. The use of air power, by which states achieve national and strategic objectives by influencing and conducting activities through and from the air, is highly prevalent on both the Ukrainian and Russian sides (Royal Australian Air Force, 2022). The effectiveness of this air power is dependent on various factors, with one of the more significant being targeting.

Targeting is an extremely complex process, the purpose of which is to integrate and synchronise joint fires and effects to achieve command intent (Australian Defence Force, 2016). The targeting process is multidimensional, involving the detection and identification of targets, the prioritisation and selection of targets, matching appropriate effects to targets and conducting battle damage assessment (BDA) of any delivered effects (Australian Defence Force, 2016). Targeting is underpinned by a systems analysis approach and aims to affect critical nodes that deny the greater workings of systems, crushing the capability of the adversary (Australian Defence Force, 2016).

Targeting can be either deliberate or dynamic. Deliberate targeting aims to achieve set effects on planned targets, while dynamic approaches deal with targets of opportunity that may present themselves too late to be dealt with deliberately (Australian Defence Force, 2016). This paper argues that both Ukraine and Russia have been able to successfully utilise unmanned systems and precision-guided munitions to target through the air. However, Ukraine has also benefited from projecting air power through the

sharing of external targeting data, while Russia suffered from poor and illegitimate targeting strategies.

5.1 Drones

Both Russia and Ukraine have demonstrated significant success in using UAVs to target and deliver effects throughout the battlespace. The mass innovation into even commercial UAV systems has made them extremely affordable and capable platforms in recent years (Osinga, 2015). Their ability to act as a kamikaze or munition-releasing platform while streaming a live feed back to the operator has been immensely useful since the very beginning of the war (Burgess, 2023). Ukraine has demonstrated their successful ability to use munition-carrying UAV systems to target Russian infantry, armoured vehicles, tanks, ships, aircraft and critical infrastructure both deliberately and dynamically (Burgess, 2023). A credible dynamic example can be seen from a recently released video feed of Ukrainian UAVs flying into Russian T72-B tanks followed by a detonation, with subsequent BDA imagery confirming the tanks were either destroyed or degraded (The Eurasia Times, 2023).

Some air power assets represent force multiplying critical capabilities. Ukrainian targeting of a Russian A-50 Airborne Warnign and Control Systems (AWAC) sitting on a runway in Belarus by UAV, detonating its payload on top of the aircraft's internal radar system and degrading the asset's capability (Venckunas, 2023) is a good example of drone exploitation. The impact this one drone's detonation can have on Ukraine is extremely significant. AWAC aircraft like the A-50 provide an almost essential capability to support other aircraft, particularly fighters in Ukrainian airspace (Venckunas, 2023). By destroying this node, the greater system is certainly disrupted and degraded. While UAVs served directly as an air platform to physically prosecute targets, they also had other targeting-related roles.

When not being directly used as a weapon to target enemy forces, UAV systems in Ukraine have served as platforms to collect essential targeting data and BDA. Various long-range strike capabilities on the Ukrainian battlefield, including recent additions of High Mobility Artillery Rocket Systems by Ukraine or Russia's existing use of land attack cruise missiles, all require extensive targeting information to be effectively used (Russian News Agency, 2023). UAV systems, both commercial and military, have proved invaluable to laser designate, provide coordinates and stream constant ISR of enemy positions in the most dynamic of situations (Russian News Agency, 2023). Both Russia and Ukraine have demonstrated the use of UAV systems to generate targeting data for artillery strikes within Ukraine, with the time-on-station capability of UAV systems to track and provide live BDA in any strikes (Kunertova, 2023). Providing targeting data was so useful that external sources of information also played their part throughout the battlespace.

While UAV systems have certainly provided targeting data in the Ukraine invasion, external intelligence has also played its part in helping target and destroy assets in the air domain. It is confirmed that US intelligence has been supporting Ukrainian forces throughout the war, highlighting the locations of strategic targets, including the flagship of Russia's Black Sea Fleet, the *Moskva* (Bertrand & Lillis, 2023). This allowed Ukraine to target the *Moskva* using R-360 Neptune anti-ship cruise missiles, striking it twice over at least 50 nautical miles away, consequently sinking the ship (Lendon, 2022). Further examples include the fact that Ukraine is collaborating with Poland and the Netherlands to provide targeting data in Ukraine through F35s operating within Polish airspace (Nikolov, 2023). Due to the controversial views on Russia's invasion, no countries have officially declared that they are helping Russia in terms of intelligence and information sharing. However, even these powerful examples involving Ukraine prove that external intelligence is an important factor in targeting and delivering effects within battlespaces. Targeting and delivering effects throughout the conflict has, at times, been highly dependent on sophisticated and precise weapon systems.

5.2 Precision-guided munitions

The use of precision-guided munitions (PGM) throughout the Ukrainian conflict has been significant in targeting and delivering effect to both deliberate and dynamic targets; however, there is a power shift at play involving their use. The onset of the invasion saw the Russian military's order of battle being significantly larger than Ukraine's, including the stockpile of munitions, including laser- and GPS-guided bombs, as well as cruise missiles (Tegler, 2022). Russia has, to an extent, been able to successfully target Ukrainian forces using this stockpile, degrading the Ukrainian military, especially against tanks, through UAV-released laser-guided munitions. However, throughout the war, Russia has expanded almost all of its PGM stockpile (Tegler, 2022). Meanwhile, Ukraine has and continues to receive PGMs in the form of military aid from countries including the US. This has included Joint Direct Attack Munition extended-range bomb kits and the HARM anti-radiation missile (Thomas, 2022). Ukraine has successfully deployed these weapons *en masse*, with their precision allowing for highly successful targeting of Russian military targets (Thomas, 2022). Ukraine has confirmed that HARM has allowed Russian air defence systems to be successfully targeted and destroyed, giving Ukrainian aircraft the freedom to operate within the region (Thomas, 2022). Despite the successes, targeting—if done incorrectly—can certainly play a pessimistic role in the projection of air power.

While PGMs have been successfully utilised by both sides, Russia's targeting strategies to deliver air power have also been indiscriminate, controversial, illegal and ineffective. Throughout the conflict, Russia has expended a significant portion of its cruise missiles on civilian infrastructure as underpinned by the Strategic Operation for the Destruction of Critically Important Targets doctrine (Beaumont & Sabbagh,

2022; Mackintosh & Kesaieva, 2022). The result of this was the deliberate targeting of Ukrainian electricity infrastructure, with the aim of demoralising the population and forcing a surrender (Human Rights Watch, 2022). These strikes, however, have not been deemed highly successful due to underestimations of the greater Ukrainian strength and will to fight, comparable to the underwhelming effects of strategic bombing during World War II (Kuzio, 2022). Russia's targeting also deliberately breached the Laws of Armed Conflict, committing multitudes of war crimes through its use of the air domain (BBC News, 2023).

Russia has used various chemical and cluster munitions that in themselves are banned by various conventions, including Geneva (Avery, 2022). This has been accompanied by the deliberate targeting of civilian populations throughout the war (Avery, 2022). In one instance, these techniques technically satisfy Russian objectives through demoralisation; however, there are far more severe long-term consequences. Engaging in these actions has degraded Russian credibility while also opening itself up to further sanctions and legal repercussions. A strike in July 2022 saw a Russian submarine-launched Kalibr cruise missile target and strike a collection of residential buildings, killing 22 civilians (Somerville, Parekh, & Zagon, 2022). The World Health Organization has concluded that Russia has targeted and struck over 859 health facilities in Ukraine since the beginning of the war (Agence France-Presse, 2023). These events, as well as many others, have led to calls for Russia to face global accountability through economic sanctions and additional legal systems, including the International Criminal Court (BBC News, 2023). The poor targeting that has led to this level of external attention has certainly done the opposite of supporting Russian war efforts and has, therefore, been a poor use of air power.

Ultimately, targeting has proven essential in both Ukrainian and Russian strategies in employing air power throughout the conflict. Simultaneously, targeting has proved essential in the effective utilisation of air power, while, contrastingly, air power alone also serves as a tool to generate and facilitate additional targeting opportunities. While both nations have succeeded in their approaches, generally speaking, in targeting through UAVs and PGMs, Ukraine's targeting capabilities through external intelligence gave it a credible edge in employing air power and creating significant effects in the battlespace. Meanwhile, Russia's approaches in targeting civilian populations and electricity through the air with indiscriminate and banned weapons have destroyed the country's credibility and degraded its war efforts.

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6
The psychological reason for Russia's lack of air superiority

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> *The development of air power in its broadest sense, and including the development of all means of combating missiles that travel through the air, whether fired or dropped, is the first essential to our survival in war.*
>
> Viscount Hugh M. Trenchard, 1946

Since February 2022, the Russian invasion of Ukraine has been a serious international crisis, with both sides exercising a variety of military tactics. Air power quickly became a crucial capability for the combatants in this situation, with both Russia and Ukraine relying on their employment of air power to accomplish military-based goals. Nonetheless, despite having a more advanced ability to deliver kinetic power from the air, Russia was unable to prevail in the fight for the skies. This section contends that Russian forces' inefficient use of air power, notably their inability to utilise auxiliary components such as logistical troop support or defence from opposing ISR, is underpinned by a deeper psychological problem that has majorly contributed to their defeat in the struggle for air superiority.

It should be reinforced that the vast majority of information and sources cited throughout this paper are from sources with Western backgrounds. This is due mainly to a lack of access to information provided by Eastern subject matter experts due to translation and access barriers. In future, effort should be applied to locate and compare Western and Eastern information to combat ideological and systemic biases.

6.1 Air power enablers

Analysis of key air power auxiliaries utilised by Russia has shown a repeatable, critical failing of the systems in place. A particular reoccurring failure seen from the very start of the war is Russia's inability to deliver critical personnel to a given location via air. Some 45,000 paratroopers in four divisions make up Russia's sizable airborne force (*Vozdushno-Desantnye Voyska* or VDV), a military branch that acts as shock soldiers and a rapid-intervention force. It was this force that was used in the invasion of Hostomel Airport, northwest of Kyiv, on 24 February 2022 (Stewart, 2022). While it may at first seem unbelievable that a large conventional force such as the VDV could be beaten by such a significantly smaller adversary, dialogue with members of the Russian defence publication reveals just how deep Russia's air power integration deficiency runs. According to one commentator of the publication, the VDV have a wide range of vehicles that cannot be dropped from aircraft, and, if they were, soldiers would have no idea how to rationally integrate them. However, it is not just vehicles that have poor integration. Russian commentator Alexander Timokhin goes on to detail that despite its large number of troops, the VDV lacks even sufficient numbers of transport planes to drop a full division simultaneously (Peck, 2023). More than just troops, poor utilisation of air power ISR defence lost the Russians one of their flagships.

6.2 The *Moskva* example

As discussed more in a later paper, the *Moskva*, a 510-person guided missile cruiser, served as the flagship of Russia's Black Sea Fleet. According to US sources, it sank on 14 April after being hit by two Ukrainian Neptune anti-ship missiles. Moscow claimed that the ship sank following a fire. Russian casualties were reported to be high, but the exact number is unknown. US sources informed that the attack took place after the Ukrainian military enquired about a ship in the Black Sea south of Odesa from the Americans. According to officials, the US recognised it as the *Moskva* and assisted in confirming its location. The Ukrainians then attacked the ship (Dilanian, Kube & Lee, 2022). A critical fault on the part of the Russian Navy.

During the battles with Ukraine, the *Moskva* cruiser of the Russian Navy operated in a constrained sea area. As a result of its constrained movements, it was particularly vulnerable to detection by sensors and drones stationed on land. It is thought that the ship's command was aware of its hazardous predicament when naval analysts watching the ship's movements identified a predictable pattern. The *Moskva*, which had supposedly been struck by two Ukrainian anti-ship missiles, eventually sank as a result of an unexplained fire. The ship was vulnerable due to a lack of awareness of Ukraine's capabilities, complacency, fatigue, trust in its anti-air and anti-missile defences, and the constrained sea zone in which it was operating (Sinha, 2022). However, with such a large force and extended history of conflict, it is almost unfathomable that

the Russian military could experience such critical events.

6.3 Failure to deliver air superiority

There must be a valid justification for why the Russian Aerospace Forces (VKS) fighter and fighter-bomber fleets are unable to achieve air superiority in Ukraine. At first, commentators attributed this to possible Russian challenges with deconfliction between ground-based SAMs, a lack of precision-guided weapons, and a shortage of pilots with the necessary skills to carry out precise strikes (Bronk, 2022). None of these hypotheses, however, are adequate to explain the VKS's continuous inefficiency. One defence is that NATO forces are being deterred from intervening directly by holding the VKS fighter fleets in reserve. Another argument suggests that large-scale strikes with unguided bombs and rockets were avoided to prevent damaging critical infrastructure, but this theory no longer explains the lack of large-scale VKS strikes (Bronk, 2022).

So, if Russia is unable to project personnel force through its own air capability and is unable to defend itself adequately from imposing air power, then why does Russia continue to make such an effort to exert air power over its adversary? The answer to this question may lie in the very psychological thinking of war directors in the Russian command. Analysis of conflict history and doctrine has demonstrated the critical importance of air power, and this fact is not lost on Russian commanders. Yet, exploration of psychological analysis of Russian war-thinking shows Russia simply does not possess the innate ability to efficiently project all auxiliaries of air power due to longstanding doctrine and radical force changes.

Considerable changes post Cold War to the Russian Airforce (*Voenno-Vozdushnye Sily* or VVS) may point to the start of the many issues Russia is facing today. Research from the time highlights that after the Cold War, the VVS was left with no clear mission other than homeland defence at the western edge of Russia, which it was not equipped to do anyway. This, coupled with issues such as declining aircrew morale and retention, led to drastic drawdowns by the VVS. The 1996 VVS found itself as an air force with less than half the number of aircraft it had in 1989, so drastically starved for funds that it could not obtain new aircraft and was unable to maintain a current and proficient force of aviators (Hill, 2016). While it could be argued that the pre–Ukraine invasion VVS was much more well equipped and had undergone dramatic air-combat equipment mobilisation to irradicate the issues faced in the 1990s, it is still important to note that an individual's mindset and an ability to integrate does not mobilise just because the equipment around it does. It is this acknowledgement that is represented by the way the VKS utilised its aircraft in practice.

The modern VKS's inability to establish air superiority can only be explained by its institutional inability to organise, brief and execute complicated air operations at

scale. While the VKS has conducted several combat operations over Syria since 2015, only small formations of aircraft have been flown during those operations. This means that in a high-threat air environment, its operational commanders lack a great deal of practical experience in how to organise, brief and coordinate large air operations involving tens or hundreds of aircraft (McDermott, 2021). The planning, systems and battle strategy of the Russian military have proved ineffectual in Ukraine. Hybrid warfare was emphasised; however, it did not have any impact on the outcome of the battle. Russian military parades and showdowns are not the same as genuine fighting. Russia's reliance on its officers to be competent, effective thinkers may have been dramatically overplayed.

Leadership failings is a theory supported by Russian nationals themselves, with Mason Clark, the Russian team lead at the Institute for the Study of War stating:

> *One of the hallmarks of the Russian, and before that the Soviet, system was they effectively designed around the fact that their baseline infantrymen were not as skilled as in the US or NATO, or, in World War II, the Axis powers but the intent was that the officers were competent, and the overall operational minds were very effective, and they sort of played to their own strengths. We're not seeing that here*. (Ioanes, 2022).

6.4 Summary

When compared to conventional Western force's doctrine and policy, it is evident that there is a weakness in the way Russia utilises its air power, and this problem with Russian ground–air joint operations doctrine is far from an emerging one. Analysis of combined operations highlights that the Russian military struggles to understand and apply the concept of a joint evolution to the same extent that the US and NATO do. While the US and the West have moved through a modern revolution with air–ground joint operations and engaged in conflicts with campaigns for air domination during the past 30 years, Russia lacked equivalent battlefield experience with opponents on a par with its foes in the West (Wiswesser, 2023).

While the systemic failures in Russia's inability to capture Ukraine cannot be solely attributed to their poor use of air power, it is more than a critical contributor to the lack of success. Investigation of the observable lessons in the realm of amplifying effective air power during the Russian invasion of Ukraine has yielded profound results and demonstrated that, on a tactical level, Russia cannot perform auxiliary capabilities of air power effectively. The root cause, however, is deeper.

One of the most important lessons that can be learned from the Russia–Ukraine conflict is that, despite desperately wanting to dominate the air domain, Russia is failing. To understand why, we should focus more on theory and its application in air campaigning in the West rather than Potemkin villages and displays of military power.

Due to the severe restrictions placed upon decision-makers by poor doctrine and training, Russian air power operations in Ukraine have been and will continue to be a complete disaster.

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7
Ground-based air defence

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The Russian invasion of Ukrainian territory in February 2022 provided many opportunities to delve into the effectiveness of land- and sea-based air power as a defensive asset. Many early air power theorists, such as General Giulio Douhet and Air Marshal Hugh Trenchard, conceptualised air power as inherently offensive (Douhet, 1921/2019; Miller, 2016). However, in 1918, aircraft were still a novel idea, with limited methods of countering the *enemy fliers* that would 'instil a paralysis in both officers and men' as stated by General Otto Liman von Sanders (Trumpener, 1966). Modern systems, technology and doctrine have changed the equation. This led to a more favourable outlook for countering an attacking enemy through the air domain (Preble, Cooper & Marlowe, 2023).

This paper contends that land- and sea-based air power is a viable way for nations to compete in the air domain. It examines this thesis through various forms of defensive land- and sea-based air power application. Notably, the use of highly mobile air defence units and the way in which they are employed will be explored. Further, the role of air power in influencing naval campaigns is also examined—emphasising the criticality of cross-domain interdependence.

It is important to understand air power within this paper as it plays a central role. Air power traditionally includes fixed-wing and rotary-wing aircraft and surface-to-air-missiles (SAMs). However, it is far broader than that—as anything tangential to the air domain inevitably impacts it—due to warfare being a complex adaptive system. This may include radars, cyber or any type of missile as they traverse through the air. Ultimately, air power is a fluid term, particularly in the modern era, where all domains are interconnected (Atkins, 2018).

7.1 Ukrainian GBAD

The key to the success of Ukraine's initial defence and avoidance of collapsing was its ability to keep much of the air defence network intact. Experts, such as Justin Bronk, Research Fellow for Airpower and Technology in the Military Sciences team at RUSI, have argued that Ukraine's denial of air superiority to Russia 'has been one of the defining features of the invasion so far' (Cook, 2023). This has been largely in part to the high-mobility systems that Ukraine uses, such as the S-300 SAMs and man-portable air defence systems (MANPADS). The Ukrainian Air Force was outmatched both quantitatively and qualitatively compared to its Russian counterpart. This reality forced them to approach air defence from another angle. Utilising defensive land-based power, they engaged Russian aircraft from the ground rather than head-on in the air.

The highly agile and portable GBAD systems that Ukraine used allowed them to quickly concentrate and dissipate firepower, not too dissimilar to groups engaging in asymmetric warfare in the Middle East (Larter, 2017). The conflict in Ukraine has continued with the *Hider Finder* relationship between defensive and offensive forces, as theorised by Calcara et al. (2022). Ukraine has done so by utilising highly mobile systems. A critical part of creating a highly agile force stemmed from the 1,400 Stinger missiles that the US shipped to Ukraine (Stone, 2022). Not allowing Russia to easily target their GBADs, as could be done against fixed anti-air systems, has provided Ukraine the defensive edge. Keeping its air defence systems intact, Ukraine has solidified an anti-access/air-denial (A2/AD) area through the innovative use of its available systems.

Ukraine's *layer upon layer upon layer* utilisation of air defence systems, as described by Air Combat Command's General Mark Kelly, has played a large part in creating an unflyable zone for Russia's fixed- and rotary-wing aircraft (Bremer & Grieco, 2023). Through layering and integrating multiple air defence systems, such as S300s and MANPADS, Ukraine has created an A2/AD area that poses a high risk for the Russian Air Force. While having weaknesses such as a limitation of ammunition or systems, it ensures that it will be a costly venture if the penetrating force has not refined their process in terms of 'tactics, techniques, procedures, technologies, and capabilities necessary' (Brungess, 1994; Calcara et al., 2023).

The integration of multiple air defence systems provided Ukraine with an effective multi-layered air defence network. The larger air defence systems have targeted Russian aircraft at higher altitudes, forcing them to fly within the range of MANPADS (Holliday, 2022). It has also proved successful against less traditional forms of air offence, downing more than 300 Iranian-made suicide drones employed by Russia (Hunder, 2022). MANPADS, with the later aid of mobile air defences, were so effective that Russian sorties of rotary- and fixed-wing aircraft had effectively ceased by April 2022 (BBC News, 2023). In essence, the denial of Russian air superiority and

supremacy has come down to Ukraine's GBAD ability, specifically its asymmetric characteristics.

7.2 Maritime air defence

Air power in the maritime domain has played a limited yet vital role in Ukraine's successful disruption of the Russian Federation Navy (RFN) to conduct effective offensive operations in a single service and a joint domain. Ukraine's area denial, while not comprehensive, has sufficed to suppress Russia's offensive capability in the Black Sea. Ukraine's relatively underpowered navy has resulted in Ukraine pursuing a similar asymmetric defence to counter Russia's naval forces (Fiott, 2022). Ukraine's successful disruption of Russian naval operations by air power has resulted in significant losses for Russia's capability in terms of platforms and manpower.

The RFN's potential to conduct amphibious landings was heavily hampered by the sinking and damaging of three amphibious ships by Tochka-U ballistic missiles (Rogov, 2023). Taking place in Berdyansk, a captured Ukrainian port in the Sea of Azov, Ukraine's strikes on RFN ships in-port have created a psychological effect as well as an operational one. This is well documented by the RFN relocating its Kilo-class submarines from Sevastopol to Novorossiysk due to a 'change in the local security threat level in the face of increased Ukrainian long-range strike capability', according to the UK Ministry of Defence (2022).

Two Neptune missiles were enough to sink the Flagship of the RFN. While there is still much speculation in the open-source domain as to exactly what happened, it highlights the importance of air power at sea if a nation wants to project maritime power—even being capable of doing so from the shore. Ukraine's strategy in the maritime domain bears close resemblance to Sir Julian Corbett's (1911) theory, in which he advocates for sea denial rather than sea control. Ukraine's ability to project into the maritime domain through missiles rather than a traditional navy follows a similar trend seen on land—asymmetric defensive air power is a highly capable way of controlling and influencing the relevant domains against a much larger force.

7.3 Summary

The aim of this paper was to explore and analyse how air power has been used in a defensive way in both the land and maritime domains. Through analysing Ukrainian use of GBAD as well as their ability to strike maritime targets through the air, this paper synthesised a reasoned explanation of why Ukraine has exceeded initial expectations. Predominantly, this came down to surviving the initial air campaign from Russia with most of their air defences still intact. This was ultimately due to the use of asymmetric systems as the defining aspect in the air domain. This creates an environment in which it is far too risky for Russia to operate without incurring significant losses, much like

the porcupine strategy (Diamond et al., 2023).

Military analysts and scholars around the world will be able to reflect upon the Ukrainian air war and draw key lessons. The future conflicts in the air domain will be heavily influenced by those who were able to successfully apply lessons learned from the Ukrainian conflict. However, one must not transcribe all the same trends onto the next war, as it will inevitably change and adapt to a new scenario.

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8
Russia's lack of maritime air defence

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Shore-launched anti-ship missiles have developed significantly in mobility, range and destructive potential over the previous decades, serving as an increasingly capable threat to current shipborne air defences, as demonstrated in Ukraine and as will likely have continuing ramifications into the future of sea-based air defences. This threat was demonstrated by the sinking of the Russian Black Sea flagship, the *Moskva*. Although briefly mentioned earlier, this paper dives deeper into the presence of the anti-ship missile threat to determine the technical failings of the *Moskva* and assess how this is relevant in the context of contemporary ship air defences. It also considers what tactical and intelligence-based failures contributed to the sinking and assesses what implications this has for contemporary and future shipborne air defences.

While it is unlikely either capability will result in the obsolescence of its counterpart, varying progressions in different fields may force tactical and strategic considerations that limit the operational versatility that naval assets may have enjoyed in previous conflicts. Understanding these changes will allow for a more developed understanding of Russia's failings in the conflict in Ukraine.

8.1 The threat of anti-ship missiles

Ukraine has proven the threat of modern anti-ship missiles in the Russia–Ukraine conflict. Ukraine achieved this through its use of a domestically manufactured Neptune R-360MC missile; 'two Neptune cruise missiles, which Kyiv designed and developed for a reported total cost of US$40 million (AU$57.7 million), sunk the Russian flagship *Moskva*, estimated by Forbes to cost US$750 million' (Jennings, 2022). Despite

an advanced layered air defence system, one theoretically able to deal with a threat far surpassing two subsonic anti-ship missiles (Dutta, 2014) and designed to defend a task group worth billions of USD, the *Moskva* failed to intercept even a single missile. The Neptune missile is a case study in modern shore-based anti-ship missile systems; the truck-mounted system provides excellent mobility, which negates what has historically been one of a ship's greatest advantages against coastal defences: mobility (Calvo, 2015). This reduces the vulnerability of shore batteries dramatically and increases their lethality, as it allows for disproportionate effects, such as in the sinking of the *Moskva*. As demonstrated in Ukraine, shore-launched anti-ship missiles, through their affordability, mobility—and therefore survivability—and lethality have become a key part of shaping the naval air defence environment, enforcing new limitations on areas of operation and threats within the operational environments of ships on coastal operations.

While the sinking of the *Moskva* demonstrated extreme vulnerabilities in the air defences of the Russian air defence ship, these implications do not necessarily spread to those of other navies. There were a number of factors that played into *Moskva*'s vulnerabilities outside of its technological capabilities. The Russian vessel was in an extreme state of disrepair, as claimed by a leaked maintenance report (Carlson, 2022). The report alleges, among other findings, that none of the three-tiered missile-defence systems were functional, engines were thousands of hours past their service replacement dates, only 50 of 500 fire extinguishers were present, some watertight doors were wedged open or leaking, none of the damage control systems were operational and, due to theft, safety equipment was locked in storage that only the admiral held the key to. These findings suggest that the vulnerabilities displayed were not inherent to ship-based defences but may have been exacerbated by uniquely Russian issues of corruption and poor materiel readiness. It is, therefore, not inherently indicative of the failings of shipborne air defences that *Moskva* was sunk, as her defences were unable to be used in the first place. Rather, it was a failure of the Russian Navy and Russian defence industry to properly maintain materiel and personnel readiness. This corruption and/or incompetence resulted in a vessel that would have been considered unserviceable by Western standards (Sea Power Centre, 2017, p. 36) being deployed to an active threat area and being unable to survive in a contested environment. Russian failings in air defence capabilities cannot be entirely, or even mostly, due to technological failings in current air defence systems' capability to intercept missile-based threats.

The survivability and effective use of naval assets involve more than just technology, as tactics and intelligence are fundamental elements to effectively using force in various naval environments. For example, US intelligence was reportedly used to locate and sink the *Moskva* (Dilanian et al., 2022), while Russian intelligence had little to no knowledge of the Ukrainian missile threat (Sinha, 2022). Despite any failings in *Moskva*'s maintenance or systems, without this intelligence advantage, sinking

the flagship would not have been possible. Additionally, it is important to consider the strategic limitations of systems like the Neptune missile and their implications on shipborne air defences.

Shore-based missile batteries have limited power projection, and any projection of missile power beyond their reach off the shore must be delivered by other means. The sinking of the *Moskva* has little direct implication on blue water warfare, where large capital ships have a significant advantage, being able to take advantage of sea room and avoid the possible reach of the enemy's 'ground-based ISR systems, missiles, and aircraft; and while enabling themselves the freedom to "shoot and scoot" at high-speed when required' (Sinha, 2022).

The utilisation of the *Moskva* in a littoral context where it was particularly vulnerable failed to exercise the strengths of the ship's design and played into the hands of the Ukrainian anti-ship systems. Therefore, the sinking of the *Moskva* is not inherently indicative of failings with contemporary ship air defence design; rather, the poor operational manoeuvring of a ship in less-than-ideal conditions, as well as an enemy with an intelligence advantage, were critical contributors to the destruction of the *Moskva*.

8.2 The need for change

If ships are to remain survivable into future conflicts, they will need to embrace emerging technologies and emphasise a connected tri-service intelligence environment to prevent exposing vulnerabilities such as with the *Moskva*. An example of changes in shipbuilding to reflect strategic needs is demonstrated through the US force structure plan, where the service looks to expand its fleet by building larger numbers of smaller ships to maintain capability while greatly increasing the difficulty as well as cost–benefit of targeting their vessels (Axe, 2021). Additionally, emerging technologies, such as the Stryker laser weapon system or Israeli Iron Beam (Iddon, 2022), provide answers to drone swarms and allow for economic response to low-cost munitions. Systems such as the Iron Beam cost of US$2 per intercept (Iddon, 2022) could be effectively used to counter swarms of low-cost UAVs and drones, such as those utilised by Ukraine, preventing the need to exhaust magazines of multi-million-dollar ship defence missiles.

While laser-based weapon systems have their own limitations, if an effective air defence strategy is to be developed by modern navies, it is essential that they embrace new technologies and adapt to most effectively make use of their tactical and strategic strengths and weaknesses. Holistically, an ability to disperse assets, increase their survivability and deliver lethal effect through low-cost measures has been shown to be critical in sustaining a modern war of attrition, as witnessed in Ukraine (Jennings, 2022). The Russian defence industry has been unable to maintain a sufficient supply of advanced high-cost systems (Hill, 2023), whereas Ukraine has seen high levels of

success through the sustainability of their warfare using low-cost drones—although the provision of high-cost Western systems is not to be ignored. In all aspects of future warfare, industry, affordability of systems and the sustainability of warfare are essential, and in the future of air defence, this must be achieved through the dispersal of assets and the acquisition of low-cost interception options.

8.3 Summary

The sinking of the *Moskva* represents a grave failure in the abilities of Russian naval leadership to maintain their ships, use them effectively, gather intelligence and, most importantly, adapt to the needs of contemporary regional and coastal conflicts. Through these implementation failures, it can be reasonably deduced that the failures of the *Moskva* do not necessarily indicate failures for all contemporary air defence systems. Nonetheless, the Russia–Ukraine conflict provides general lessons about the need for low-cost, sustainable solutions and the criticality of adaptability.

An inability to learn from the lessons displayed in Ukraine would indeed sign the death warrant of those who fail to innovate accordingly in future conflicts. However, if Western powers, such as the US, continue to innovate in their force composition and implement emerging technology effectively, then catastrophic and disproportionate losses, such as Russia experienced with the *Moskva*, are avoidable. The implications of the sinking of the *Moskva* range only as far as observing powers allow them to, representing not inherently a failure of equipment but a failure to effectively utilise it.

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9
Artificial intelligence ethics risk Ukraine's survival

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It is becoming an increasing possibility that autonomous weapons systems (AWS) will be deployed in the Ukrainian campaign against Russia. However, as the technology continues to emerge, so do ethical concerns. The ethics of AWS employment threatens the West's support of the Ukraine Campaign. On the basis that the ethics of AWS remain largely indefinable and subject to global disagreement, Ukraine's employment of AWS technology could jeopardise support from NATO and other global partners. Therefore, such a strategic enterprise could cost Ukraine the war. This paper considers AWS as any ground or airborne unmanned system that, once activated, can select and engage targets with little to no intervention by a human operator (Liivoja et al., 2020).

9.1 Legality

The legality of AWS is contingent on its compatibility with Laws of Armed Conflict (LOAC). In the absence of a comprehensive and specific ruling on the legality of AWS, the lawfulness of a system is dependent on its ability to comply with LOAC's core principles of distinction, proportionality and precaution (International Committee of the Red Cross [ICRC], 2023), especially the principles that AWS do not cause superfluous injury or unnecessary suffering; they are not of a nature to strike military or civilian targets without distinction; and are not intended or expected to cause serious, extensive and protracted damage to an ecosystem (Liivoja et al., 2020). An AWS, like any other weapon, can contravene any one of these three precautions. Thus, it would then be considered inherently unlawful, and its employment prohibited. Nonetheless,

there's a difference between a weapon that is illegal per se and the unlawful employment of an otherwise legal weapon (Etzioni & Etzioni, 2017). Hence, granted some AWS may violate LOAC, it cannot be concluded all AWS would do so. Therefore, the lack of an existing ruling means AWS are not necessarily inherently unlawful, but in doing so, occupy an ambiguous space in international law.

AWS technologies remain hostage to international disagreement and contention. Calls for a prohibition on AWS have grown steadily in the last decade. As of late 2018, the campaign to Stop Killer Robots had 87 non-governmental organisations in 49 countries (Wareham, 2018). In an address in 2018, UN Secretary-General Guterres (2018) echoed these concerns, asserting that AWS are 'politically unacceptable' and 'morally repugnant' and should be banned by LOAC. By contrast, Japan and South Korea, nations with big robotics industries, remain opposed to any multilateral treaty against AWS. Unsurprisingly, the major powers—the US, Russia, China and India—also remain opposed to any international declaration prohibiting AWS technologies (Etzioni & Etzioni, 2017). The Pentagon has argued that robots are better equipped than humans for dull, dangerous and dirty missions (Clapper et al., 2007). Meanwhile, countries like the United Kingdom are of the opinion that existing international laws provide ample regulation (Welsh, 2015). As for Ukraine, Digital Minister Mykhailo Fedorov surmised that AWS are a rational and inevitable next step in weapons development (Bajak & Arhirova, 2023). Seemingly, the international community lacks consensus on the issue.

The ethics of AWS and their application in warfare are still largely undefined. The ethical debate is fierce and multifaceted. Critics of AWS raise grave concerns over reducing—or totally removing—human agency in decisions to apply lethal force (Etzioni & Etzioni, 2017), noting that even humans cannot always be sure of a target's legitimacy, let alone an autonomous system's ability. As such, they assert that this would be a dehumanising process that is at cross purposes with our shared humanity and values (ICRC, 2019). However, values and the conception of humanity differ globally.

Several military experts and technologists argue that AWS are not only morally acceptable but are ethically preferable to human combatants. Proponents of AWS believe AWS will behave more humanely in operations for several reasons. For one, they will not be programmed with a self-preservation instinct, thus eliminating the 'shoot first, ask questions later' mentality. Their decisions will not be clouded by emotions of fear or being overwhelmed, and they will be able to process sensory data at superior speeds to humans (Etzioni & Etzioni, 2017). On the contrary, critics believe AWS will struggle to determine who is a combatant and who is a civilian, a problem that plagues even humans (Etzioni & Etzioni, 2017), thus impinging on the LOAC principle of distinction. Evidently, there is no conclusive or agreeable ethical determination on AWS. Any significant shift in the ethical debate, particularly towards opposing these technologies, could have serious implications. Nonetheless, AWS are a lynchpin for

the Ukrainian effort.

9.2 Aerial autonomous weapon systems

Airborne AWS have been crucial in Ukraine's campaign for national survival. Aerial capabilities like loitering munitions have assisted Ukraine's battlefield surveillance, artillery spotting and targeting mobile units. These systems continue to dominate the air war over Ukraine primarily because of their superior persistence, range and reduced cost in comparison to their manned counterparts. For instance, loitering munitions can search, identify and engage targets independently (Global Data, 2022).

The extent of autonomy is dependent on the threat environment. These systems proved their effectiveness in Ukraine's successful counteroffensive in late 2022 (Vox, 2023). They particularly proved their worth in striking artillery, armoured vehicles and logistic depots behind enemy lines. Thus, as the evidence suggests, the use of airborne AWS has been fundamental in Ukraine's campaign. Their value in the Ukrainian campaign has raised the prospect of fully autonomous systems, yet their implementation remains a concern.

9.3 Western support

The West's support is pivotal to Ukraine's continued campaign for national survival. Since Russia's invasion in February 2022, NATO lethal aid has been essential to the sustainment of Ukrainian operations. The US alone has provided US$46.6 billion in lethal aid, from uniforms to advanced artillery systems and main battle tanks (Vox, 2023). Meanwhile, NATO nations have contributed over US$20 billion of lethal aid (Sabbagh, 2023). Ukraine's military today is a far cry from the neglected and impotent force it was pre-invasion. Clearly, the nation's military proficiency is attributable to the provision of Western military aid and training. Yet, the West's support is not totally assured, nor is it coalesced.

Western support is not endless, nor is it completely unified. As the conflict enters its fourteenth month, NATO is rapidly depleting its ammunition stocks to support Ukraine's eastern front. Recent analysis by the Pentagon uncovered that it is nearing the minimum threshold required for its own military planning (Vox, 2023). Equally concerning for Ukraine is the shifting public opinion in the US. A recent Pew Research Center poll showed the proportion of citizens against the extent of US aid has grown by 24% (Cerda, 2023). GOP leader Kevin McCarthy admitted US aid is 'no free blank check' (Amiri & Freking, 2022). More disconcerting is the lack of NATO unity, as both Bulgaria and Hungary refuse to deliver arms to Ukraine. Meanwhile, Slovakia negotiated an energy deal with Russia despite an ongoing EU ban on its oil (Muzikárová, 2023). Ergo, the finite and divided nature of Western support should be a concern for Ukraine.

9.4 Summary

The fragility of Ukraine's support system could cost its national survival. In the event that Ukraine decides the deployment of fully independent AWS is a strategic necessity, it could cost them the war. Thus far, Ukraine has fought a legitimate war. Legitimacy is a major node in the complex adaptive system of the war. It provides the moral foundations for Western military aid. Hence, the sensitivity of relationships—between Western support, ill-defined ethics and AWS employment—means any small, unanticipated event could result in a disproportionate impact on the entire system. A small event as simple as an AWS breaching LOAC could act as a tipping point, after which Western support changes from reasonably assured to exponentially intermittent—even completely discontinued. Any reduction, let alone discontinuation of Western support, could seriously jeopardise Ukraine's survivability and, ultimately, cost it the war.

The potential deployment of AWS in the Ukraine campaign poses a significant threat to the West's support. This is because the ethical implications of using AWS in warfare remain unclear and subject to global disagreements. As a result, Ukraine's employment of AWS technology may jeopardise its support from NATO and other global partners, ultimately putting the success of the campaign at risk.

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10
The *Kestrel Papers* closing reflections

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This collection of papers has introduced a number of preliminary air power lessons from the ongoing conflict in Ukraine. The most common question vexing military commentators has been the unexpected absence of air power from both sides. While the answers to this are varied and interdependent, the opening papers of this collection have highlighted how effective intelligence and technological ingenuity helped Ukraine defeat Russia's opening air assault. Other explanations include Russia's inability to pivot from its entrenched air power doctrine of supporting the nation's long-standing approach of land forces; had it been employed for greater use against strategic targets, Ukraine's ability to repel the initial assault would have been completely undermined.

Beyond the initial assault of Kyiv, the use of traditional air power has also been muted. The effective use of ground-based air defence—by both sides—has been a significant player in limiting offensive air capabilities. In response, however, both sides have exploited the use of smaller, cheaper and attritable drones to occasionally slip through legacy air defence sensors. This rapidly developing capability has been shown to be equally effective in maritime settings as it is over traditional land targets.

The nonlinear tipping point of drone use in a proxy great powers conflict has introduced a new problem. The Ukrainian war of national survival (vice war of choice for Russia) has seen a national mobilisation of the country's best and brightest minds. This means drones are not only replacing a number of traditional military activities and thus reducing the number of humans in harm's way, but they are also testing ethical uncertainties around warfare. In particular, the commensurate rise of artificial

intelligence–based autonomous systems in the civilian sector has discipline-hopped into the military arena. While the legality of AWS remains murky, Ukraine's flirtations on the battlefield raise questions about risking Western support. Once lost, regaining international support could be impossible and, therefore, a fatal blow to its ability to prosecute a war against a numerically superior (former) superpower.

The Russia–Ukraine conflict has seen a host of paradigm challenges to legacy military theory. External observers have much to learn about the new trajectories of so many innovations in this war's first 12 months alone. As Justin Trudeau astutely noted, 'the rate of change has never been so great, but it will never be this slow again'. Perhaps the greatest lesson to come out of the current conflict is that studying eighteenth-century theorists might be self-gratifying for historians but is of minimal use to those charged with preventing tomorrow's wars. Modern militaries should be mindful of the past but be future focused.