Aerospace & Defense

Journal of the Elrom Center for Air and Space Studies at Tel Aviv University

No. 1(1) | November 2024

ELROM CENTER FOR AIR AND SPACE STUDIES
TEL AVIV UNIVERSITY

Aerospace & Defense

Journal of the Elrom Center for Air and Space Studies at Tel Aviv University

No. 1(1) | November 2024

Aerospace & Defense is a multidisciplinary academic journal published by the Elrom Center for Air and Space Policy and Strategy Research at Tel Aviv University. The journal serves as an exclusive platform for scholarly discourse on critical issues pertaining to air, space, and security. It actively promotes the dissemination of research articles that offer rigorous, critical, and innovative analytical perspectives. Our mission is to foster a comprehensive understanding of these domains, particularly in the context of contemporary advancements in technology, strategic frameworks, geopolitical dynamics, military operations, and policy development.

ELROM CENTER FOR AIR AND SPACE STUDIES
TEL AVIV UNIVERSITY

Elrom Center for Air And Space Studies
Tel Aviv University

ISSN: 3080-020X

Graphic Design: Michal Semo Kovetz,
TAU's Graphic Design Studio

Table of Contents

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

Message from the Editor-in-Chief

Dear Readers,

We are thrilled to publish the inaugural issue of the journal Aerospace & Defense. This journal will cover a broad spectrum of topics related to security, policy, strategy, and technology in the realms of air and space. Our scope ranges from military and air force-related subjects to technological advancements, national and military policies, industry developments, international relations, and more. Our goal is to create a platform for scholarly discourse—both theoretical academic research and applied policy studies—for researchers in universities and relevant research institutes, as well as for the security community engaged in air and space domains, and for those involved in technological and developmental work in these fields.

The publication of this journal has gained heightened importance over the past year as Israel has been thrust into an unprecedented strategic turmoil in its 75 years of existence. The discussion and discourse on strategic issues, including those in the air and space domains, as manifested in the Iron Swords War between Israel and Hamas, the conflict with Hezbollah in Lebanon, and the attacks and responses involving other Iranian proxies and Iran itself, are of utmost significance.

However, this is not limited to Israel alone. The two and a half years since the outbreak of the Russia-Ukraine war, as well as other conflicts that have occurred worldwide, have brought the topic of air and space to the forefront of global discourse. This includes both the strategic systemic aspects and the anticipated development of these domains in relation to humanity and its future, especially considering the still untapped potential of space. All these factors have driven us to create this journal, with the first issue, naturally, dedicated to aspects of the Iron Swords War, published one year after the Simchat Torah massacre on October 7, 2023. Future issues will focus on a variety of topics researched here and beyond.

I take this opportunity to thank everyone who has contributed to being part of the journal's editorial team and all others who have helped us reach this milestone of publishing the journal.

Eviatar Matania,
Editor-in-Chief

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

Editorial Note

The surprise attack by Hamas on Israel on October 7, 2023, and the ensuing Iron Swords War are the focal points of the five articles in the inaugural issue of **Aerospace & Defense**. This war has been a pivotal event in various aspects of Israel's national security, with one of the most prominent being the technological and qualitative asymmetry between Israel and Hamas. This asymmetry significantly influenced the actions of both sides before and during the war, exposing the challenges and evolution of the modern aerial battlefield in strategic, technological, and theoretical dimensions, as detailed by the researchers in their articles.

In the opening article, "The Role of Airpower in Battle: Some Preliminary Insights from Combat in Gaza in the Iron Swords War," Asaf Heller challenges the traditional operational paradigms of the Israeli Air Force (IAF). Heller examines the evolution of air power deployment from the Second Lebanon War in 2006 to the present, highlighting the IAF's operations from the perspective of the needs of maneuvering ground forces. He analyzes the changes in the IAF's operational concept, indicating the need to reassess the doctrine of air power deployment in Israel and modern air forces. Heller discusses this while pointing out differences in the characteristics of combat arenas and operational concepts from the period preceding the Iron Swords War.

Following this, Meir Finkel's article, "Not a 'War of Its Own': Offensive Air Support for the Maneuvering Forces in the Iron Swords War in Gaza—Factors of Success and Looking Ahead," discusses the development of close air support for maneuvering forces by the IAF. Finkel identifies patterns of organizational learning and adaptation considering several unique aspects of the combat characteristics that enabled the IAF to provide close air support to maneuvering forces on an unprecedented scale. The article's title alludes to Uri Bar-Joseph's critique in his book "Its Own War — The Air Force in the Yom Kippur War" (2021), which argued for the limited contribution of the IAF to the ground battles of that war. Finkel identifies the same central patterns that show how the organization learned and adapted to provide effective close air support in the Iron Swords War. He suggests linking the IAF's achievements to those of the maneuvering forces and compares this war to previous operations to draw lessons for future battlefield deployment.

In the third article of this issue, Alex Dan addresses the relevance of attack helicopters and the considerations for their acquisition and development in light of evolving combat technologies. In his article, "The Need for Attack

Helicopters: Characteristics and Challenges in the Era of Modern Warfare," he demonstrates how military benefits were derived from attack helicopters and discusses developments in unmanned systems and precision weapons that necessitate a reassessment of attack helicopters' benefits. Emphasizing a meticulous methodology, Dan applies SWOT analysis principles to attack helicopters and recommends a balanced approach to future force building, considering the total cost of ownership, their relative vulnerability, and the emerging and available alternatives.

Ehud Langer's article, "Powered Paragliders and the Air Assault Threat to Israel," the fourth article in this issue, explores a new tactical approach to aerial assault employed by Hamas, utilizing powered paragliders as an alternative and efficient platform to attack helicopters. Langer discusses the implications of this threat and questions Israel's air defense readiness to counter it. The article underscores the importance of perception, recognition, and preparation for emerging threats in modern combat.

Finally, an in-depth analysis of the technological implications of the war is presented in the article by Eviatar Matania and Alon Berkman, "Digital Weapons: How Global Digital Platforms May Potentially Disrupt the Modern Battlefield." They show how commercial digital platforms can be adapted for use as digital weaponry, creating disruptive innovation. Their argument is based on lessons from the Russia-Ukraine War (2022) and the Hamas attack on October 7, 2023, exemplified by the use of social media as a strategic tool for war management and creating cognitive effects. They argue that adapting civilian digital platforms into digital weaponry could alter the global balance of power.

Together, these articles paint a detailed, though not complete, picture of the complex world of air and space security. They shed light on the strategic factors that have influenced activities in these areas in Israel from October 7 and over the following eleven months.

Aerospace & Defense is a peer-reviewed scientific journal, ensuring that all published articles undergo a rigorous double-blind review process. We invite researchers and practitioners to contribute their comments, insights, and original articles on a wide range of topics within the field of air and space security.

We extend our heartfelt gratitude to the journal's editorial team and all those who contributed to the writing and preparation of the articles for publication. A special thanks goes to the article reviewers, whose dedication and expertise have significantly enhanced the quality of this issue.

Sincerely,

Nir Hassid,
Editor

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

The Role of Airpower in Battle: Some Preliminary Insights from Combat in Gaza in the "Iron Swords" War

Assaf Heller

Summary

The operation of the Israeli Air Force in the Iron Swords War in Gaza was a departure from the IDF's airpower concept of operations (CONOPS), which, since the Second Lebanon War in 2006, has focused primarily on the use of airpower to erode the enemy's military capabilities while also providing support for ground troops in combat. However, in Gaza the task of aiding the ground troops became the Air Force's primary mission, and the number of targets attacked was greater than in any of Israel's wars to date. This article will try to analyze the roots of this change and discern what might be learned from the operation itself as to the operating concept that is best for the operation of airpower in general – and specifically the Israeli Air Force – in future combat.

This analysis has shown that the operation of the Air Force differed from the CONOPS primarily because of the goals of the war, the civilian surroundings in which the enemy operated (above and below ground level), and the integration between air and ground forces, as it has developed over recent years. Therefore I propose to distinguish between conclusions that apply to the operation of airpower in urban terrain and conclusions that apply to the Israeli Air Force's general CONOPS. With regard to operation in urban environments, the article employed the methodology of comparing the Iron Swords War and the war against ISIS in Mosul and Raqqa, and presented the large scope of strikes required to support ground forces, the limitations of airpower in inflicting physical damage on enemy forces, and the inevitable harm to civilian populations. The IAF's CONOPS must address a multitude of varying arenas that are very different from the Palestinian arena – both in their goals and in the nature of the operational environment. In these

arenas, airpower will constitute the larger share of military force deployed, and the solution required will be based on principles from previous CONOPS, begging means and methods that differ greatly from those needed in Gaza.

Introduction

Prior to the current war, the IAF's CONOPS considered the Air Force a key combat tool for operational and strategic needs, with the ability to incur significant, rapid, and widescale damage to the enemy's infrastructure and attack capabilities. Providing support to ground forces was one of the IAF's roles, and it was assigned to support ground maneuvers. In Gaza, however, the support of ground troops in urban environments soon became the IAF's primary combat role. In the war in Gaza, the Air Force became an " Army aviation", in that it was operated from the perspective of the ground maneuver's requirements.

This article begins by discussing the reasons for the difference between the IDF/IAF CONOPS prevalent prior to this war and the way the IAF was deployed *de facto.* My discussion is based on a survey of the development of Israeli airpower CONOPS, with an emphasis on the last two decades. This survey is based on a wide research database which is partly theoretical and partly historic. I then analyze the operation of airpower in the Palestinian arena, which has only become an operational arena for the IAF in the last 20 years, and a significant one in the past decade with the establishment of Hamas' military and political power in Gaza. My discussion focuses on the unique characteristics of combat in the Gaza Strip in comparison with previous wars and in the way the operation of airpower developed during combat, primarily in its use as an "Army aviation" in an urban environment.

I later discuss what can (and cannot) be learned from the method of operation in Gaza, in two aspects: a) Conclusions to be drawn for battle in urban terrain, which is a unique case for the IAF, as it has no historical test cases for this. For this reason I chose a comparative approach with the Global Coalition's battle against ISIS in the previous decade, where airpower was operated as support for ground maneuvers, especially in Mosul and Raqqa. Analyzing the similar and different operational characteristics when fighting ISIS compared to Hamas allows us to consider the insights from the was in Gaza in a wider framework; b) Conclusions that apply to the Air Force when addressing battle in non-Palestinian arenas. This discussion is based on examination of the differences between arenas and a renewed observation of operating concepts from the pre-Iron Swords era.

Changes in the role of the IAF in combat

Throughout half of its existence, Israel's military confrontations were mostly with its surrounding Arab neighbor countries, with the highest priority assigned to responding to a combined attack from all Arab countries ("The 'Total' Scenario"), and not to "routine defense" (Freilich, 2019, p. 36). According to the Israeli security doctrine, Israel needs absolute victory in any war in order to remove the immediate threat, to establish deterrence, and to postpone the next war; and this victory needs to be achieved quickly in order to minimize the damage of a prolonged war (Eisenkot and Siboni, 2019; Ben Gurion, 1981; Dekel and Einav, 2017).

In the first few decades after its foundation, Israel's military doctrine was based on victory achieved by the maneuvering of ground forces into enemy territory to remove the immediate threat, to overcome the absence of strategic depth in Israel and to achieve dominance. Inability to bear the expense of a large conscripted army led to the need to rely on a relatively smaller regular force, accompanied by a large reserve army that would constitute the lion's share of the maneuvering force. Under this doctrine, the Air Force had a number of important roles: protecting the home front from aerial attacks, defending the recruitment of reserve forces and aiding the ground troops in combat. As David Ben Gurion said in 1950:

> "The Air Force cannot manage war on its own. It cannot win alone, but I believe that without an air force we have no chance of winning, although the victorious army shall be the ground forces. However, the ground forces have no chance of winning without an efficient air force, especially one that is efficient from the very first moment war breaks out." (Brun, 2022, p. 37).

Therefore, from its very first years Israel invested approximately half of its defense budget in its air force. The concept of victory on ground via maneuvers into enemy territory was materialized in the wars of 1956 and 1967, and, after an initial phase of defensive operations, in 1973. The Air Force was successfully deployed on missions of defense against aerial threats, including operations of "offensive defense" by attacking enemy air forces on the ground, and less successfully in missions of aiding ground troops (Shelach and Heller, 2022, pp. 9-16).

Until the end of the 20th century, the Air Force continued to develop and improve its capabilities, but the basic concept remained the same: victory in war would be achieved on the ground, and airpower was required to assist in defending the aerial arena and in the ground battle. The role of the Air Force

in ground battles expanded far beyond providing Close Air Support, to include methodical strikes on enemy infrastructures: attacks on fortifications, command centers, and artillery, as well as interdiction (Finkel, 2022, pp. 179-185). Later on, the Air Force took on a central role in defense against future enemy ground invasions as part of "the Central Project" (Ben, 2022). This concept was similar to the AirLand Battle concept consolidated in the US during those years to halt any possible invasions by the Warsaw Pact against Western Europe (FM 100-5, 1982). Focusing the Israeli CONOPS on the ground defense corresponded to the gravest threat: on-ground invasion by enemy armies. Threat of strikes deep into Israel was posed primarily by enemy planes, and was addressed by air defense and attacks on air bases. Threats from artillery attacks were mostly limited to areas close to the front.

The turn of the 21st century saw the development of a conceptual change in operating airpower. Airpower had been unsuccessful in winning wars via conventional attacks, even when bolstered by the investment of vast resources, as was done in the Second World War or the Vietnam War. And, at the end of the 1980's, technological change led to developments in the American concepts, with the advent of precision munitions, the survivability of "stealth" aircraft and more rapid dissemination of information. John Warden offered a new approach to the operation of airpower: identifying the enemy country as a complex system and its "dismantlement" through precise, widescale and simultaneous aerial strikes against its physical system (Warden, 1995). The Effects-Based Operation (EBO) approach was a further evolution of Warden's suggestion and proposed simultaneous aerial strikes against the enemy, to achieve specific effects and not the destruction of targets per-se (Deptula, 2001). According to some of the scholars, this approach was what enabled victory over Serbia using airpower alone in 1999, and in Iraq in 1991, where air strikes shattered the Iraqi Army's logistic and control abilities, facilitating a short ground maneuver that led to a swift victory (Luttwak, 2002, pp. 236-240).

At the beginning of this century, the Israeli Air Force adopted the EBO approach as a CONOPS, alongside the IDF's study of the Revolution in Military Affairs (RMA), and the development of the systems approach by its General Staff. Together these components led to the consolidation of a new doctrine for the IDF (Brun, 2022, pp. 121-125). The basic idea was the precise and simultaneous multi-targeted use of force in order to dismantle the "enemy system" instead of wearing down the enemy's capabilities. An attempt to realize this concept was made in the Second Lebanon War in 2006. Before the war, the "Ice Breaker" plan was formed, meant to create leverage through aerial attacks alongside a limited ground maneuver, and bring about a new situation in Lebanon as terms

for ceasefire (Laish, 2016). However, the government rejected the IDF's plans to attack Lebanese infrastructures at the onset of battle simultaneously with strikes against Hezbollah targets, and the IDF engaged in direct battle with Hezbollah (Golan, 2022, pp. 45-50). In that war the Air Force battled Hezbollah wherever the terrorist organization was deployed in Lebanon, while ground forces operated near the border throughout most of the war.

Two primary conclusions drawn from the Second Lebanon War influenced the role of the Air Force and its CONOPS. The first was that ground maneuvering alone could not remove the threat of rockets on the Israeli home front from deep within enemy territory, and thus could not provide a solution for the leadership, while on the other hand it took a heavy toll: strategic risk resulting from the prolonging of war as a result of the conquest of land, strategic risk resulting from foreseeable damage to population centers, and the political and social difficulty entailed in sustaining a large number of casualties. This led to an increased necessity to develop an airborne solution that would replace the ground maneuver and provide a response that was customized to the needs of the leaders. The second conclusion was that the Air Force could not remove the threat in its current mode of operation. The EBO approach was developed for wars against states, and was unsuitable for war against non-state actors such as Hezbollah in Lebanon or Hamas in Gaza. Apparently, when faced with these enemies, the IDF confronted a shortage of levers to exert pressure, and, as these were scattered and made up of small units that operated within civilian populations in urban terrain, there were no "gravity centers" to strike (Norkin, 2020). The paradoxical nature of strategy, as Luttwak defined it (2002), led these non-state organizations to a concept that minimized their weaknesses when faced with Western armies that operated a strong Air Force – those armies that had been so effective in warring against states (Brun and Valensi, 2010).

In light of accumulated experience and technological developments, the IDF updated its CONOPS over the past decade, also rethinking the role of the Air Force. The IDF's strategy determined that victory would be achieved through wide-scale erosion of the enemy's capabilities, with an emphasis on its attack capabilities. This would lead to its inability to attack Israel and effectively defend itself, and allow Israel to coerce political agreement from a position of power (IDF strategy, 2015, 2018). In a way, this approach is similar to a theory posited by Robert Pape: his claim was that one hundred years of airpower have taught us that the effective means of enforcement via airpower is the erosion of military capabilities, which leads the enemy to acknowledge its inability to continue fighting (Pape, 1996). Within the IDF's doctrine, the role of the Air Force is to attack many targets simultaneously, at a high capacity of 3,000 per day (Ben

Yishay and Zeitun, 2021), including targets that are deep in enemy territory and out of the reach of ground forces. From the scope of attacks mentioned, we realize that the concept was not aimed at strikes against "gravity centers" like the EBO approach; it rather preferred eroding the majority of the enemy's military capabilities (Amidror, 2021). "The concept of victory" continues the IDF's strategy and elaborates primarily on the operational side of war: it deals "not only with the question of '**what will lead to victory**' […] but more profoundly with the issue of '**how we will lead to victory**' (Kochavi, 2020, p.8, emphasis in original). The operational approach includes exposure of a hiding enemy and a fast-paced attack, while relying on accurate intelligence, advanced technologies, distribution of these abilities to the forces on the battlefield, and a tight integration between the various military branches.

In the concept of victory, airpower is considered a key component in attaining victory. Its role departs from the defensive missions and integration with on-ground battle as in the older Israeli concept. Similarly to the effects-based approach, in the concept of victory, the accomplishments of the Air Force attacks constitute a significant portion of the total military achievements of the war. To fulfill its role, the Air Force must be a sophisticated "strike factory", capable of attacking the "targets bank" at high volumes: a factory that starts with the assembly of munitions at the bases, proceeds with the rapid arming of combat planes, and on to effective control and flexibility in choosing targets at a fast pace (Norkin, 2020).

The Air Force in battle in the Gaza Strip

The Palestinian arena differs from others. Over the years, the IDF used its power for routine defense operations and not for changing the security reality, except in Operation Defensive Shield (2002). Those years saw the escalation of terrorism that began during the Second Intifada, and the Israeli leadership gradually recognized that the Palestinian leadership under Yasser Arafat had become an enemy and was no longer part of the solution to fight terrorism, but part of the problem. The goal of Defensive Shield was to change the security reality by temporarily taking over most of the areas under the PA's control, while neutralizing terrorist activity as well as the influence of the Palestinian leadership (Lasloy, 2022, p. 208) – a goal that was irrelevant to how Israel's security doctrine dealt with Arab states. Ongoing defense operations have since continued with periodic invasive operations to strike against terrorist infrastructure ("mowing the grass"), but without the intent of reshaping reality via military action. After Hamas took over the Gaza Strip, Israel preferred 15 years of limited rounds of battle over a war to annihilate the terrorist organization. The role of

the Air Force in the Palestinian arena included participation in reconnaissance and targeted killings as part of the routine, and attacks during the limited rounds of battle in the Gaza Strip.

On October 7th, 2023, the situation was fundamentally changed by Hamas' murderous attack on Israel. After many years in which Israeli governments accepted Hamas' rule in Gaza, the goal was now to topple Hamas' rule and destroy its military capabilities – to annihilate it once and for all (Cohen, 2023). This is an especially demanding goal. In the past, Israel's military doctrine has acknowledged its inability to irrevocably defeat the surrounding states. This was also the approach towards Hezbollah in Lebanon – the aspiration was to a military achievement that would force it to agree to a ceasefire (Norkin, 2020) and enable future arrangements (IDF Strategy, 2015). Unlike what the IDF had prepared for in other arenas, the goal of the war in Gaza determined that at its end, Hamas would cease to exist and would not play any part in a future agreement on Gaza.

The destruction of Hamas necessitated a military accomplishment of widescale physical attack on infrastructures and elimination of many Hamas and Palestinian Islamic Jihad (PIJ) militants. During the first three weeks of battle, the IAF performed a wide-scale attack on many targets in Gaza, but it was obvious from the start that the required military achievement could not be attained through air strikes alone. Eliminating Hamas and PIJ militants who hid among civilians and in underground tunnels (many of which were not pre-mapped) required a ground invasion and a lengthy battle of attrition – house by house, tunnel by tunnel.

Along with the Air Force's essential role in defense against missiles, rockets and unmanned air vehicles, its primary role in the attack was once again integration in on-ground battle: attack of targets, collection and medical evacuation via helicopters. In this situation, air strikes are very different from those designated to erode enemy capabilities. They are not strikes on a pre-planned and well-known bank of targets, as the IDF strategy and concept of victory decreed. This kind of support attacks is characterized by the targets being "created" during battle, and they are of two primary types: crushing enemy facilities before ground troops enter a new area, in order to minimize conflict and danger (Ben Yishay, 2023); and close support attacks in real time, against targets identified by the forces as they move in the battlefield ("flash" attacks) (Zeitun, 2024).

What led to the change of CONOPS in the Air Force and to its operation in Gaza under the rationale of an Army Aviation whose missions were derived primarily by the needs of the ground forces? Firstly, air strikes were ineffective for inflicting enough damage upon Hamas terrorists and infrastructure in an urban and underground environment to collapse the Hamas regime. Secondly,

the intensive air support provided to the troops on ground corresponded with the jointness approach consolidated by the IDF in recent years. Thirdly, the operation of the Air Force was adjusted to the needs of the ground forces that went into a perilous and dense area, as the Air Force Commander explained: "We have developed a fighting technique in which any ground force encounters the enemy [while being] surrounded by air support" (Now 14, 2023). Finally, perhaps it was the approach of the General Headquarters – who guided the ground maneuvers and allocated aerial munitions – that led to the allocation of larger scopes of air support to the ground maneuver.

One of the results of the altered IAF CONOPS in Gaza was the very large number of targets and bombings during the war. By the end of 2023, after three months of combat, the Air Force had dropped 29,000 bombs, the majority (approx. 60 percent) of which were precision guided munitions (Ynet, 2023). This is a very large number compared to previous wars, especially considering the small area of battle in the Gaza Strip in relation to the arenas of past wars. For the sake of comparison, in the First Lebanon War the IDF dropped 13,000 bombs, few of which were precision munitions ("smart bombs"). During the Second Lebanon War, 20,000 bombs were dropped, approximately a quarter of which were precision munitions (Brun, 2022, p. 155). During the Yom Kippur War, where Israel fought bitter battles against two states with large armies, the Air Force dropped 40,000 non-precision-guided munitions ("dumb" bombs). Attacking with "dumb" bombs requires the launch of several bombs on each target, and this is the reason for the relatively large number of targets attacked from the air in Gaza – by mid-February 2024, thirty thousand targets had been attacked in Gaza (compared to 7,000 in the Second Lebanon War), most from fighter planes (Amir, 2024).

Aerial attacks are very effective for damaging buildings, and these attacks led to large-scale damage in Gaza's buildings. Along with fear from IDF invasion, they were probably a significant factor in the flight of most of Gazans from their homes even before the ground maneuver began (Malam, 2023), but the required physical achievement – killing many Hamas terrorists – was achieved slowly and partially. After six months of battle, one third of 40,000 Hamas and Palestinian Jihad militants were killed (Arbeli, 2024), not all by aerial attacks. The widescale damage to infrastructure and personnel makes it very difficult for Hamas to fight, but does not prevent its rehabilitation after the war.

The war against ISIS

There are similarities between Israel's war on Hamas in Gaza and the Coalition's battle against ISIS in the cities of Mosul and Raqqa in the previous decade. On

the strategic level, the Coalition's battle against ISIS also faced an entity that had started out as a radical non-state organization and had become a state in practical terms. The war's goal was to defeat the organization (US Department of State, 2014), and later obliterate it completely (Watson, 2017). On the operational level, the battles in Mosul and Raqqa were also conducted in dense urban surroundings. ISIS used civilians as human shields, turning schools and mosques into military sites; its militants hid and moved in tunnels and spread canvas sheets in the streets to prevent detection from the air. Airpower was operated for the purpose of "shaping the battlefield" by striking at targets before the entry of ground forces, and primarily provided support in real time to ground forces that entered to purify the cities, along with artillery support (McNerney et al., 2022; MSG, 2017).

The battle at Mosul began two years after ISIS entrenched itself in the city and lasted for nine months, from October of 2016 to July of 2017. Mosul is a large city, with an area that is half the size of the Gaza Strip and a population of 1.5 million. Many of its civilians fled from ISIS, and at the beginning of the battle there were 750,000 in the city (Airwars, 2018), with 3,000 to 5,000 ISIS militants (MSG, 2017, p.5). The battle at Raqqa took place three and a half years after it had effectively become the ISIS capital, and lasted four months: from June to October of 2017. Raqqa's area spans 10 percent of Gaza's, its population is half a million, and when the battle begun there were 100,000 civilians and 3,000 to 5,000 ISIS militants (McNerney et al., 2022) on and under the ground. Both Mosul and Raqqa harbored fewer civilians than Gaza at the outset of war, and these gradually left the cities as war continued. The number of ISIS militants battled by the Coalition in each of these cities was one tenth of the number of Hamas and PIJ militants in Gaza.

In battle, Coalition forces in Mosul launched 29,000 aerial and artillery munitions (Oakford, 2017); of these several thousand were bombs, under the assumption that at the height of combat 2,000 bombs were launched per month (AirForceTimes, 2017) in addition to 6,000 bombs dropped on Mosul in the two years preceding the battle, according to AFCENT (Pawlyk, 2016); in total, 10,000-15,000 bombs were launched on Mosul. In Raqqa, Coalition forces struck with over 21,000 aerial and artillery munitions in combat alone; of these, 5,000 were bombs (Oakford, 2018). The majority of aerial attacks used precision guided munitions and relatively small warheads (Paveway-IV and GBU-54's with laser/GPS homing technology and 500lb warheads, as well as 250 lb. GBU-39's). A large portion of the Coalition's artillery was relatively accurate (Excalibur, GMLRS and guidance kits for shells), alongside "dumb" artillery such as mortars (Airwars, 2018; Lambeth, 2021; McNerney et al., 2022;

MSG, 2017). The intensity of attacks in the urban areas of Raqqa and Mosul, at 70-140 bombs per square kilometer, is similar to that in Gaza. However, as the battles in Raqqa and Mosul were focused on particular areas, the intensity of strikes in these areas was significantly higher. Also, the warheads used in Gaza were larger (up to 2000 lbs.).

The majority of the terrain in which the Coalition battled against entrenched ISIS militants was destroyed. According to a UN report, 70 percent of the buildings and structures at Raqqa were damaged or destroyed, deeming the city uninhabitable, as were 80 percent of the buildings in the Old Area in Western Mosul. The number of civilians killed in both cities was estimated at 12,000 (10,000 in Mosul and 2,000 in Raqqa). Coalition strikes caused one third of the civilian casualties in Mosul and two-thirds in Raqqa, many in buildings that collapsed during the strikes (Airwars, 2018; George et al., 2017; McNerney et al., 2022; Oakford, 2017, 2018). According to some estimates the number of civilians killed was much higher, perhaps even four times as high (Cockburn, 2017). The percentage of civilians killed in air and artillery strikes in the cities was 0.5-1.5 percent – similar to the percentage of civilians killed by these measures in Gaza: out of 2.2 million civilians, 20,000 were killed – which is the difference between the total number of casualties reported by the Gazan Ministry of Health and the number of Hamas and PIJ militants killed according to IDF estimates (Harel, 2024).

Insights on operating airpower in densely populated urban environments

The ongoing battle in the urban environment necessitated an operating concept that was different from what the IDF had developed over the past decade: instead of emphasizing intensive strikes against targets whose location and number were known (more or less), this situation required strikes against many targets, as part of support provided to the ground forces. This result is similar to the conclusions drawn from the battles in Mosul and Raqqa, where the pace of attacks required intensified when the ground maneuver began, and continued to increase as the ground forces encountered stauncher enemies.

In battles in urban terrain, most targets are created as the ground forces progress, based on the needs that arise when encountering the enemy. Therefore the number of targets continues to increase, and as long as the targets are infrastructures that allow the defensive forces to hide and counterattack – e.g. buildings and suspected underground infrastructures – there is no practical way to avoid this. As battle continues, the need for "preparatory" and support

attacks increases, based on the scope of maneuvering forces and the duration of their progression.

Combat in Gaza, as in Mosul and Raqqa, revealed the discrepancy between the physical achievement of air strikes which damage buildings, and the physical achievement of harming enemy militants. The number of air strikes and buildings damaged is much higher than the number of enemy militants killed. The air strikes contribute to the survivability and mobility of the ground forces, but even if it plays an important part in inflicting overall damage upon the enemy, it does so at a high cost of resources.

Aerial attacks of enemies who use civilians as human shields and civilian infrastructures as military sites leads, of course, to massive damage to civilian populations and infrastructures. The volume of damage to civilians is greater than the damage to enemy militants, even when considerations of collateral damage are taken into account, as seen in the wars in Gaza and against ISIS. Harming civilians also comes at the significant political price of diminished legitimacy to the continuation of the war, as is happening in Gaza and in the Ukraine war (Rakov and Feinberg, 2023).

Combat in urban environment shows the great importance of jointness between ground forces and airpower. The forces need to share a common situational awareness picture as well as the ability to synchronize planning and control in real time, in order to enable the conversion of knowledge accumulated on the ground into air strike targets and to minimize the risk of friendly fire due to the short distances between the forces and the targets they identify. This conclusion corresponds with the jointness approach in the IDF (Kochavi, 2020), and is also prominent among the American insights from the war against ISIS (MSG, 2017, pp. 10-19).

Conclusions as to the role of the Air Force in battle

The war in Gaza has posed a new challenge to the Air Force, which was a result of a combination of three factors: the goal of the war, which required a prolonged ground maneuver, the nature of combat in an urban environment, and increased expectations of intensive air support to the ground forces operating in enemy territory. Combat in Gaza required a CONOPS that differed from what had been formed over more than a decade, and focused on air support for ground maneuvers and not on an air campaign.

The war in Gaza has an attribute that is unique to Israel's wars to date: the goal, as defined by the political leadership – the dismantling of Hamas – led to a demand not to stop fighting "until absolute victory" (Mazuz, 2024). In previous wars (and in the IDF strategy paper), the goals were always defined

as removing the threat to Israel, damaging the enemy's military capabilities and forcing a ceasefire from a position of strength, and it was therefore possible to suffice with the military achievement of eroding the enemy's capabilities. In the Gaza war, even if Hamas' ability to damage Israel was severely compromised in the first few months of war, its total collapse requires a military achievement that cannot be fulfilled in practice from the air. In terms of an aerial strike, this is an "infinite" enemy in practical terms, as arises from the ratio between the number of bombs dropped and the number of Hamas militants killed in the bombings (the ground maneuver in the urban environment requires large resources too – six divisions have been active for several months in an area that does not encompass the entirety of Gaza, compared to half of this volume which was required to conquer the Sinai Peninsula in the Six-Day War, and less than half of this force which was needed to conquer the West Bank and the Golan Heights).

In other arenas the situation is different, firstly because of the goals of the war: they do not necessitate "absolute victory" but rather the coercion of the enemy to accept a long-term ceasefire arrangement, and also because of the size of arena: it is practically impossible to pursue all of Hezbollah's militants to the end of Lebanon, and certainly not when faced by an enemy at a distance of over 1,000 kilometers from Israel. Therefore, in other arenas the achievement demanded from the IDF is entirely different, as is the corresponding CONOPS. In these arenas the Air Force may be used to inflict significant damage on the enemy and erode its capabilities, primarily when faced with an enemy state but also when facing a non-state enemy. The components of previous concept – neutralizing the enemy as a system and eroding its military capabilities by aerial strikes – are once again relevant.

Except for the special case of the Palestinian arena, in other arenas airpower will play a dominant role and will not be merely a support force. This does not go to say that air support is unimportant – it is very critical and important. This is also not a claim that there is no need for ground maneuvers. When battling the Hezbollah, airpower has the potential to secure military and psychological achievements that could impact the ability to coerce an arrangement after the war, provided the maneuver is successful in achieving its goals (Shelach, 2021). However, in Lebanon, and certainly in farther arenas, the centers of gravity of decision making and majority of weapon systems that pose a threat to Israel are beyond the range of ground maneuvers. Even the ground maneuver cannot guarantee the elimination of the majority of Hezbollah militants – it can strike down those who fight but not those who retreat to the north, and it will be very difficult to battle those who decide to hide in villages, wooded areas and

underground facilities. In any case, within the ground maneuver, airpower plays an important role in providing support, and many of the tactical, organizational and technological lessons learned from the war in Gaza are very relevant to it.

Reliance on air campaigns has sustained a variety of critiques throughout the years. The enemy has changed on the tactical level, effectively coping with aerial strikes by hiding, distribution and use of underground sites, as well as on the strategic level, through its willingness to sustain a great deal of damage, to adopt a doctrine of "victory via not losing" and the erosion of legitimacy. Therefore it is difficult to translate the ability to carry out a precise and massive strike against a "targets bank" into a strategic accomplishment in war (Laish, 2011; Finkel, 2017). This criticism may grow in light of the experience in Gaza, due to the Air Force's difficulty in attaining systematic achievements other than in providing assistance to ground forces. However, despite the criticism, there is currently no other practical tool of attack besides aerial strikes, which can inflict damage upon the enemy and erode the threats against the Israeli home front – even those that are far north of the border with Lebanon, and all the more so those in Yemen, Iraq, the depths of Syria and Iran. In these arenas the Air Force plays a major role, but the question of how it should develop its capabilities exceeds the scope of this discussion.

Conclusion

The war in Gaza is an opportunity to learn about the suitable CONOPS for airpower, especially in light of the discrepancy between the prevalent CONOPS before war and the way the Air Force was operated *de facto*. Important lessons have been learned about air support in urban environments, but one must be very careful when applying these lessons on airpower roles to other contexts, and most especially when considering the proportion between air support missions and the airpower's missions derived from its role as a key player in inflicting damage enemy capabilities. The Air Force's missions in various contexts of warfighting require tools that are different from what is required in Gaza: principles and means from previous CONOPS – doctrines, air frames, systems, munitions, organizational structure, and training.

Sources

Airwars (2018). *Death in the City*: *High levels of civilian harm in modern urban warfare*. https://tinyurl.com/3d5vhhkb

Amidror, Y. (2021). *The war against Hezbollah in Lebanon – for what do we fight?* Bein Haktavim, Issue 2. IDF: Dado Center, 31-32, pp. 31-39. (Hebrew) https://tinyurl.com/3y8pn79d

Amir, N. (2024, February 19). *The Air Force summarizes 4.5 months of battle – with a message to Hezbollah*. Makor Rishon. (Hebrew) https://tinyurl.com/ykpxzm7f

Arbeli, F. (2024, April 7). *Tens of thousands of targets and thousands of targets eliminated, the numbers of war are revealed.* Maariv.(Hebrew) https://tinyurl.com/mry466eb

Ben Gurion, D. (1981). *The Army and the Nation*, Maarachot, IDF publishers.,11-2, pp. 279-280. (Hebrew) https://tinyurl.com/3bvws4cj

Ben Yishay, R. (2023, December 8) *The race for the breaking point at Han Yunes.* Ynet (Hebrew) https://tinyurl.com/mv22tmxz

Ben Yishay, R., and Zeitun, Y. (2021, February 16) *From escalation to war: A surprise drill in the north – and the message to Nasrallah.* Ynet. (Hebrew) https://tinyurl.com/47bh3mx2

Benn, A. (2022, July 21). *30 years after "the drone wars" in the upper echelon of security, Israel breaks its silence.* Haaretz. (Hebrew) https://tinyurl.com/5bc8ycdy

Brun, I. (2022). *From aerial supremacy to multidimensional strikes*, Memorandum 219, The Institute for National Security Studies. (Herbew) https://tinyurl.com/2svy2p92

Brun, I., and Valensi, C. (2010). *The revolution in the military affairs of the radical axis.* Maarachot, IDF Publishers, 432, pp. 40-53. (Hebrew) https://tinyurl.com/yhme58ny

Cockburn, P. (2017, July 12). *The Massacre of Mosul: 40,000 Feared Dead in Battle to take back city from ISIS as scale of civilian casualties revealed*. Independent. https://tinyurl.com/ykz7m5a8

Cohen, G. (2023, October 16), *Collapsing Hamas and a solution of the hostage issue: the goals of war are revealed*. Kan 11. (Hebrew) https://tinyurl.com/2s4yryx6

Dekel, A. and Einav, A. (2017), *An updated national security concept for Israel*. Special memo, the Institute of National Security Studies. (Hebrew) https://tinyurl.com/mr43bwwp

Deptula, D. (2001). *Effects-Based operations: Change in the nature of warfare*. Aerospace Education Foundation. https://tinyurl.com/2h9m2x3z

Eisenkot, G. and Siboni, G. (2019). *Guiding Principles for Israel's Security Concept*. Memorandum 196, the Institute for National Security Studies. https://tinyurl.com/5n95ra33

Finkel, M. (2017). *Efficiency and the Height of Success.* Between Polarities, 11-12, 57-64. https://tinyurl.com/vn7enas8

Finkel, M. (2022). *The Air Force Command.* Modan.

FM 100-5: *Operations, 1982* (1982). Department of the Army. https://tinyurl.com/54xt8x77

Freilich, D. (2019). *Israel's National Security Concept.* [translation: E. Eidan]. Modan.

George, S., Abdul-Zahra, Q., Michael, M., & Hinnant, L. (2017, December 21). *Mosul is a graveyard: Final IS battle kills 9,000 civilians.* AP. https://tinyurl.com/42624mwk

Golan, S. (2022), *Fire in Lebanon 2006*, Modan.(Hebrew)

Harel, E. (2024, July 17). *The IDF estimates that the pressure on Hamas has been fruitful and improved conditions for a hostage deal*. Haaretz (Hebrew) https://tinyurl.com/yvw2ynsp

IDF Strategy *(2015),* IDF, Chief of Staff's Office. (Hebrew) https://tinyurl.com/mrxmsvnt

IDF Strategy *(2018),* IDF, Chief of Staff's Office. (Hebrew) https://tinyurl.com/r4jxwfea

Israel Intelligence Heritage & Commemoration Center (24 October 2023): *The Iron Swords War, status report as of October 24, 2023.* https://tinyurl.com/4nd8jf8n

Kochavi, A. (2020). The Chief of Staff's Introduction. *Between Polarities,* 28-30, *7*-10. (Hebrew)https://tinyurl.com/2s3r8nss

Lambeth, B. (2021). *Airpower against the Islamic State*. The Mitchell Forum. https://tinyurl.com/bde4kcwt

Lasloy, A. (2022). *Operation "Defensive Shield": from containment to victory*. The Ministry of Defense Publications. (Hebrew) https://tinyurl.com/2pbrsrye

Lish, G. (2011). *These are not the goals*. Maarachot, IDF Publishers, 439, pp. 56-59. https://tinyurl.com/2d4x22vh

Lish, G. (2016). *The Second Lebanon War and the preceding period*. Maarachot, 466-467, pp. 37-41. https://tinyurl.com/2uxyfdtm

Lotwak, A. (2002*). A Strategy of War and Peace* [translation: M. Guggenheimer]. Maarachot.

Mazuz, A. (23rd January, 2024): *Netanyahu: "I mourn our soldiers, we will not stop fighting until victory."* 14 Now. https://tinyurl.com/7hzsy8ew

McNerney, J.M., Tarini, G., Rosenblatt, N., Sudkamp. K.M., Morre, P., Grise', M., Sacks, B., & Lewis, L. (2022, March 31). *Understanding civilian harm in Raqqa and its implications for future conflicts*. RAND. https://tinyurl.com/bdf3vzhs

MSG– Mosul Study Group. (2017). *What the battle for Mosul teaches the force*. US Army. https://tinyurl.com/2vp77v5b

Norkin, A. (2020), *A multidimensional blow to the concept of victory.* Between Polarities, 28-30, pp. 229-239. https://tinyurl.com/ms86cf5y

Now 14 (16th November, 2023). *Commander of the IAF: "The connection between the pilot and the tank commander has never been so strong."* [clip]. YouTube. https://tinyurl.com/42wpy8we

Oakford, S. (2017, July 1). *Mosul's Capture sees ISIS Vanquished – But at a terrible cost*. Airwars News. https://tinyurl.com/2yuenur5

Oakford, S. (2018, March 12). *Raqqa: A city destroyed then forgotten*. Airwars News. https://tinyurl.com/ye439vux

Pape, R. (1996). *Bombing to Win*. Cornell University Press.

Pawlyk, O. (2016, November 5). *'Intense' US bombing in Mosul meant strike every 8 minutes*. Militaty.com. https://tinyurl.com/4rsm52su

Rakov, D. and Feinberg, S. (2023). *The increasing influence of civilian population on the modern battlefield.* Elrom Center, Tel Aviv University. https://tinyurl.com/tx9hn5yt

Shelach, O. and Heller, A. (2023). *Integration or Independence?* Elrom Center, Tel Aviv University. https://tinyurl.com/4znv6dmw

US Department of State (2014, December 3). *Daily press briefing*. https://tinyurl.com/ur534zra

Warden, J. (1995, Spring). The enemy as a system. *Airpower Journal*, *9*(1), 41-55. https://tinyurl.com/3skch7yf

Watson, K. (2017, May 28). *Fight against ISIS has shifted to "annihilation tactics," Mattis says*. CBS News. https://tinyurl.com/bdekckcn

Ynet (25th December, 2023). *Mosul and Haleb multiplied: the scale of bombings in Gaza comes to light | Comparing destruction via satellite images* https://tinyurl.com/3w5fhzyj

Zeitun, Y. (19th February 2024). *31,000 bombs, 186,000 flight hours: the "unprecedented" data of the Air Force in the war*, Ynet. https://tinyurl.com/ynncc5up

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

Not a "War of Its Own": Offensive Air Support for the Maneuvering Forces in the Iron Swords War in Gaza

Factors of Success and Looking Ahead

Meir Finkel[1]

Abstract

This article explores the offensive air support the Israeli Air Force, mainly by using its fighter jets, provided to maneuvering ground forces during the key combat stages of the Iron Swords War in Gaza. Following a brief overview of the history of air-ground cooperation and a detailed analysis of the developments in offensive air support over the decade preceding the conflict, the article argues that the offensive air support provided in this war was exceptionally effective in relation to Israel's military history.

This success is attributed to several factors, including pre-war force-design processes and training, procedural adjustments implemented during the conflict, the extensive allocation of munitions by the Air Force, and unique conditions specific to the Gaza combat environment. Additionally, the article suggests that the nature of air support in this war reflects a cultural shift within the Air Force, where success is now measured by the achievements of maneuvering ground forces. The discussion then compares this conflict with the Second Lebanon War (2006), the Gaza Operations Cast Lead (2008–2009) and Protective Edge (2014). The article concludes with insights on offensive air support in the context of

[1] **Brig. Gen. (Res.) Dr. Meir Finkel** is the Head of the Research at the Dado Center for Interdisciplinary Military Studies and a former Commander of the Center. During his tenure as Head of the Doctrine and Concepts Department in the Ground Forces Command (2007–2014), he specialized in advancing air-ground cooperation. His recent publications include *The Air Force Command Headquarters: Force-Building Processes and the Development of Operational Plans* (Modan, 2022); *The Evolution of Combined Arms Combat in the IDF* (Editor) (Maarachot and Modan, 2023), and *Israeli Military Intelligence: In a Complex and Changing Reality* (Modan). Dr. Finkel holds three PhDs, one in political science, another in evolutionary biology, and a third in prehistoric archaeology.

a potential future war in Lebanon, which could involve large-scale ground maneuvers.

Introduction

The field of air support for ground forces in the Israel Defense Forces (IDF) encompasses a wide array of elements and a rich, dynamic history marked by successes and challenges. This article focuses on offensive air support, which utilizes fighter jets, attack helicopters, and remotely piloted aircraft (RPAs, formerly referred to as UAVs). This aspect of air support was exceptionally effective during the Iron Swords War in Gaza, surpassing its performance in previous conflicts.

The article examines the patterns of offensive air support during the Iron Swords War in Gaza within the context of the historical developments that shaped them. It highlights the significant changes and adaptations made during the conflict and explores the risks and opportunities associated with a potential future war in Lebanon involving large-scale ground maneuvers. Rather than serving as an investigative analysis, this piece offers a historical, conceptual, and critical perspective on the subject.

My argument is that the Iron Swords War stands out as a unique case in Israeli military history, and potentially on a global scale, for several reasons. To illustrate its distinctiveness, I compare the events of this conflict with the Second Lebanon War (2006) and with the Gaza Operations Cast Lead (2008–2009) and Protective Edge (2014), while also offering a general examination of urban combat against ISIS in Mosul (2016–2017) as a broader reference point.

Despite some similarities between these conflicts and the Iron Swords War—such as the need for air support for maneuvering forces, air superiority, and combat against a terrorist organization or terrorist army—several unique circumstances make the offensive air support during the Iron Swords War an exceptional case worth studying. This study aims to provide insights that can support efforts to refine and sustain the capabilities developed and employed during the conflict as well as advance the evolution of a modern theory of air warfare.

The exceptional nature of this case stems from several distinct features of the combat in the Iron Swords War in Gaza. These include the substantial reliance on fighter jet support, driven by the large-scale deployment of ground forces in urban environments and the extensive network of underground infrastructure (subterranean tunnels) beneath them, the Air Force's advanced capability to deliver such support effectively, and the General Staff's allocation of significant

air force resources, as well as a considerable stockpile of munitions to fulfill this mission.

This analysis focuses on the air support provided by fighter jets to ground forces, with additional attention to the roles of attack helicopters and RPAs. Particular emphasis is placed on close air support for maneuvering forces—striking targets in close proximity to friendly forces while maintaining coordination through various methods. Such proximity inherently increases the risk of friendly fire. Requests for these strikes typically originate at the battalion, brigade, or division levels. The nature of combat in Gaza—a territory characterized by dense urban areas, extensive underground tunnel networks, close engagement ranges, and an enemy concealing itself by exploiting the terrain's complexity—heightened the demand for close air support, resulting in an unusually high proportion of such operations compared to previous conflicts.

It should be noted that there is another type of offensive air support for ground forces, which is not the focus of this discussion. This type involves strikes carried out deeper in the combat zone to assist ground forces, but not in their immediate vicinity. Examples include targeting bridges, enemy reserves, or command centers. These operations take place within the "interdiction zone"—a deeper area of the battlefield designed to prevent enemy forces from intervening in frontline combat. In recent years, planning for such targets has been carried out primarily at the regional command level.

Following the introduction, which provides a brief overview of the development of close air support in Israel, the article details the advancements in offensive air support over the decade preceding the war and the specific characteristics of the support during the conflict itself. This section forms the foundation for the article's argument that offensive air support using fighter jets during the Iron Swords War was exceptionally effective compared to Israel's military history. The discussion explores three key aspects that support this claim. It begins by examining the unique and favorable conditions of the Iron Swords War that enabled this unprecedented level of air support. It then proposes that the nature of this support reflects a cultural shift within the Air Force, where success is now measured based on the achievements of the maneuvering ground forces. Finally, it compares the Iron Swords War to previous conflicts, including the Second Lebanon War and the Gaza Operations Cast Lead and Protective Edge. Following the discussion, the article presents insights on offensive air support in a potential future war in Lebanon involving large-scale ground maneuvers.

It should be noted that there are additional aspects of the Air Force's support for ground operations during the war that merit further research. In some of these elements, challenges and shortcomings were revealed during the war,

particularly in the ongoing campaign along the northern border. Key examples include "detection for warning" systems designed to identify drones and remotely piloted aircraft (RPAs) operating at low altitudes near the ground and developing defenses against such threats. Other areas not covered here also saw significant changes, such as the medical care and ground evacuation capabilities provided by Unit 669 to ground forces on the battlefield, in addition to its traditional roles of airborne rescue and medical evacuation.

A Brief Overview of the Development of Close Air Support in Israel

The IDF's rich history of close air support is closely intertwined with Israel's broader military history, and it has witnessed significant periods of progress and setbacks. Advancements in this area have often been driven by the needs of ground forces and the Air Force's recognition of those needs, alongside its commitment to develop inherently complex solutions to meet them. One example of such progress emerged after the First Lebanon War in 1982 (Operation Peace for Galilee), when the need to breach complex defensive systems on the Syrian front was aligned with the Israeli Air Force's proven ability to counter surface-to-air missiles and establish air superiority (Finkel, 2022, pp. 161–186).

Periods of decline were marked by a reduced need for air support for ground forces and the increasing prioritization of "air-centric" missions for the Air Force. From the 1960s to the 1980s, Air Force commanders often regarded support for maneuvering ground forces as not being a core mission entirely depending on the Air Force (as opposed to the growing number of missions for which there was no substitute for the Air Force). Instead, it considered such support as a desirable but non-essential role for assisting ground forces against enemy armor, against which aircraft bombs were not particularly effective. Another contributing factor was the perception, beginning in the late 1970s, that attack helicopters could serve as a substitute for fighter jets in targeting enemy armored vehicles.

Limited progress in the field of joint operations also stemmed from the complexity and difficulty of employing the Air Force in such tasks from the perspective of ground force commanders, which led to the ground forces' lack of a full commitment to advance these joint initiatives. For example, by the early 1990s, following the collapse of the Soviet Union, the likelihood of a war with Syria seemed to decrease. At the same time, the Air Force's ability to strike Syrian targets in the interdiction zone rather than in close support of ground forces increased. This, combined with an intense focus on striking surface-to-surface missiles at longer ranges following the Gulf War in 1991,

led to a certain decline in close air support for ground forces, although not in overall cooperation between air and ground forces. Strikes on enemy command centers and artillery concentrations deep in the battlefield still supported ground forces, while also ensuring the optimal use of aircraft allocated for support (Finkel, 2022).

A major decline in close air support for ground forces culminated in the early 2000s when IDF commanders came to view counterterrorism as the new standard of warfare, believing that large-scale wars were unlikely to return. During operations in the West Bank, attack helicopters were widely used to provide direct support to ground forces. At the same time, the doctrine for close air support by fighter jets at the brigade level was discontinued, along with the role of the Brigade Air Support Officer (Shoresh, 2007).

Offensive Air Support for Ground Forces in the Decade before and during the Iron Swords War

Changes during the 2012–2023 decade

The years following the Second Lebanon War were characterized by a growing tension between the ever-increasing demand for offensive air support in urban combat and the Air Force's expanding responsibilities as operational and strategic levels headquarters, such as striking extensive target banks across the theater of operations. Despite these competing priorities, the Air Force implemented a series of initiatives aimed at strengthening its support capabilities for ground forces. These efforts gained significant momentum under the leadership of Air Force Commander Maj. Gen. Amir Eshel (2012–2017) and continued under his successors, Maj. Gens. Amikam Norkin and Tomer Bar.

During this period, the Ground Forces Command acquired precision-guided munitions such as the Romach rocket and precision mortar shells. However, these were procured in limited quantities, and their relatively light warheads made them less suitable for striking buildings or conducting urban warfare. Explosive drones were still in experimental stages before the war and had not yet been adopted for operational use. This situation left the ground forces reliant on "light" air support from attack helicopters and RPAs for their offensive capabilities.

Before focusing on the division-brigade-battalion levels, it is important to note that substantial changes have been made at the regional (i.e., Southern and Northern) command level over the past decade, although these are not discussed in detail here. However, one noteworthy adjustment in personnel significantly improved air-ground cooperation by fostering inter-branch trust: the appointment of an Air Force officer as the Regional Artillery Commander

in the Northern Command in late 2015 (Col. Aviad Dagan), whose role was redefined as the Commander of the Fire Support Center. A similar adjustment was later implemented in the Southern Command. The appointment of Air Force colonels to these positions within the regional command headquarters greatly enhanced the Air Force Command's confidence in the regional commands' ability to utilize airpower effectively. Another milestone in inter-branch integration was the establishment of the Multi-Domain Strike Staff Division within the Ground Forces Command in late 2020, led by a brigadier general from the Air Force.

The major changes implemented during the decade spanning 2012–2023 were as follows (their order does not reflect their significance):

Expansion of Planning and Coordination Bodies. The establishment of fire coordination centers within brigade headquarters based on intelligence-enriched combat capabilities began in 2012. These changes have continued to evolve to the present day, with the addition of officers and strike cells (Multi-Domain Strike Division, 2024). The Joint Air-Ground Operations Unit underwent significant expansion during this decade, including the establishment of a school for air-ground collaboration in 2012. In early 2021, a training school for strike cells was established under the Multi-Domain Strike Division (IDF website, 2021).

A **Ground-Air Support Center, also referred to as** the **Offensive Air Support Center,** has operated in the "Pit" (the IDF's operational headquarters) since the Yom Kippur War. This center has been instrumental in coordinating target planning with regional command headquarters over the years. Recently, an additional planning entity was established within the Air Force Headquarters, the Maneuver Planning Center, dedicated to planning targets at the division and brigade levels. This division of responsibilities has significantly enhanced the Air Force's capacity to execute real-time strikes in support of maneuvering forces.

Training and Certifications. These underwent significant development during the decade in question. The Air Force's participation in brigade exercises began roughly a decade ago and gained considerable momentum in 2021 with the establishment of the Strike School under the Multi-Domain Strike Division in the Ground Forces Division. For the first time, the new staff division enabled the Ground Forces Command to conduct oversight of the readiness of personnel in ground forces headquarters positions, by name and in detail.

Air-ground cooperation training for ground force commanders at the division, brigade, and battalion levels is not a new concept. Traditionally, these programs involved visits by ground commanders to Air Force bases, where the Air Force's support capabilities were presented with an emphasis on the conditions required for their employment. In 2019, a significant innovation was introduced: training programs for ground commanders conducted in the Air Force "Pit." There,

commanders gained hands-on experience in Air Force decision-making processes related to operational demands defined by the ground commander. These included determining bomb size to ensure the desired effect, safety measures such as the distance of the target from friendly forces, target sensitivity (for example, UNRWA facilities), and collateral damage assessments based on the presence of civilians in the combat zone.

Ground commanders practiced these processes alongside Air Force planning and control officers in the Pit, gaining insight into the considerations and procedures involved. This training equipped them with far better tools than before to understand how to properly request airstrikes and the conditions they need to verify at the brigade or division headquarters before making such requests.

At the battalion level, the establishment of the Operational Air Training Center (acronym ALPHA in Hebrew) in 2020 marked a significant step in training battalion commanders in air deployment and decision-making using simulators (Kochergin, 2023). Dedicated teams were also deployed to work with battalion commanders and their staff during field exercises, focusing on the processes of requesting and directing various types of air support. By 2022, these teams had participated in 85% of battalion exercises, reaching nearly 100% by 2023. The number of training sorties conducted during ground exercises has fluctuated over the years due to several factors, including the often-changing scope of ground forces training. In 2022 alone, thousands of training sorties were conducted across a range of platforms, including fighter jets, attack helicopters, RPAs, assault helicopters, and transport aircraft.[2]

The "Flash" Technique (formerly known as "urgent target") is characterized by its streamlined process, which bypasses the division and regional command levels to establish a direct, short loop between the brigade and Air Force headquarters. This allows for an exceptionally rapid response, with the time from request to strike being less than an hour. This technique was practiced extensively during the four years leading up to the war and was implemented on a very large scale, with approximately 7,000 strikes conducted by February 2024. Additionally, a similar number of targets were struck in support of maneuvering forces through coordinated sorties, focusing on pre-planned strikes against designated targets (Air Force website, 2024).

Reducing Safety Distances for Fighter Jet Support. For decades, the safety distance between a target struck by a fighter jet and the forward position of ground forces was set at 1,000 meters. This standard, established in the 1950s, remained in effect until the mid-2010s despite dramatic advancements in bomb

2 Data presented at a meeting with the Commander of the Joint Air-Ground Operations Unit, May 2024.

accuracy, ground force positioning technology, communication systems, and the operational need for close air support in urban combat. The resistance to change stemmed from the Air Force Commander's deep concern about the risk of accidentally striking friendly ground forces. The shift began under Air Force Commander Amir Eshel during Operation Protective Edge in 2014, when safety distances were reduced for operational needs. Preparations for such reductions had already been made during Operation Pillar of Defense in 2012 in anticipation of potential ground operations, which did not take place. The change was formalized in 2015, reducing safety distances to just a few hundred meters, thereby enabling closer air support in urban areas (Ground Forces Command, 2015). This adjustment allowed the IDF to close a decades-long gap with the U.S. military, which bases its safety distance assessments for JDAM bombs on a 0.1% probability (1 in 1,000) of harm to ground forces, with distances ranging from 200 to 300 meters, depending on the size of the bomb (Army, Marine Corps, Navy, Air Force, 2007, Table 33).

Integration of Air-Ground Command and Control Systems relied on the "Masuah" ("Torch") battle management system but faced limitations due to high user loads over small operational areas in Gaza. The ability of the Air Force Headquarters to view the target's location in relation to the maneuvering force's armored vehicles remained critical for target approval. At the same time, gaps in relaying information about infrastructure to the forces in the field, such as restricted targets, probably led to some proposed targets being disqualified during the process.

"JDAM in direct control by the Battalion Commander" ("Barad LaMagad"). Developed in the years before the war, this technique aimed to streamline the strike process within a short decision loop between the dedicated team (the "Storm" team) at the battalion level and the fighter jet (Coleman, 2021). Currently, it is not in use due to the high concentration of forces in Gaza's small operational area and other constraints requiring brigade-level oversight. However, it may prove necessary and effective in warfare in Lebanon, where the larger operational area could mitigate some of these limitations.

Adaptation during Combat: Doctrinal, Procedural, and Organizational Aspects

Refinement of the Flash Technique and reduction of safety distances. Originally developed prior to the war and tested only in limited exercises, the technique was significantly improved during the initial days and weeks of the ground maneuver in Gaza, driven by intense operational experience. One critical

adjustment was the reduction of safety distances from friendly forces, enabling strikes within as close as 100 meters in dozens of cases.[3]

Incorporating pre-planned underground target strikes ("Breakthrough Facilitator") into the maneuver plan. Conceptual and practical integration was achieved between two previously distinct domains: underground target strikes, carried out by the regional command echelon and pre-listed in target banks for independent attacks at earlier stages of the combat (code-named "Breakthrough Facilitator"), and close air support for ground forces. This integration maximized the impact of each strike, simultaneously damaging underground infrastructure and creating improved conditions for ground forces to advance, effectively countering the enemy operating from these subterranean infrastructures (Perl, 2024).

Expanding the "Matas" (flight) technique to include shorter and dynamic strikes. Prior to the war, sorties were spaced several hours apart. However, maneuvering needs led to the development of a new operational pattern known as the "Matason" (small flight), which enabled brigades to synchronize strikes with their real-time progress on the ground.

Use of small diameter bombs (SDB) for close air support operations. The 125-kg SDB bombs were introduced into the Air Force's arsenal in the early 2010s and were first used operationally during Operation Protective Edge in 2014 (Tsurani, 2015). Due to their compact size, which allows a single F-16I Sufa or F-35I Adir aircraft to carry multiple bombs, they were originally intended for pre-planned airstrikes on designated targets. However, at the start of the war, Air Force Commander Maj. Gen. Tomer Bar decided to deploy them to provide close air support for maneuvering ground forces.[4]

Doubling the workforce in the Joint Air-Ground Operations Unit. The manpower of the Joint Air-Ground Operations Unit was expanded by approximately 100%, with several hundred additional personnel recruited from veteran volunteers. These individuals underwent refresher training and certification during the war through dozens of specialized courses for roles such as strike cell commanders, strike officers, strike cell intelligence officers, and more.[5]

These changes can be summarized schematically and visually as a redistribution of resources, where higher-level resources were significantly reduced and reallocated to lower levels.

---

3 Testimony provided in a personal conversation with Brig. Gen. (Res.) A., Commander of the Maneuver Support Control Cell.

4 Correspondence with the Head of the Multi-Domain Strike Division, May 15, 2024.

5 Data presented at a meeting with the Commander of the Joint Air-Ground Operations Unit, May 2024.

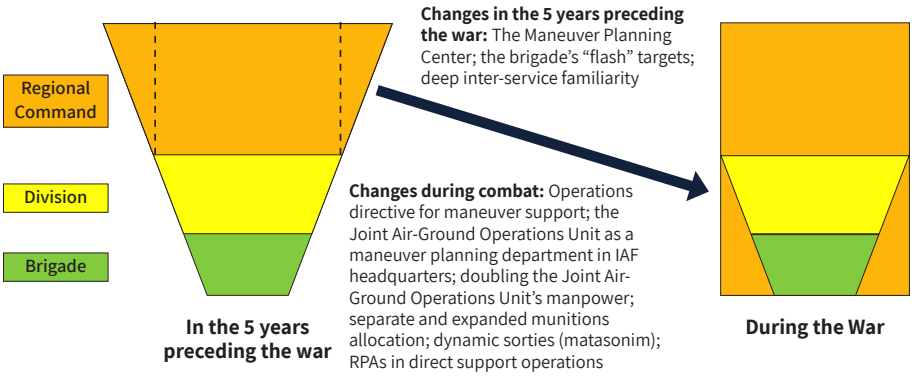

Figure 1: Resource allocation structure for offensive air support to maneuvering forces in the five years preceding the war and during the war.

* The Resources include personnel for planning and coordination, munitions allocation, and strike authorization.

Discussion: Is Offensive Air Support in *Swords of Iron* War a Unique Case?

Distinctive and Favorable Conditions

Each war presents unique challenges across strategic, operational, and tactical levels. In the Iron Swords War, offensive air support has been shaped by the following factors:

High demand for support: This is due to the large number of maneuvering forces in the area, predominantly urban terrain with high-rise buildings requiring heavy munitions for effective strikes, and extensive underground complexes necessitating the use of heavy munitions.

Relatively favorable conditions: There were no aerial threats and only a very limited risk to Air Force bases; the Air Force had sufficient resources and focus due to the war's single-front nature; ground forces advanced at a relatively measured pace; command and control systems functioned well enough to provide a reliable picture of friendly forces before strikes were authorized; there was prior intelligence on underground infrastructure; and the war's focus on a single theater allowed resources to be concentrated there.

As the conflict unfolded, resources were increasingly prioritized for maneuvering forces. The Southern Command target bank was exhausted early, with the regional command generating relatively few new targets during the fighting. Notably, decisions regarding the scope of aerial munitions allocated for maneuver support and the overall fire deployment policy were made by the General Staff, not the Air Force Command. The allocation of munitions

for maneuver support during the war was extensive, driven by several factors. Two of these are speculative and difficult to quantify: the need to ensure the success of the maneuver after a prolonged decline in confidence in ground forces and the desire to minimize casualties as much as possible. While these decisions offered significant advantages, they also had a notable drawback in terms of "munitions economy."

The limitations on offensive air support: One significant challenge in providing offensive air support has been the presence of civilians in combat zones. This issue has been largely mitigated by encouraging civilians to evacuate these areas before and during maneuver operations, thereby reducing the risk of harm. A second challenge involves concerns about the potential for harm to hostages and prisoners of war.

Those unique characteristics—the wide demand for support, the relatively favorable conditions and relatively few constraints faced—combined with the prolonged duration of the war, which enabled learning and adaptation over time, played a pivotal role in the successful integration of air support. However, replicating these results in a future conflict, particularly in the northern theater where large-scale maneuver operations are anticipated, will be significantly more challenging due to differing circumstances.

Underlying Factors: The Evolution of Air Force Culture in Support of Maneuvering Forces

The book *The Air Force Command Headquarters* (Finkel, 2022) explores the organizational culture of the Air Force headquarters. It describes the organization as wearing "four hats": a strategic firepower arm (second and third circles of engagement), an aerial defense arm against aircraft, missiles and rockets, an operational level fires command (the primary operational command in the first circle of engagement); and a tactical air force providing support to ground forces (p. 34), which was referred to in the 1970s as "flying artillery."[6]

Historically, the Air Force has been reluctant to fully embrace its role as a tactical air force, particularly in providing close air support for ground troops. This reluctance stems largely from the unique demands placed on the Air Force within the IDF. It is responsible for a broad range of missions in which it serves as the sole operational branch capable of responding (its first three primary

6 "The airstrikes carried out by the Air Force served as a substitute for missions typically performed by the Artillery Corps. However, a severe shortage of artillery in the combat zone, combined with the extensive scope of the required missions, led to the involvement and deployment of the Air Force. This aerial activity became known as "flying artillery." Standard munitions were used for these missions, which primarily targeted enemy compounds and artillery batteries" (Roichman & Arbel, 2016).

roles). In contrast, the use of airpower for supporting ground forces is seen as partially redundant, as some of these tasks can also be carried out—albeit to a limited extent—by ground-based artillery or other firepower systems. Additional concerns include the risk of friendly fire and the perception among Air Force commanders that deploying airpower for close support is "inefficient," particularly due to the difficulty of achieving high strike rates in such operations (Finkel, 2022, p. 35).

The exceptional level of support provided to maneuvering forces in this war, compared to previous conflicts, can be attributed to two main factors: the Air Force's increased commitment to this mission over the past decade and the unique conditions described earlier, which enabled the Air Force to focus on such support. As noted, decisions regarding the scope of air support for maneuvering forces fall under the responsibility of the General Staff and, during wartime, the General Headquarters. The improvements made in recent years to collaborative processes between the General Headquarters, the Air Force Headquarters, and the regional command headquarters likely played an important role in the support provided during the war. However, even if this holds true—and perhaps additional motivation was sparked by pre-war claims framing Air Force pilots as "refuseniks" who would "abandon" ground forces as part of their protest against the judicial system change —there may be evidence of a much more significant cultural shift within the Air Force.

Occasional remarks by Air Force personnel, such as referring to "the Air Force and the IDF" or stating that "the Air Force supported the IDF," highlight an important aspect of how the Air Force views itself— that is, as a "strategic arm" of the state. This perception of independence is also reflected in how the Air Force evaluates and describes its operations. In conventional wars between armies, the Air Force traditionally measured its success separately from the broader IDF, focusing on specific achievements like downing enemy aircraft and bombing airfields (outcome-based metrics). In contrast, its support for ground forces was assessed using resources-based measures, such as the number of airstrikes conducted. This approach was evident during the Yom Kippur War, the First Lebanon War, and the Second Lebanon War.

However, as combat shifted to urban environments, the Air Force's operational independence significantly declined. For missions targeting enemy infrastructure, launchers, and senior enemy operatives in built-up areas, the bulk of the intelligence was provided by the Military Intelligence (AMAN) and, for senior leaders targeting also the Shin Bet. In these scenarios, success was primarily measured by inputs, such as the number of sorties flown and targets struck, since determining the number of enemy combatants killed in the strikes was

often extremely challenging. (In cases of targeting senior figures, assessing success was somewhat more straightforward.)

It is possible that during the Iron Swords War, the Air Force's perception of itself as an integral part of the IDF evolved further. In November 2023, Air Force Commander Maj. Gen. Tomer Bar stated:

> From the moment the ground maneuver begins, the Air Force provides it with an exceptionally powerful aerial umbrella. The simplistic historical division between air and ground forces is a thing of the past. Never before has the connection between a pilot and a tank commander been so direct and close. We've developed a combat method where every ground force encountering an enemy on the battlefield is supported by aerial assistance from a fighter jet that attacks and destroys the enemy. (IDF Website, November 2023).

The commander of the Joint Air-Ground Operations Unit, who concluded his tenure in early July 2024, echoed this sentiment in his change-of-command speech:

> Our banner proudly declares, "Victory in Maneuver." [...] This special connection between Blue [the Air Force] and Green [the ground forces] is inspiring. [...] You gave the company commander on the front line the confidence of knowing that the full strength of the Air Force was right there by his side. (Joint Air-Ground Operations Unit Commander, 2024).

Despite the media's focus on the number of targets and munitions used to support ground forces, it is possible that the Air Force, albeit unofficially, measures its success by the success of the maneuvering ground forces. In other words, just as various ground forces—infantry, armor, engineering, ground-based firepower, and others—understand that success depends on integration rather than the achievements of any single arm, the Air Force may also now view its success as tied to that of the combined forces (for example, as in the success of the 401st Brigade Combat Team or the Givati Brigade Combat Team). If this is indeed the case, it marks the beginning of a significant cultural shift. This perspective is shared by ground commanders, as expressed by Southern Command Chief Major General Yaron Finkelman: "The Israeli Air Force today is not just the pillar of fire leading the camp, it is with the camp and within the camp." (NWS News, 2024).

Comparison to the Second Lebanon War and Operations in Gaza

As noted in the introduction, there are several fundamental similarities between the Iron Swords War and the Second Lebanon War, Operation Cast Lead, and Operation Protective Edge. In all these conflicts, the fighting was against irregular enemies (Hezbollah and Hamas), ground forces required offensive air support, and the IDF maintained air superiority. However, the differences between the Iron Swords War and these earlier conflicts are too significant to allow for a meaningful comparison. Table 1 below outlines the similarities and differences in the use of offensive air support with fighter jets during these conflicts (Druk, 2023; Johnson, 2012; Lambeth, 2011).

Table 1: Comparison of Offensive Air Support with Fighter Jets in Wars and Operations

	Second Lebanon War (2006)	**Operation Cast Led (2008–2009)**	**Operation Protective Edge (2014)**	**Iron Swords War (2023–2024)**
Preparations for providing or receiving support	No preparations. The doctrine was discontinued; the role of the Brigade Air Support Officer was discontinued; and there were no relevant training or exercises.	Two years after the doctrine was reinstated and the Brigade Air Support Officer role was restored; large safety margins were used; and initial training had begun.	Full training and joint exercises; large safety margins (reduced during combat).	Expanded planning and coordination units; training; incorporation of techniques; reduced safety margins; and more.[7]
The nature of ground combat requiring air support	Rural areas: ground forces operated in villages and outskirts of towns in hilly and mountainous terrain, often with dense vegetation cover.	Open areas and towns with low-rise or 2–3 story buildings (e.g., Beit Hanoun, Beit Lahia, al-Atatra); minimal combat in high-density urban areas (e.g., the Zeitoun neighborhood).	Focus on tunnel shafts and close support in rural areas and towns (e.g., Beit Hanoun, the village of Jabalia, Beit Lahia, Abasan, Deir al-Balah, Bani Suhaila, the outskirts of Rafah, Nusairat); combat in built-up areas with high-rise buildings (e.g., Shuja'iyya); limited underground defense infrastructure.	Urban combat in high-rise built-up areas, refugee camps, rural areas, and towns; extensive underground infrastructure of various depths, complexity, and designs.

7 Detailed in the subsection above titled "Changes during the 2012–2023 Decade."

	Second Lebanon War (2006)	**Operation Cast Led (2008–2009)**	**Operation Protective Edge (2014)**	**Iron Swords War (2023–2024)**
Number of ground forces operating simultaneously in villages/towns/ cities	Three–five brigades. The most significant urban battle was on the outskirts of Bint Jbeil, involving three brigades fighting simultaneously	Four brigades in the specified areas, along with battalion-level operations under the Gaza Division	Around ten brigades, most operating in rural areas or towns	Four attacking divisions, with approximately 15–20 brigades fighting simultaneously
The Air Force's ability to support ground forces with fighter jets	Precision-guided munitions relied on laser designation. The attack process was relatively complex.	Initial use of JDAM by the Air Force.	Expansion of the precision-guided munitions arsenal in both variety and quantity. First use of SDB bombs (not for ground support).	Further expansion of the precision-guided munitions arsenal in both variety and quantity. First use of SDB bombs for ground support. Policy of shortening safety margins during combat, building on pre-war reductions.
The ground forces' ability to utilize air support	No Brigade Air Support Officer and no command-and-control systems.	Initial implementation of the "Tsayad" (Hunter) digital army system; first steps in upgrading brigade headquarters with relevant air support roles.	Widespread operational use of the Tsayad system; full brigade headquarters.	Tsayad integrated across all units; brigade headquarters enhanced with additional specialized air support roles; strike cells providing direct support to battalions.

In light of the above, the Second Lebanon War is not a suitable basis for comparison in the field of offensive air support. This is primarily because the IDF had eliminated this capability before the war, the Air Force at the time lacked appropriate munitions for such combat, and the additional reasons are outlined in the second column. In the Gaza operations, the infrastructure for air support—on the sides of both the Air Force and ground forces gradually improved. However, the scale of forces operating in built-up areas, the nature of the urban terrain, and the operational objectives required from the forces were fundamentally different from those in the Iron Swords War.

In his comparative study of the Second Lebanon War and Operation Cast Lead, senior RAND Corporation researcher David Johnson (RAND, 2012) proposed a framework distinguishing the roles of airpower in three fundamental scenarios against three types of adversaries, using concepts then in use by the U.S. military: irregular enemies (terror organizations), hybrid enemies (irregular forces with advanced weaponry, such as Hezbollah), and state armies engaged in "major combat operations" (e.g., Russia). The Iron Swords War falls into Johnson's second category, hybrid enemies. Regarding air-ground coordination in such scenarios, Johnson argued that operations against hybrid enemies require a balanced integration of ground and air forces. This requires close coordination, extensive training, and the designated rehearsals prior to execution. He further emphasized that effective coordination must ensure high airpower availability for ground units and should occur below theater-level command (the equivalent of regional command in the IDF). In the Iron Swords War, however, coordination occurs at much lower levels—the brigade level—which Johnson associates with operations against irregular enemies. In such cases, rapid closing of targeting loops between ground and air forces is critical. The war in Gaza involves elements of all three scenarios defined by Johnson: the IDF conducted major combat operations against a "hybrid" enemy while employing low-level coordination between ground forces and the Air Force.

At the start of the war, many comparisons were drawn between the coalition forces' fight against ISIS in Mosul during 2016–2017 and the combat Israel was expected to face in Gaza. However, comparing the use of offensive air support for maneuvering forces in these two cases is far from straightforward. The differences stem not only from fundamental differences in combat conditions, such as the vast disparity in the scope of underground infrastructure and the number of civilians in the combat zone (Knights, 2023) but also from the nature of the operations. In Mosul, the city was heavily bombarded from the air before Iraqi forces entered, while close air support for Iraqi ground maneuvers was provided by coalition aircraft and Western coordination mechanisms (Losey, 2017).

Looking Ahead: A Future War with Large-Scale Maneuvers in Lebanon

Unlike the conflict in Gaza, a future war in Lebanon involving large-scale maneuvers will likely require the Air Force to focus on achieving air superiority. This will include striking "Air Force targets" deep within strategic areas, such as long-range missile launchers and command centers, as well as targeting "regional command targets" within the Northern Command's area of operations in southern Lebanon. The Air Force will also be tasked with other missions in this theater and potentially in additional arenas. These demands will likely reignite the longstanding tension between prioritizing such strategic and operational level missions and providing close air support to ground forces.

Resolving this tension will hinge on the General Staff, which allocates aircraft and munitions and sets fire policy. In this context, the General Staff, alongside the Air Force, will need to carefully manage the expectations of ground commanders who experienced the high levels of air support in Gaza. This "recalibration" will be essential to avoid a potential crisis of confidence if similar support cannot be delivered during large-scale maneuvers in Lebanon. However, experience suggests that pre-planned target banks are typically exhausted within the first few days of combat, a period during which ground forces are often still organizing for their maneuvers. If this timeline holds true, and if conditions in southern Lebanon remain relatively favorable—such as the civilian population evacuating northward as seen in previous conflicts—the Air Force could achieve similar levels of success in supporting maneuvering forces in the northern theater.

To ensure this high level of support, several key measures will be critical. Advanced training programs focused on air-ground planning processes must continue to ensure operational readiness. The expanded personnel levels in the Joint Air-Ground Operations Unit should be sustained through additional staffing and enhanced training resources. Maintaining substantial stockpiles of munitions specifically allocated for supporting maneuvering forces will also be crucial. Additionally, thorough investigations of "near-miss" incidents from the recent war are necessary to further reduce the risk of friendly fire. Most importantly, it is vital to foster and strengthen the perception that the success of maneuvering forces is integral to the success of the Air Force.

*

I would like to thank the following for their feedback: Col. Y., Commander of the Joint Air-Ground Operations Unit; Brig. Gen. Roee Bakshi, Head of the Multi-Domain Strike staff Division in the Ground Forces Command; Brig.

Gen. (Res.) A., Commander of the Maneuver Support Control Cell; members of the 35th paratroopers Brigade Headquarters: Chief of Staff, Col. (Res.) Y.; Brigade Fire Support Commander, Lt. Col. (Res.) A.; and the Brigade Air Support Officer, Maj. (Res.) K.

References

Air Force Website (2024, February 20). 31,000 targets across all theaters: Air Force operations over 136 days of war. Israel Air Force. (Hebrew) http://tinyurl.com/mpzthh3r

Army, Marine Corps, Navy, Air Force Air Land Sea Application Center (*JFIRE)* (2007). "Multi- Service tactics, techniques, and procedures for the joint application of firepower." https://www.alssa.mil/mttps/jfire/

Coleman, R. (2021). Storm over the ground. *Air Force Magazine,* 257. http://tinyurl.com/4w4ckhxa

Commander of the Joint Air-Ground Operations Unit (2024, July 7). Speech given at the Joint Air-Ground Operations Unit Command handover ceremony. Internal IDF document.

Druk, D. (2023). The joint and integrated battle, 2006–2014. In M. Finkel (Ed.), *The evolution of the joint battle in the IDF: Past, present, and future* (pp. 262–322). *Maarachot* and *Modan*.

Finkel, M. (2022). *The Air Force Command Headquarters: Force-building processes and the development of operational plans*. Ministry of Defense and *Modan*.

Ground Forces Command – Doctrine and Concepts Department (July 2015). Professional directive: Planning and deploying fighter jets in support of ground forces. Internal IDF document.

IDF (2021, February 23). "A new school has opened for multi-armed strikes." (Hebrew) http://Tinyurl.com/3jzp7zan

IDF Website (2023, November 16). Air Force Commander: 'Hitting Hamas on the ground and underground. We've neutralized thousands of terrorist and we'll get to all the rest.' (Hebrew) http://tinyurl.com/282pw845

Johnson, D.E. (2012, January 19). "Hard fighting: Israel in Lebanon and Gaza." RAND. https://www.jstor.org/stable/10.7249/mg1085a-af

Knights, M. (2023, October 13). Gaza's urban warfare challenge: Lessons from Mosul and Raqqa. The Washington Institute. https://tinyurl.com/ypfhrxc7

Kochergin, Y. (2023). Multi-Armed operations. *Air Force Magazine,* Issue 55. http://tinyurl.com/27ct4ws5

Lambeth, B.S. (2011, May 23). Air operations in Israel's war against Hezbollah – Learning from Lebanon and getting it right in Gaza. RAND. https://tinyurl.com/2s3m5et9

Losey, S. (2017, March 28). With 500 bombs a week, Mosul airstrikes mark 'the most kinetic' phase of ISIS air war so far. Air ForceTimes. https://tinyurl.com/5n86jr6m

Multi-Domain Strike Division (2024, June). Ground forces seminar presentation: Insights from the Iron Swords War – Ground and Multi-Armed Fire. Internal IDF document.

NWS News (2024, February 8). "Southern Command Chief, Maj. Gen. Yaron Finkelman, speaks at the Air Force Conference" [Video]. YouTube. http://tinyurl.com/ycy955nh

Perl, G. (2024, April 11). 'The distinctive strength of the IDF, whose commanders are its secret weapon': Lessons learned from 1982–2023. *Maarachot*, IDF Publishers. (Hebrew) http://tinyurl.com/2yrjv96z

Roichman, R., Arbel, B. (2016, October 9). 'Flying artillery': A double-edged sword. Always a Gunner. IDF Artillery Corps Website and the Association for Artillery Veterans. (Hebrew)http://tinyurl.com/5c5b3dxz

Shoresh, R. (2007). The development of close air support capabilities with fighter jets: A historical review. Ground Forces Concepts Department. Internal IDF document.

Tsurani, S. (2015, November 8). "More lethal, more precise: The Air Force's advanced bomb." Mako. (Hebrew) http://tinyurl.com/bdd9pa8t

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

The Need for Attack Helicopters: Characteristics and Challenges in the Era of Modern Warfare

Alex Dan[1]

Summary

Attack helicopters are suitable for a wide array of defense and offense scenarios. Over the past two decades, they have been proven necessary in various wars worldwide, including the Russia-Ukraine and Iron Swords wars. However, limitations in operating attack helicopters and technological progress leading to a new variety of solutions for operational needs in the modern-day battlefield have changed the array of solutions provided. Other than helicopters, this includes using unmanned aerial vehicles (UAVs) for attacking and interdiction mobile targets, hovercraft assigned to ground forces for aerial intelligence and precision bombing, and other means such as guided munitions. As part of any modern army's considerations of procurement of highly technological weapons and the need to balance the variety of arms available for achieving its war goals, this article focuses on the cost-effectiveness of the attack helicopter when compared with available alternatives as a study case for this question. The article reviews the integration of attack helicopters in modern warfare, analyzes their attributes and capabilities, and discusses the central implications of this question, including the cost of ownership, relative vulnerability, and the alternatives evolving today.

Introduction

Since the Korean War, attack helicopters have taken part in battle according to changing operational needs based on the various battlefields and the evolution of competing technologies. The emergence of uncrewed aircraft – which are increasing in quality and quantity – enabled a comprehensive solution for

[1] **Brigadier General (Ret.) Alex Dan** is a senior researcher at the Alrom Center at Tel Aviv University.

a diversity of operational missions formerly assigned to manned platforms, including attack helicopters – which primarily face the enemy's armored corps. Such a mission, which is so "classically" an attack helicopter mission, has raised an important question among armies and air forces worldwide about the continued procurement of attack helicopters and their correct integration within the total array of aerial platforms.

The United States Army, for instance, has recently decided to cancel the Future Attack Reconnaissance Aircraft (FARA) project. This ambitious project was meant to develop the next generation of attack helicopters to give the US Army an advantage over potential enemies and cope with threats of asymmetric and other kinds. General Randy George, Commander of the US Army, addressed the various reasons for canceling the project (Ferrari, 2024) in an interview, citing several key aspects that had to do with (1) The specific attributes of arenas faced (with an emphasis on the asymmetric battle and densely populated areas, where enemies hide among civilian populations); (2) The need to equip with a variety of guided missiles that are adapted to such arenas; and (3) Conclusions drawn from the Russia-Ukraine War, which emphasized that aerial reconnaissance and attack have changed dramatically, as sensors and unmanned "loitering" UAVs (which are also inexpensive) create a significant need for procurement by the US Army.

In recent years, the Israeli Air Force has also gradually reduced its fleet of attack helicopters. As of October 6th, 2023, the inclination was to shut this array down completely while expanding the use of unmanned vehicles to replace the attack helicopters in missions. The variety of scenarios involving attack helicopters on October 7th with Hamas' invasion of the Western Negev (aiding ground forces, attacking terrorist groups inside and adjacent to villages, controlling fire on the border crossings between Israel and Gaza, all through the point of view of a human (pilot) which is still unattainable for unmanned drones) has sparked new enthusiasm among proponents of the helicopter array, for those missions that unmanned aircraft cannot perform in the same way or with the same effectiveness. So, the Ministry of Defense hurried to promote a deal to acquire new attack helicopters.

Is shutting down or reducing the scope of attack helicopters, as the Air Force promoted before October 7th, the correct thing to do when considering the battlefield of the future, especially in the Middle Eastern and Israeli arenas? Or was the post-October 7th decision to push forward the acquisition of helicopters more suitable for the Israeli arena?

Procurement of piloted attack helicopters is a lengthy and expensive process, with implications spanning over two decades forward for the Israeli Air Force.

It would, therefore, be prudent to examine this issue while looking twenty years ahead to foreseeable changes in battle, considering developing technologies and alternatives to attack helicopters and based on the unique arena the IDF faces with enemies of various kinds—from terrorist groups to modern armies. This should all be done with the caveats needed when making technological or arena-related predictions.

This article addresses this complex question, which has a futuristic dimension: the extent to which Israel needs to arm itself with attack helicopters, considering the evolving technologies and potential arenas. This is done using two complementary methodologies. The first is an attempt to conclude ongoing wars, emphasizing the Russia-Ukraine war. The second is a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis.

Initially developed in business administration, the SWOT method examines strengths, weaknesses, opportunities, and threats to perform a strategic evaluation to plan the organization's development. It is currently used for a structured quality examination of various issues or circumstances. This method is based on an internal axis focusing on the organization's strengths and weaknesses and an external axis examining the threats and opportunities in the external strategic environment in which the organization is active (Gurel, 2017). In this article, the SWOT analysis examines attack helicopters as an operational tool in the Israeli Air Force. The internal axis focuses on the strengths and weaknesses of attack helicopters, while the external axis examines them compared to alternatives vis-vis their strategic environment.

The article is relevant to those involved in strategic planning, including staff officers, policymakers, and decision-makers in modern air forces in general, and specifically in the Israeli Air Force, as a study that will be used to decide the issue of attack helicopters. Israel's confrontation with a multi-dimensional battlefield during the Iron Swords War is testimony to the shifting of the modern battlefield, in which more advanced technologies are integrated into the aerial arena with a varying degree of autonomy – some of which may be confronted by Western countries in future conflicts. This article hopes to enable other armies to draw conclusions from the Israeli experience and to serve as a methodological basis for figuring out this dilemma in other countries.

Historical background of attack helicopters

The first development of helicopters may be attributed to World War II, where they were used primarily for reconnaissance and medical evacuation. The first practical helicopter, the Sikorsky R-4, was deployed in a limited fashion throughout the war and showed the potential of rotary-wing aircraft in military

operations. After the Second World War, there was a significant progression in helicopter technology. Innovations included improved engines, aerodynamics, and load abilities, expanding the helicopter's operational roles. At the end of the 1940s, helicopters were used by various military forces, setting the stage for their expanded use in many conflicts (Leishman, 2000), as detailed in the enclosed appendix.

The first steps leading towards firing live ammunition from helicopters were taken in Korea by the United States Army. This began with firing from within the open doors of the cargo hold of a helicopter used for transporting troops. Similarly, in the wars in Algeria and Indochina, the French adapted utility helicopters for assault roles. Using helicopters for assault missions in these wars significantly developed military tactics. It proved the versatility and effectiveness of rotary-wing aircraft in offensive battle scenarios, which scaled beyond transporting troops to conflict areas or even battle zones (assault operations), evacuation of casualties, and other missions. The conflicts in Korea, Indochina, and Algeria, which included unique challenges and opportunities, provided infrastructure for the development of military doctrine for helicopters and shaped the technological development and armament of attack helicopters (Rollie, 2014; Soboliev, 2016).

The Vietnam War (1955-1975) saw a significant expansion in the widespread use of helicopters, especially attack helicopters, after introducing platforms dedicated to offense missions. At first, munitions were installed on Bell UH-1 ("Huey") helicopters, and later came the development and use of the AH-1 attack helicopter. The AH-1 (also known as "Huey," "Cobra," or "Snake") is a single-engine attack helicopter developed and manufactured by Bell Helicopters. The AH-1 featured shorter wings that could accommodate several types of weapons (missiles and rockets), a cannon in the nose, and a unique tandem cockpit (this was an innovation over previous helicopters, where crew members sat adjacent to – and not behind – each other). After a demonstration of its abilities on September 7, 1965, the US Army approved the helicopter, and mass production started. The AH-1 began its operational service in June of 1967 on missions of support for ground troops, escorting utility helicopters, and designated attacks (Lepore, 1994; Rollie, 2014).

Within a few decades, this helicopter model was the core of the US Army attack helicopter fleet and later that of the airborne divisions of the US Navy and Marines. It was gradually replaced by an advanced helicopter – AH-64 ("Apache"), manufactured in various models on a Boeing platform. Similar developments occurred in European (mostly French) helicopters in parallel with the American developments. In the Soviet Union, an armed tandem helicopter

was developed simultaneously with an attack helicopter based on a Mi-8 platform (a utility-transport helicopter according to the doctrine of arming a versatile helicopter that could transport troops and ammunition). The use of these helicopters was a revolution in aerial combat within the context of attacking targets on the ground, as when providing close support to ground forces, assault of high-quality targets in designated operations, assassinations, armed escorts for utility helicopters in assault operations, and reconnaissance and intervention missions (Culchane, 1977; Soboliev, 2016).

The Apache proved itself to be a decisive multifunctional weapon in modern wars, especially in the operations in Iraq and Afghanistan. It was initially planned for anti-tank missions, but its flexibility enabled it to adapt to various missions. In the Iraq War, it was used primarily for aerial aid and in-depth offensive attacks, leveraging its ability to work under difficult weather conditions or at night. Afghanistan's role was adjusted to the challenging mountainous terrain for observation, intelligence support, and combating terrorism. Its primary advantages include multifunctionality, durability, precision, flexibility, speed, and maneuvering abilities. The Apache showed the importance of a multifunctional helicopter in its ability to provide close aerial support, conduct precise attacks, and operate under challenging conditions, proving to be a vital weapon in modern warfare (Hawkins, 2013; Jones, 2019; Smith, 2012).

We will briefly prove a counter-terrorism arena without shared borders through the battle against ISIS. Attack helicopters were primarily used for close offensive support to ground forces, attacking targets (especially in urban areas), and escorting offense operations (widescale ground operations or special forces). It is noteworthy that the lion's share of publicity on the use of attack helicopters in the battle against ISIS is about their capacity for targeted assassination operations (CENTCOM, 2023).

The Israeli Air Force bought helicopters in the 1950s for transport, evacuation, and special ops missions. After the Yom Kippur War, it began buying attack helicopters to thwart armored attacks (Israel Air Force, 2023). Attack helicopter missions were expanded to include support of ground forces, prevention of expeditionary forces, escorting utility helicopters, targeted attacks, achieving aerial supremacy, and protecting Israel's airspace (Marom, 2013). Over time, these missions were further expanded to provide support in asymmetric combat (in the West Bank and Gaza) while adjusting the operating modes to changing operational contexts as terrorist organizations developed methods that challenged the advantages of attack helicopters.

In recent years, helicopters have focused on asymmetrical combat. According to Tal Tovy (2020), their activity can be divided into the specific, intelligence-

based attack stage and the close support for ground troops stage, which began in Operation Defensive Shield and continued in the Lebanon and Iron Swords War. The advantages of using attack helicopters include precision and maneuvering in urban environments, but their vulnerability was also revealed in these various wars. Attack helicopter fleets were cut back as squadrons shut down, and the focus was solely on AH-64s (Marom, 2021).

To conclude, it is possible to examine the procurement of attack helicopters through two core scenarios: (1) Combat against guerrilla or terrorist forces, which has become a dominant issue in Western armies' views of the nature of conflict in the last two decades (e.g. the war in Afghanistan, the battle against ISIS and so on); (2) Scenarios of support and prevention: collection of **quality intelligence** to provide a clear picture of the enemy's intentions and abilities, allowing for planning of preventive action, and conducting **methodical reconnaissance and ambushes** for early discovery and thwarting of potential threats. An intelligent combination of intelligence and ground activity may prevent severe attacks such as suicide attacks or invasion of enemy forces (Mazzarella, 1994).

Primary takeaways from the Russia-Ukraine War

The Russia-Ukraine War is a suitable arena for examining the use of attack helicopters in combat between regular armies. Attack helicopters, especially armed utility helicopters of the Mi-8/Mi-17 and Mi-24 models, have played a significant role in this war. Both sides used them for various missions, including assault and support for ground maneuvers, transport, and assault missions by the same helicopter (unique to the Russian doctrine but also applied by Ukraine). Attack helicopters continue to play critical roles in both countries' efforts, especially on the part of Ukraine, where the primary use for attack helicopters is to attack armored forces. In the southern combat areas, Russian attack helicopters are a significant part of the counterattack in Ukraine and allow the Russian troops to conduct remote assaults. Despite their large-scale use, the war has exposed the tremendous general vulnerability of helicopters (whether parked in refueling areas or heliports) or to an anti-aircraft fire. According to an unverified report, out of a fleet of 889 Russian helicopters, 323 were destroyed (on the ground) or shot down by Ukrainian forces by mid-2023 (Van Brugen, 2023).

From this war, we can conclude that attack helicopters were widely used for support missions, prevention and assault of armored forces, and their vulnerability on the battlefield. It would be worth examining the use of attack helicopters compared with the widescale use of diverse types of UAVs and precision-guided munitions by both sides and looking into the balance between these systems and attack helicopters.

Primary takeaways from the Iron Swords War

The Air Force has yet to publish the investigations of its activity during the Iron Swords War, specifically on October 7th. When these became known, the role of attack helicopters in the war would be clarified. In this war, the primary use of attack helicopters was to provide support to ground forces, initially in thwarting the surprise attack by Hamas and later by support in combat. On the first day of the war (October 7th), on-call helicopters were alerted to the border, which had been breached at several locations. Considering the multitude of breaches, as well as the difficulty in identifying the enemy (some of the terrorists wore civilian clothing) and firepower limitations, the support provided was limited. Also, despite the supplementation of several conflict areas with attack helicopters, the distance from arming and refueling points (turnaround) and the limited number of aircraft reduced the impact of these platforms during Hamas' attack (Ofir, 2023; Dostri, 2023).

As the war continued, attack helicopters were used as an added tool in the arsenal of close support for ground forces, including support in targeted attacks on enemy compounds or targeted strikes. Attack helicopters provide precise airborne support to the troops on the ground, especially in urban terrain, while minimizing collateral damage to civilian populations. They also employed their leverage and maneuvering abilities to attack critical targets and defend ground forces from enemy attacks. Considering the takeaways from operating attack helicopters, Israel is considering the procurement of additional helicopters with adapted ammunition (Egozi, 2024).

Based on what we know so far, several noteworthy conclusions exist from using attack helicopters in the Iron Swords War. The effectiveness of attack helicopters depends on the number of helicopters that can be useful in engagement areas. The need for more planes to provide support increases with increased hot spots and the growing distance from refueling and arming stations. Also, helicopters were not used to create a general situational "picture" or awareness, and this is an essential condition for the command and control of all forces to understand the operational challenge and guide forces effectively. To date, the attack helicopter provides immediate support for the needs of ground forces while maximizing command and control abilities with the maneuvering force.

SWOT Analysis

Strengths

Attack helicopters are assigned to a variety of missions because of their unique capabilities: the ability to hover over a defined location ("hotspot") and "skip" locations in the same sortie following the battlefield's development; the cockpit

crew's ability to create a broader situational "picture" of battle than what the ground force has to work with; the ability to fly at low altitudes and take advantage of the terrain to improve durability; and the ability to perform rapid arming in frontal locations that do not have complex infrastructure. All these have made the operation of attack helicopters very versatile and have contributed to their operational effectiveness while adjusting the aircraft for "any mission" that comes up.

Moreover, in recent years, attack helicopters have been equipped with command and control systems that are connected to those of the ground forces – thus, they become an additional sensor in the network of operational information and an effector following their relative advantage in battle (Brittingham, 1980; Redman, 1998). Attack helicopters are adapted to various scenarios – they can arrive rapidly from their home bases to conflict areas and carry out varying activities in those areas; they are somewhat flexible in dealing with challenging weather conditions (albeit not all conditions, they are especially limited when dealing with fog, low clouds, etc.); they can provide direct and accurate support to ground forces (including acquisition of independent goals and use of advanced control and command systems to create accurate situational reports in real-time). Finally, they have versatile threat-based arming capabilities (ammunition adapted for the destruction of armored vehicles or the destruction of other targets).

The attack helicopter's most prominent strengths are its ability to reach the battleground and engage quickly with the enemy in uncertain circumstances, to build a good "picture" of the battlefield, and to join forces with the ground (and naval) troops as one of their weapons, as can be concluded from the Iron Swords War (Gruszczak, 2023).

Weaknesses

Along with their versatility, attack helicopters have a few disadvantages (some of which are like those of piloted combat planes). Other than high maintenance and lifecycle costs, their usability differs from that of different aircraft (due to the complexity of dynamic mechanisms). The durability of helicopters has eroded over the years as their field of action became filled with threats (especially anti-tank missiles and shoulder-launched missiles). There have always been risks entailed in flying any helicopter near hot spots on the battlefield. Still, over the years, there have been significant changes in the attitude towards attack helicopters as key targets to be shot down by enemy forces.

Additional shortcomings include a relatively high footprint on the battlefield (they are noisy and visible in comparison with other weapons), various ground obstacles that could restrict their area of activity (especially in urban terrain or

where there is an abundance of impediments such as power lines, smokestacks, and the likes), vulnerability to cyberattacks (due to their dependency on digital systems and communications), and more.

Among the central ways in which the battlefield has changed is the internalization (including by terrorist organizations) of the attack helicopter's vulnerabilities as aerial objects that are also unsatisfactorily protected and thus can be shot down. New generations of portable surface-to-air (SAM) missiles, which are home on helicopters, are another change in the battlefield, as well as increased use of anti-tank missiles to shoot at helicopters. These changes led to an adjustment of the operational doctrine for attack helicopters. When avoiding threats like anti-tank or shoulder missiles, the focus of activity is shifted away from low altitudes (in specific scenarios); thus, sometimes, the ability to fly low is no longer an advantage. Moreover, fatality considerations (when unmanned tools may carry out similar missions), the cost of training and maintaining pilot readiness (compared to the cost of operating other means) and the helicopter being an "attractive" target for the enemy to showcase achievement – all these change the location of the "activity focus" and may distance this focus from the core activity of ground forces, including because of challenges of flight and line of sight between the helicopter and forces in urban areas (Barret, 1989; Loewer, 2017).

Opportunities

The future of attack helicopters presents numerous opportunities and challenges that will shape their role in military action. One significant opportunity lies in promoting digitalization and communication technologies, improving operational effectiveness, and enhancing helicopter crews' situational awareness (Marrone and Nones, 2015). We can also foresee the combination of battle arrays that combine attack helicopters and unmanned vehicles. This could improve their durability, the extent to which their capabilities are realized, and their influence, especially in complex and high-risk terrain (Himes, 2020). However, the challenges of the urban battlefield, which demand a delicate balance between mission execution and the need to minimize collateral damage to uninvolved parties, are critical. These challenges become especially pronounced in densely populated areas and low-impact conflicts (Tovy, 2020). They are met by using several techniques, including combining attack helicopters with ground forces that point out the target, employing innovative guided arms from the helicopter to specific targets without eye contact between the helicopter and the target, and increased load capabilities (which enable lengthy "loitering" and increased ammunition loads),

all of which will maximize the potential of attack helicopters in future battle scenarios.

There is significant potential for improvement in the ability of attack helicopter fleets to integrate into the battlefield. When fully realized, this ability enables large fleets to maintain high readiness at several engagement points along the borders, create supply and refueling abilities near the front lines, and more. This potential for improvement should instill a sense of optimism about the future of attack helicopter fleets. Properly investing resources in these areas could create a solution for missions of surprise attacks on the borders, highlighting the crucial role that attack helicopters can play in military strategy.

Risks

Over the years, new weapons and capabilities have evolved to perform an increasing share of formerly "classic" attack helicopter missions. Drone-based arrays have been created for diverse battle roles, and their advantages (as presented below) have put the need for procuring attack helicopters at a lower priority (Elmeseiry et al., 2021). As ground and naval troops are equipped with independent reconnaissance and attack capabilities (such as drones and other small UAVs, especially FPVs), their operational needs are fulfilled – sometimes in a manner superior to the response provided by helicopters. I should note that FPV (First Person View) UAVs are becoming more prevalent. This craft is unique in its ability to precisely target attacks inexpensively (Chavez & Swed, 2023; Seo et al., 2023). Procuring precision munitions by all players on the field and independent reconnaissance abilities minimize the relative advantage enjoyed by attack helicopters in the past (Mutschler et al., 2024).

The availability of drones and various UAVs and the continued improvement of their effective arming have significantly expanded the scope of missions to which they apply. The spectrum of conflicts that have seen effective use of these weapons is noteworthy, as it includes the Azari War in Armenia, the War on ISIS, the Iron Swords War, the Russia-Ukraine War, and others. However, the different wars have revealed diverse challenges when using these tools, especially regarding their durability. This underscores the resilience and adaptability of attack helicopters in the face of evolving threats and changing battlefield conditions, providing reassurance about their continued effectiveness.

A significant operational and technological development is the use of precision-guided munition. The advantages of these tools are apparent, as some of them can "loiter" (remaining in interest until the acquisition of the target), and they can be launched from the ground or aerial platforms. They also enjoy high durability, are easy to operate (compared to manned or unmanned aircraft), and

are cost-effective. This emphasis on the cost-effectiveness of precision-guided munitions should instill confidence in their value. There are many types of guided munitions in the various arrays, including those used in the Russia-Ukraine war (Russian "Lancet" missiles, Israeli "Spikes," American "Switchblades," and more). Their effect on battle is significant, and even possessing a large amount of them is a deterrent to various organizations (Pomper & Tuganov, 2023).

What are the alternatives to the attack helicopter?

Throughout the years, various alternative aerial weapons have evolved for a diversity of missions (in different scenarios). These alternatives may be classified into different dimensions: manned alternatives for support missions (including planes or armed utility helicopters), remote manned options (in a variety of sizes and munitions adapted to the arena), missile-based alternatives (of various sizes), and the combination of all alternatives for operational results (for instance, an unmanned aircraft hovering in the battle zone and marking targets for remotely launched missiles).

Since many missions that were previously the domain of combat helicopter fleets are now performed by other means, and since ground and naval forces can now meet their various needs through the organic collection and attack assets assigned directly to them, the question arises whether the availability and firepower response of combat helicopters is still relevant in various combat scenarios. Prioritization of the alternatives requires an in-depth discussion of their potential to fulfill attack helicopter roles in missions where the latter are still dominant. Due to a shortage of space, it is difficult to expound upon each alternative's relative advantages and shortcomings. Still, considering recent battles (the coalition's war on ISIS, the Russia-Ukraine War, and the Iron Swords War), several general directions may be laid out:

- Unmanned aerial vehicles, including unmanned rotorcrafts that can be independently controlled by ground forces, including an option of "swarms" that carry out coordinated missions: the development of different types of rotary UAVs indicates the ability to carry hundreds of effective pounds of munition, and the option to integrate reconnaissance tools of various kinds to create an accurate battle picture (Yaacoub et al., 2020). FPV drones' use in various offensive missions has expanded among all players and has become a remarkably effective and applicable alternative, especially in urban warfare (Jeangène Vilmer, 2023).
- Manned fixed-wing planes, such as light attack planes, for missions in low-threat areas. Their advantage is that they have a lower cost than attack helicopters and a higher munitions capacity (Tadjdeh, 2020).

- Armed attack helicopters that can carry diverse munitions. The ability to transition between attack and transport mode may provide a financial solution as the fleet is relatively uniform (this reduces maintenance costs). The ability to carry ammunition protects utility helicopters in high-threat areas (Szilvássy, 2022).
- Precision-guided munitions (the wide variety of them – from cruise missiles to loitering munitions) – these may saturate the battlefield and create an ongoing impact on the enemy (when battling terrorist organizations in urban terrain or full-scale conflict between armies). The Russia-Ukraine War, Israel's conflict with countries without a shared border, improved precision and durability, and low cost over the years – all point toward a procurement direction for various missions in different combat scenarios (Franklin, 2022).

Is it the end of the attack helicopter era?

The alternatives mentioned herein and an increased understanding based on the cumulative experience with attack helicopters in various arenas beg an in-depth discussion of the question: Is it the end of the attack helicopter era? This question can be examined on two levels: discussing where attack helicopters are still advantageous over the alternatives and analyzing the procurement approach according to the central scenarios (combat vs. terrorist organizations, including surprise attacks and wars between armies).

It should be noted that the rate of attack helicopters shot down in various arenas dramatically depends on their operation mode, the type of terrain, and the duration of their presence in a specific area. For example, the Russians used a classic battle doctrine to operate their attack helicopters (close support, escort, and attack of targets, sometimes by day). Available sources reveal that the loss of Russian helicopters was derived from their operation methods, which allowed the Ukrainians to shoot down 45 helicopters.

When juxtaposing the advantages and disadvantages of the various alternatives to attack helicopters for a specific mission, we can see that some options have significant benefits in conducting multiple missions (in combat vs. terrorist organizations and a high-impact war between armies).

The answer to this question requires changing how the relevant weapon is chosen for battle missions (Lassman, 2013). The rationale behind procurement processes in general and specifically in aircraft should be constantly tested vis-à-vis rapid changes in several aspects: advanced (and inexpensive) technology of a variety of UAVs in various sizes that provide solutions to some challenges of battle (Battsengel et al., 2020); the flexibility in operating aerial weapons (manned and unmanned) in a variety of scenarios (from "conventional" to OOTW)

(Pong, 2020); the changing of targets in the modern battlefield and different types of identification and adjustment of munitions for their destruction (Kosal, 2020); the rate of change in aerial defense arrays of various kinds, which can disrupt and impede the activity of aerial vehicles of different types and swarms of drones (Tianfeng et al., 2023); and finally varying trends in technologies of independent reconnaissance and attack (such as 5th generation combat planes) (Adamson & Snyder, 2017).

Methods such as examining procurement processes through risk management (Louth & Boden, 2014) and reviewing a portfolio of weapons as a response to the threats of battle (Ekström et al., 2020, Ardil, 2022) may help figure out the question of whether the attack helicopter is still relevant to the battlefield. The final takeaways from the Russia-Ukraine war (Lubiejewski, 2023) and the Iron Swords War (which have yet to be sufficiently clarified) may provide further directions for discussing the relevance of attack helicopters. Their limited significance in a threat-saturated battlefield, the relatively high maintenance and procurement costs, and the alternative means for conducting their missions are all factors that warrant a renewed examination of the feasibility of procurement.

To conclude, the substantial technological development of a variety of munitions launched from unmanned or remotely operated vehicles, their low cost, simple operation, and maintenance (compared to manned aircraft in general and specifically to helicopters) all indicate the need to examine the future procurement of attack helicopters.

Appendix

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
1	Algeria War (1954-1962)	Sud Aviation SE Allouette II (France)	Patrol and escort of utility helicopters	Limited firepower for offensive attacks	War on uprising	Approx. 30	Light cannons, machine guns, unguided rockets	Rollie (2013); Shrader (1999); Villatoux et al. (1995)
2	Vietnam War (1955-1975)	UH-1 Iroquois (Huey) (US) AH-1 (Cobra) (US)	Close air support, escort of utility helicopters	Light weapons and mobile anti-aircraft arrays hit many helicopters.	War on guerillas	Approx. 7,000	Guns, unguided rockets, 20 mm. cannon (Cobra)	Gillett (2014); Rollie (2013); Tyler (2003)
3	Afghanistan-USSR War (1979-1989)	Mil Mi-24 HIND (USSR)	Close combat support, attacking precision targets, escort for utility helicopters	Limited altitude and maneuvering in mountainous terrain	War on uprising	Approx. 250	30 mm cannons, unguided rockets, land-air missiles	Groenke (2005); Khalilzad (1986); Rollie (2013)
4	Operation Just Cause (1989)	AH-64 Apache (US)	Close combat support, attacking precision targets	The importance of nighttime operations and precise attacks in urban environments	Special operation	Approx. 12	30 mm cannon, Hellfire missiles, unguided rockets	Smith (1992); Hansen (1984)

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
5	Operation Desert Storm (1991)	AH-64 Apache (US)	Destruction of tanks and anti-aircraft arrays, close combat support	High efficiency at the beginning of the conflict in removing precise targets, nighttime operational importance	war between armies	approx. 277	30 mm cannons, Hellfire missiles, unguided rockets	Hinton et al. (1992); Nelson (1992); Tucker-Jones (2014)
6	Somalian Civil War (1991-2009)	AH-64 Apache (US), MH-6 Little Bird (limited use) (US)	Escort of convoys, attacking precision targets	The importance of aerial support in urban environments, vulnerability to RPGs	The war against guerilla forces	Approx. 20	Machine guns, unguided missiles, 30 mm. (Apache)	Hansen (1984)
7	Kosovo War (1998-1999)	AH-64 Apache (US) Longbow (limited use) (US)	Close combat support, attacking targets	Challenges in using in Europe, need for improved coordination with ground forces	War between armies	Approx. 24	30 mm. cannon, Hellfire missiles, unguided rockets	Holmes (2000); Grant (2000); Lake (2009)
8	Afghanistan War (2001-2021)	AH-64 Apache (US) MH-6 Little bird (US) AH-1Z Viper (US)	Close combat support	Importance of attack helicopters for rapid response and precise attacks, need to improve defense against anti-tank missiles	War against uprising	Approx. 200	300 mm cannons, Hellfire missiles, unguided rockets	Groenke (2005); Pastor (2012)

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
9	Iraq War (2003-2011)	AH-64 Apache (US), AH-1Z Viper (US)	Close combat support, special ops, targeted attacks	Critical role in urban warfare and against uprisings	The War between armies, war on uprising	Approx. 200	300 mm cannons, Hellfire missiles, unguided rockets	Pastor (2012); Groenke (2005); Petrescu et al. (2017)
10	Lebanon War (1982)	AH-1 Cobra (Israel)	Close combat support, battle against tanks, damaging aerial defense systems	Efficiency in mountainous terrain, challenges in urban warfare	War between armies	Approx. 60	20 mm cannons, LAU missiles, unguided rockets	Spiller (1992); Tovy (2022)
11	Conflict in Southern Lebanon (1985-2000)	AH-1 Cobra (Israel)	Close combat support, targeted attacks	With the constant threat of guerilla attacks, there is a need for continuous aerial observation	War on guerilla forces	Approx. 20	20 mm cannons, LAU missiles, unguided rockets	Tovy (2022)
12	Second Intifada (2000 – 2005)	AH-64 Apache (Israel) AH-1 Cobra (Israel)	Targeted assassinations, close combat support	Ethical and legal challenges in targeted assassinations, effectiveness in precision attacks	War on uprising	Approx. 25	30 mm cannon, Hellfire missiles, unguided rockets	Tovy (2022); Kober (2007); Jones (2007)

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
13	Second Lebanon War (2006)	AH-64 Apache (Israel, AH-1 Cobra (Israel)	Close combat support, operations against tanks, damaging aerial defense systems		War between armies	Approx. 48	30 mm cannon, Hellfire missiles, unguided rockets (Apache), 20 mm cannons, LAU missiles, unguided rockets (Cobra)	Kober (2008)
14	Wars in Gaza (2008-2009, 2012, 2014, 2021)	AH-64 Apache (Israel, AH-1 Cobra (Israel)	War against uprising	Challenges in urban warfare, minimizing harm to civilian populations is of importance, and effective use of intelligence	War on uprising	Approx. 40	30 mm cannon, Hellfire missiles, unguided rockets (Apache), 20 mm cannons, LAU missiles, unguided rockets (Cobra)	Cordesman (2009); Tovy (2022)
15	Operation Enduring Freedom (Philippines, 2002 – ongoing)	AH-64 Apache (Israel, AH-1 Cobra (Israel)	Close combat support, precision attacks, targeted assassinations	Effective use of attack helicopters in jungle terrain, need for real-time intelligence	War on uprising	Approx. 12	30 mm cannon, Hellfire missiles, unguided rockets (Apache), 20 mm cannons, LAU missiles, unguided rockets (Cobra)	Maxwell (2021); Dunigan et al. (2012)

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
16	Civil war in Syria (2011 – ongoing)	Mil Mi-24 HIND (Syria, Russia), AH-64 Apache (US) (limited use)	Close combat support, targeted assassinations, support for urban warfare	Large-scale forces are hard to combat, helicopters are vulnerable to mobile anti-aircraft attacks and effective in dense urban environments	War between armies, war against guerrilla	Approx. 60	30 mm cannon, Hellfire missiles, unguided rockets (Apache), 20 mm cannons, LAU missiles, unguided rockets (Cobra)	Nečas et al. (2019); Lucas (2016)
17	Russia-Ukraine Conflict (2014 – ongoing)	Mil Mi-24 HIND (Ukraine, Russia), Kamor KA-52 Alligator (Russia)	Close combat support, anti-tank operations, urban warfare	High vulnerability to modern mobile anti-aircraft weapons and aerial defense systems, critical roles of drones and electronic warfare	War between armies, war against guerilla forces	Approx. 100	30 mm cannons, unguided rockets, land-SAMs (HIND) 30 mm cannons, Vikhr missiles, unguided rockets (KA-52)	Freedman (2022); Sankaran (2024)
18	War on ISIS (2014 – ongoing)	AH-64 Apache (US), Mil Mi-28 Havoc (Russia), Mil Mi-24 (HIND) (Iraq)	Close combat, targeted attacks, urban warfare	The importance of precision attacks and intelligence in urban combat, need for cooperation with ground forces	War on uprising	Approx. 50	30 mm cannon, Hellfire missiles, unguided rockets (Apache), 30 mm cannon, unguided rockets, SAMs (HIND and Havoc)	Dworkin (2016); Golf (2017); Wasser et al. (2021)

	Conflict (Dates)	Primary Attack helicopter	Primary Use	Takeaways	Type of Conflict	Number of participating attack helicopters	Type of munitions	Sources
19	Operation Neptune Spear (2011)	MH-60 Blackhawk (adapted) (US)	Escort for special ops, targeted attacks	The importance of advanced technology and the element of surprise in counterterrorism ops	Special operation	2	Machine guns	Khokhar (2011)
20	Operation Gothic Serpent (1993)	MH-60 Blackhawk, MH-6 Little Bird (US)	Escort for special ops, targeted attacks	Challenges in urban warfare, importance of armor and aerial support, vulnerability to RPGs	Special operation	Approx. 16	Machine guns, unguided rockets (Little Bird)	Ramsay (2020), Ecklund (2008)

References

Adamson, A., & Snyder, M. (2017). The challenges of fifth-generation transformation. *The Rusi Journal, 162*(4), 60-66. https://doi.org/10.1080/03071847.2017.1353256

Ardil, C. (2022). Military attack helicopter selection using distance function measures in multiple criteria decision making analysis. *International Journal of Aerospace and Mechanical Engineering, 16*(2), 15-22. https://tinyurl.com/mw7zarcs

Banasik, M. (2021). Trends in the development of Russian precision-guided weapons. *Safety & Defense, 1*, 25-36. https://tinyurl.com/4sbnn3fr

Barrett, P.W. (1989). Operating and support cost model for military helicopters. *AACE International Transactions, G-6.*

Battsengel, G., Geetha, S., & Jeon, J. (2020). Analysis of technological trends and technological portfolio of unmanned aerial vehicles. *Journal of Open Innovation: Technology, Market, and Complexity, 6*(3), 48. https://doi.org/10.3390/joitmc6030048

Bernstein, J. (2012). *AH-64 Apache units of operations enduring freedom and Iraqi freedom* (Vol. 57). Bloomsbury Publishing.

Brittingham, M.L. (1980). *Attack helicopter employment options* [Doctoral dissertation, U.S. Army Command and General Staff College]. https://tinyurl.com/e6a7d8ce

Chávez, K., & Swed, O. (2023). Emulating underdogs: Tactical drones in the Russia-Ukraine war. *Contemporary Security Policy, 44*(4), 592-605. https://doi.org/10.1080/13523260.2023.2257964

Cicurel, A., & Magnum, K.V. (2023, March 24). What Ukraine teaches us about combat helicopter operations. *Jinsa*. https://tinyurl.com/ym3v7y93

Cordesman, A.H. (2009, February 2). The "Gaza War": A strategic analysis. *Center for Strategic and International Studies (CSIS)*. https://tinyurl.com/538xvmxk

Culhane, K.V. (1977). *The Soviet attack helicopter* [U.S. Army Institute for Advanced Russian and East European Studies]. https://tinyurl.com/2jpyzvbb

Dostri, O. (2023). Hamas's October 2023 attack on Israel. *Military Review*. https:// tinyurl.com/yvy4acxm

Dunigan, M., Hoffmann, D., Chalk, P., Nichiporuk, B., & Deluca, P. (2012). The Case of Operation Enduring Freedom — Philippines. In *Characterizing and Exploring the Implications of Maritime Irregular Warfare* (pp. 19–34). RAND Corporation. http://www.jstor.org/stable/10.7249/mg1127navy.10

Dworkin, A. (2016, October). Europe's new counter-terror wars. *European Council on Foreign Relations*. https://tinyurl.com/mrxu6mrk

Ecklund, M.V. (2008). Task Force Ranger vs. urban Somali guerillas in Mogadishu: An analysis of guerilla and counterguerilla tactics and techniques used during Operation Gothic Serpent. *Australian Army Journal, 5*(2), 235-260. https://tinyurl.com/ev3drd35

Egozi, A. (2024, 5 April). Israel shifts back to the Apache as UAV switch fails. *Shephard*. https://tinyurl.com/mvxnuenn

Ekström, T., Hilletoft, P., & Skoglund, P. (2020). Guidance for the application of a dynamic purchasing portfolio model for defence procurement – A Swedish perspective. *Necesse, 5*(3), 136-158. https://tinyurl.com/bdetunzz

Elmeseiry, N., Alshaer, N., & Ismail, T. (2021). A detailed survey and future directions of unmanned aerial vehicles (UAVs) with potential applications. *Aerospace, 8*(12), 363. https://doi.org/10.3390/aerospace8120363

Ference, E.W., & Boudreau, M.W. (2002). Case study of the development of the Apache attack helicopter (AH-64) [Doctoral dissertation, Naval Postgraduate School].

Ferrari, J. (2024, February 9). Terminating the Fara Helo program was the right call by the Army chief. *Breaking Defense*. https://tinyurl.com/mvurfrpe

Franklin, M. (2008). Unmanned combat air vehicles: Opportunities for the guided weapons industry? *Royal United Services Institute (RUSI)*. https://shorturl.at/WosB6

Freedman, L. (2022, June 14). Why war fails: Russia's invasion of Ukraine and the limits of military power. *Foreign Affairs, 101*(4), 10. https://tinyurl.com/4p5exkzf

Gillett, K.T. (2014). Air mobility and the development of attack aviation during the Vietnam War from 1965-1967 [Doctoral dissertation, Fort Leavenworth, KS: US Army Command and General Staff College].

Goff, R. (2017). Building military helicopter capacity: Influences on process and effectiveness.

Goldstein, L., & Waechter, N. (2024, February 26). China looks to Ukraine war for guidance on attack helicopters. *RAND*. https://tinyurl.com/38jy7t4z

Grant, R. (2000). Nine myths about Kosovo. *Air Force Magazine, 83*(6), 50-55. https:// tinyurl.com/2ercuptk

Groenke, A.S. (2005). CAS, interdiction, and attack helicopters [Doctoral dissertation, Monterey California. Naval Postgraduate School].

Gruszczak, A. (2023). Post-modern warfare. In A. Gruszczak & S. Kaempf (Eds.), *Routledge Handbook of the Future of Warfare* (pp. 212-223). Routledge.

Gurel, E., & Tat, M. (2017). SWOT analysis: A theoretical review. *The Journal of International Social Research, 10*(51), 994-1006. https://doi.org/10.17719/ jisr.2017.1832

Hansen, J. (1984). *The role of the attack helicopter in operations other than war* [Doctoral dissertation, United States Military Academy].

Himes, J. D. (2020). The marine corps' future of attack and utility helicopters: Survivability through manned and unmanned teaming [Thesis, USMC].

Hinton, H., Billen, G., Hamilton, J., Stewart, D., & Spence, R. (1992). Operation Desert Storm, Apache helicopter was considered effective in combat, but reliability problems persist. *US General Accounting Office*. https://tinyurl.com/2s3hwvjf

Holmes, S.L. (2000). Army attack aviation and joint air operations: Doctrinal and institutional barriers. *School of Advanced Military Studies, US Army Command and General Staff College*. https://tinyurl.com/yr42vtzu

Israel Air Force. (2023, October 3). Yom Kippur War investigation – Applications. IDF Spokesperson Announcement, 50 years to the Yom Kippur War. https://tinyurl. com/3m6ut9m9

Jeangène Vilmer, J.B. (2023). Not so remote drone warfare. *International Politics, 60*(4), 897-918. https://tinyurl.com/mrxjbbk2

Jones, S.G. (2007). Fighting networked terrorist groups: Lessons from Israel. *Studies in Conflict & Terrorism, 30*(4), 281-302. https://doi.org/10.1080/10576100701200157

Khalilzad, Z. (1986). The war in Afghanistan. *International Journal, 41*(2), 271-299. http://dx.doi.org/10.2307/40202370

Khokhar, A.Y. (2011). Operation Neptune Spear: A watershed in the war against terrorism. *Strategic Studies, 31*(3), 109-123. https://www.jstor.org/stable/48527651

Kober, A. (2008). The Israel Defense Forces in the Second Lebanon War: Why the poor performance? *Journal of Strategic Studies, 31*(1),43-87. https://doi.org/10.1080/01402390701834045

Kober, A. (2007). Targeted killing during the second intifada: The quest for effectiveness. *Journal of Conflict Studies, 27*(1), 76-93. https://tinyurl.com/rnk8crfk

Kosal, M. E. (2020). *Disruptive and game changing technologies in modern warfare*. Springer International Publishing.

Lake, D. R. (2009). The limits of coercive airpower: NATO's "victory" in Kosovo revisited. *International Security*, 34(1), 83-112.

Lassman, T. C. (2013). Reforming weapon systems acquisition in the Department of Defense: The case of the US Army's advanced attack helicopter. *Journal of Policy History*, 25(2), 173-206. https://tinyurl.com/49ze6kbv

Leishman, J. G. (2000). A history of helicopter flight.

Lepore, H. P. (1994). The coming of age: The role of the helicopter in the Vietnam War. *Army History*, 29, 29–36.

Loewer, M. (2017). An analysis of factors that influence logistics, operational availability, and flight hour supply of the German attack helicopter fleet [Doctoral dissertation, Naval Postgraduate School].

Louth, J., & Boden, R. (2014). Winging it? Defense procurement as risk management. *Financial Accountability & Management*, 30(3), 303-321. https://doi.org/10.1111/ faam.12040

Lubiejewski, S. (2023). Conclusions from the use of aviation in the first half of the first year of the Ukrainian-Russian war. *Security and Defence Quarterly*, 42(2), 68-104. https://doi.org/10.35467/sdq/161959

Lucas, S. (2016). A beginner's guide to Syria's Civil War. *Political Insight*, 7(1), 12-15. https://doi.org/10.1177/2041905816637453

Marom, A. (2021, January 12). Combat helicopter legacy in the Israeli Air Force. Reaching the Sky – Aviation History in Israel. https://tinyurl.com/4s6362ds /

Marom, A. (2013). *Combat helicopter array, Heritage Page No. 70*. Israeli Air Force Association Heritage Pages. https://tinyurl.com/ycysc77h

Marrone, A., & Nones, M. (2015). The dual-use helicopters perspective. In A. Marrone & M. Nones (Eds.), The role of dual-use helicopters in the security and defense/ defence field (pp. 137–160). IAI & Edizioni Nuova Cultura.

Maxwell, D. S. (2021). Operation Enduring Freedom–Philippines: Lessons in special warfare. In *Routledge handbook of US counterterrorism and irregular warfare operations* (pp. 280–292). Routledge.

Mutschler, M., Bales, M., & Meininghaus, E. (2024). The impact of precision strike technology on the warfare of non-state armed groups: Case studies on Daesh and the Houthis. *Small Wars & Insurgencies*, 1–28. https://doi.org/10.1080/09592318.2024.2319216

Nečas, P., Vacková, M., & Lošonczi, P. (2019). Air power as a security factor: Case study Syria. *INCAS Bulletin, 11*(1), 217–230. https://tinyurl.com/jm3df568

Nelson, R. C. (1992). *Combat use of Apache helicopters in the Kuwaiti theater of operations--effective or not?* [Doctoral dissertation, U.S. Army Command and General Staff College]. Fort Leavenworth.

Ofir, D. (Ed.). (2023, 28 December). Where were the combat helicopters. Another Day [Podcast]. Kan 11. https://tinyurl.com/ytsxt2cz

Pastor, A. M. (2012). *Helicopters in irregular warfare: Capabilities, challenges, and missed opportunities*. Air Command and Staff College. https://tinyurl.com/53vvmpyn

Petrescu, R. V., Aversa, R., Akash, B., Corchado, J., Berto, F., Apicella, A., & Petrescu, F. (2017). About helicopters. Journal of Aircraft and Spacecraft Technology, 1(3), 204–223. https://doi.org/10.3844/jastsp.2017.204.223

Pomper, M., & Tuganov, V. (2023). Role of missiles in Russia's war on Ukraine and its implications for the future of warfare. In A. Vicente, P. Sinovets, & J. Theron (Eds.), Russia's war on Ukraine: Contributions to political science (pp. 69–93). Springer. https://doi.org/10.1007/978-3-031-32221-1_6

Pong, B. (2022). The art of drone warfare. Journal of War & Culture Studies, 15(4), 377–387. https://doi.org/10.1080/17526272.2022.2121257

Ramsay, N. (2020). Operation Gothic Serpent: An analysis of failure. In B. Horn (Ed.), Risk: SOF case studies (pp. 209–240). https://tinyurl.com/2eyxwhum

Redman, J. M. (1998). Changing roles: Attack helicopter as the dominant maneuver force. Naval War College Newport. https://tinyurl.com/5zsdaaa4

Rochkes Domba, A. (2023, October 25). Analysis: How are two combat helicopters on alert supposed to protect all state borders? https://tinyurl.com/4ajryyym

Rollie, M. B. G. (2014). Helicopters in irregular warfare: Algeria, Vietnam, and Afghanistan [Illustrated Edition]. Tannenberg Publishing.

Sankaran, J. (2024). The failures of Russian aerospace forces in the Russia–Ukraine war and the future of air power. *Journal of Strategic Studies*, 1–28. https://doi.org/10.1080/01402390.2024.2345899

Seo, K. I., Cho, S. K., & Park, S. H. (2023). A case study on FPV drone combats of the Ukrainian forces. *The Journal of the Convergence on Culture Technology, 9*(3), 263–270.

Shrader, C. R. (1999). *The first helicopter war: Logistics and mobility in Algeria, 1954–1962*. Bloomsbury Publishing USA.

Smith, D. I. (1992). *Army aviation in operation just cause*. U.S. Army War College. https://tinyurl.com/2kw5md4d

Soboliev, D. (2016). *Development of helicopter capabilities in the US Army during the Korean and Vietnam wars* [Doctoral dissertation, U.S. Army Command and General Staff College].

Spiller, R. J. (1992). *Combined arms in battle since 1939*. U.S. Army Command and General Staff College Press. https://tinyurl.com/y6vhp45x

Szilvássy, L. (2022). Why does the attack helicopter have more survival ability than the armed utility helicopter? *Repüléstudományi Közlemények, 34*(3), 167–180. https:// doi.org/10.32560/rk.2022.3.11

Tadjdeh, Y. (2020). Armed overwatch aircraft on SOCOM's shopping list. *National Defense, 104*(798), 45–46. https://www.jstor.org/stable/27022991

Tianfeng, F., Xiaojing, M., & Chi, Z. (2023). Development status of anti-UAV swarm and analysis of new defense system. *Journal of Physics: Conference Series, 2478*(9), 092011. IOP Publishing. https://doi.org/10.1088/1742-6596/2478/9/092011

Tovy, T. (2020). The use of helicopters against guerrillas – The Israeli model. *European, Middle Eastern, & African Affairs, 2*(3), 36–49. https://tinyurl.com/2rff9494

Tucker-Jones, A. (2014). *The Gulf War: Operation Desert Storm 1990–1991*. Pen and Sword.

Tyler, D. (2003). The leverage of technology: The evolution of armed helicopters in Vietnam. *Military Review, 83*(4), 32–37.

U.S. Central Command (CENTCOM) (2023, April 12). CENTCOM forces capture ISIS operative in helicopter raid. *Press release*. https://tinyurl.com/yx4c9x8w

Van Brugen, I. (2023, October 18). Russia's helicopter problem is getting worse. *Newsweek*. https://tinyurl.com/3vf8eafc

Villatoux, M. C., Boillot, P., & Robineau, L. (1995). Algeria 1959-1960: Memories of aviators. *Historical Review of the Armies, 200*(3), 83–93. [in French]. https://www. persee.fr/doc/rharm_0035-3299_1995_num_200_3_4480

Wasser, B., Pettyjohn, S., Martini, J., Evans, A., Mueller, P., Edenfield, N., Tarini, G., Haberman, R., & Zeman, J. (2021, February 5). The air war against the Islamic State: The role of airpower in operation inherent resolve. https://tinyurl.com/564e3p3a

Yaacoub, J. P., Noura, H., Salman, O., & Chehab, A. (2020). Security analysis of drone systems: Attacks, limitations, and recommendations. *Internet of Things, 11*, 100218. https://doi.org/10.1016/j.iot.2020.100218

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

Powered Paragliders and the Air Assault Threat to Israel

Ehud Langer[1]

Abstract

The Hamas attack on October 7, 2023, incorporated powered paragliders as a tactical element in an air assault on Israel. Gliding over the ground barrier, these paragliders intensified the attack's impact. Despite Israel's air superiority, this successful air assault exposed vulnerabilities within Israel's advanced defense systems. This article examines the air assault threat to Israel, specifically from parachuting and gliding, to assess its potential impact and evaluate Israel's preparedness to counter it. The article argues that the Israeli Air Force had not previously recognized air assault as a substantial threat and was, therefore, unprepared to respond to it on October 7. To support this claim, the article explores Hamas's development of powered paragliders as a technological reduction strategy designed to limit Israel's ability to fully leverage its air defense systems during the attack. It then traces the evolution of fighter deployment platforms, focusing on powered paragliders and the distinctive features that make them effective tools for air assault operations. Following this, the article discusses the factors heightening Israel's vulnerability to such threats, assessing the country's current preparedness and exploring the broader implications for international security. Finally, the article offers recommendations for countering the specific air assault risks posed by powered paragliders.

Keywords: Powered paragliders, air assault, force-building strategy, technological superiority, air defense

[1] **Ehud Langer** is a master's student in the Security Studies program at Tel Aviv University.

Introduction

Hamas used powered paragliders (also known as paramotors) as a tactical element during its assault on Israeli territory on October 7, 2023. Despite Israel's advanced air defense system, which is based on a network of radars and weapons systems designed to intercept a variety of threats at different ranges, several of these paragliders managed to breach the border in the early hours of the attack. They took advantage of ground assaults and heavy indirect fire on Israel, with their relatively short airtime making detection and interception challenging (Shoval, 2024; Janes, 2023). Hamas paragliders glided over the ground barrier Israel had erected along the border, bypassing the barrier to reach targets close to the northern area of the Gaza Strip (at Netiv HaAsara) and central Gaza (at Kibbutz Kfar Aza and around Kibbutz Re'im), where they participated in the massacre of 300 Israelis at the Nova Festival.

Although powered paragliders are slow, noisy, and based on outdated technology, Hamas' use of them achieved the military objective of an air assault (also known as vertical envelopment). Western military doctrines have traditionally defined air assault as the transport of friendly assault forces by rotary-wing aircraft, with the goal of directly engaging and destroying enemy forces (e.g., CJCS, 2021, p. 9; Government of Canada, 2016; UK Ministry of Defense, 2020). While the IDF does not differentiate between the terms air assault and airborne assault, most modern militaries do make a distinction. An air assault relies primarily on the firepower, mobility, and transport capacity of helicopters, and an airborne assault involves assault forces parachuting from transport planes into the battlefield (CJCS, 2021, p. 10). However, Hamas's coordinated, large-scale air assault challenges the prevailing assumption that technological advancement—particularly in connectivity, automation, and cyber capabilities—is necessary for battlefield superiority (e.g., Gat, 2023; Lewis, 2022). Operatives from Hamas's military wing demonstrated that an effective air assault can be carried out without helicopters, using powered paragliders as a far more affordable, simple, and accessible substitute.

As the threat of powered paragliders has been relatively uncommon and unfamiliar to most countries until now, its potentially wide-ranging impact on future battlefields has not been sufficiently researched. However, Hamas's powered paraglider assault serves as a warning for what may lie ahead. Contributing factors include the global attention garnered by Hamas's attack, which has inspired Israel's adversaries worldwide, the rapid learning capabilities of non-state organizations, and the realization that this civilian technology is easy to conceal, as will be discussed further below (Mann, 2023).

In the wake of Hamas's air assault on October 7, this article examines the threat posed by powered paragliders, aiming to assess the level of risk they present to Israel and whether Israel is prepared to address it. The article bridges current knowledge gaps regarding powered paragliders and their use in assault operations. It offers new insights to advance the discourse on the role of technology in asymmetric warfare and to stimulate discussion on defense strategies to counter such threats. The article's central argument is that the Israeli Air Force, despite its multi-layered defense system, did not consider air assault as a significant threat and was, therefore, unprepared to respond on October 7. This argument is supported by an analysis of the evolution of air assault as a military tactic, along with insights from Israel's accumulated experiences from the 1980s to the October 7 attack. Together, these insights lay the groundwork for a broader discussion on the current implications of this threat, both for Israel and for international security. The events of October 7 offer a unique opportunity to engage in an *a posteriori* discussion of powered paragliders on the modern battlefield. Thus, this article's primary contribution lies in examining a phenomenon that has been rarely studied as an academic field, particularly within security studies and in the contexts of military force-building, reductive technologies, and combat strategies. Practitioners will find this article a comprehensive resource on the subject, addressing both conceptual and operational gaps and outlining possible approaches for addressing this threat.

Accordingly, the second section of the article outlines the theoretical framework, explaining Hamas's strategic choice to develop powered paragliders for air assault as an advanced example of offensive technological reduction in military force-building. The third section traces the progression of platforms for deploying fighters in air assault operations, with a focus on powered paragliders and the key features that make them a lethal and efficient reductive technology. The fourth section examines how this threat has evolved within Israel's strategic landscape, analyzing Hamas's efforts to develop air capabilities using powered paragliders. Building on this, the fifth section explores the territorial, geographic, and topographic factors that make Israel particularly vulnerable to air assault threats involving gliding and parachuting. Next, the degree of threat to Israel is evaluated in two stages, analyzing the strategic impact Hamas sought to achieve on October 7 through the deployment of powered paragliders. This analysis is juxtaposed with the IDF's current air defense strategy and the Air Force's operational capability to counter this threat. A discussion follows on Israel's preparedness and the broader implications for international security, concluding with recommendations for addressing the air assault threat posed by parachuting.

Theoretical Framework: From the Democratization of Terror to Technological Reduction in Military Force-Building

With the development and widespread availability of advanced technologies over the past three decades, most terrorist attacks on Western nations have relied on basic weapons such as knives, cars, and firearms (Bergama & Kearney, 2020). This choice of weapons stemmed from pragmatic reasons related to their availability, effectiveness, and resistance to regulation. The use of simple, low-cost technologies in terrorism escalated with 21st-century advancements in technology and globalization, resulting in what Fareed Zakaria (2003) describes as the democratization of terror. This democratization is marked by easy access to information, a lowered entry barrier for adopting technology, advances in mass communication and encryption, and the ability to transform everyday objects into lethal weapons (Neumann, 2009).

Today, the core body of research on technology and terrorism focuses on a range of advanced technological applications that terrorist organizations employ in asymmetric conflict, such as drones for attack and intelligence purposes or the use of precision weaponry (e.g., Brown, 2023; Johnson, 2009; von Rosenbach, 2021). An emerging branch within this body of research examines the technological aspect of terrorist organizations' evolution and how they develop adaptive strategies that alter the dynamics between the weaker and stronger sides in modern conflicts. For example, Dominic Johnson argues that any competing entity adopts an adaptive process based on the principles of natural selection, where effective adjustments to strategies and technologies provide a competitive advantage (Johnson, 2009). According to Johnson, in armed conflicts, the advantage of the stronger side can diminish when the weaker side has a wide and diverse capacity for innovation and is pressured to adapt quickly to shift the balance. Andrew Brown further illustrates how asymmetric conflicts encourage the weaker side to adopt strategies incorporating dual-use technologies, which increase their autonomy by minimizing interactions with the adversary that could lead to interference or disruption (Brown, 2023, p. 209).

Complementing these concepts is the theory of technological reduction in force-building, which draws on principles from the democratization of terror but focuses specifically on the strategic dimension of organized military force-building by the weaker side in a conflict. This theory introduces a strategic approach at the early stages of force development, explaining how a strategy takes shape to maximize available technologies under conditions of inferiority. It illustrates how, in a setting of technological asymmetry, a combatant with limited technological sophistication facing a highly advanced adversary will adopt a cunning, simple, and low-cost strategy to counter or offset the opponent's reliance

on advanced technology (Matanya & Sari Levy, 2021). The theory provides a framework for understanding the evolution of the threat in the Israeli context and the factors that led Hamas to establish an air assault capability. Within this framework, Hamas's strategy involving the use of powered paragliders can be seen as an advanced example of offensive technological reduction in military force-building, where Hamas's inferior technological sophistication led it to maximize low-tech solutions, specifically ones that would challenge Israel's air defense systems and limit their advantage during the assault.

Air Assault

The concept of air assault first emerged as a tactical solution to break World War I's deadlock of trench warfare. Its objective was to bypass enemy defensive lines and land behind them, initially leading to the development of military parachuting and gliding, and later to the evolution of helicopter-based assault capabilities (Dougherty, 1999). World War II saw the first significant and large-scale use of combat parachuting for assault purposes, first by the Soviet Union and subsequently by Germany (e.g., the invasion of Crete in May of 1941) and then by the Allies (e.g., the Normandy invasion in June of 1944) (Theotokis, 2020; Weeks, 2013). Even after the war, militaries worldwide continued to use this capability, most notably the Americans, in the Korean and Vietnam Wars and the invasions of Grenada, Panama, Afghanistan, and Iraq (Theotokis, 2020).

Unlike parachuting, where soldiers are dispersed over a large area and must regroup after landing, gliders can land with greater precision and carry several soldiers, allowing the force to be assembled and combat-ready immediately upon landing (U.S. Marine Corps, 1996, pp. 20–23, 20–25). The first glider-borne assault was conducted during World War II by the Germans, who had developed military gliding capabilities between the wars, as the Treaty of Versailles restricted them from producing aircraft for military use [Oglethorpe, 2010; Treaty of Versailles, 1919 (Articles 198–202); Yekutiel, 1985]. German gliders were towed by transport aircraft to the desired altitude and then released to glide silently toward their target. North Korea has recently been observed developing glider capabilities, conducting military exercises likely intended as preparation for a potential invasion of South Korea (U.S. Department of the Army, 2020). While parachuting remains a widely used tactical method among state militaries, gliders have largely been phased out despite their unique advantages, particularly with the rise of helicopter assault technology (Torrisi, 2000).

Lessons from World War II and the recognition of the need to develop and refine air assault capabilities led the U.S. Navy, particularly the Marine Corps, to establish new assault methodologies using helicopters. Over time, these became a

primary assault platform and the prevailing method for conducting assaults in the U.S. military and other armed forces (Dougherty, 1999; Shurkin, 2014; Theotokis, 2020). This shift was intentional and driven by clear advantages: helicopters offer robust transport capabilities (for soldiers, artillery, and weaponry), firepower, and exceptional mobility, with the ability to land vertically to swiftly secure strategic points (Durand et al., 2012). These strengths embody the principles of force concentration, surprise, and combat efficiency, fully aligning with the core objectives of air assault (Tovi, 2017, p. 41).[2]

Powered paragliders were invented in the 1960s in Canada and France by engineers and amateur parachutists and have since undergone advancements (Laver & Mei-Dan, 2013). Unlike traditional parachutes, which are designed primarily to slow a parachutist's descent, paragliders allow for more precise maneuvering and landing. Built with a wing-shaped nylon canopy that inflates with airflow, they offer quiet flight and a low radar signature. Additionally, they are simple to operate, requiring only about one to two weeks of training to achieve proficiency (Krytskyi et al., 2023; Steele, 2021). Powered paragliders include a suspended load, or "gondola," which is the frame connecting the canopy to the control mechanism, and they are piloted using air currents or a small engine connected to a propeller (Babinsky, 1999). These paragliders are highly compact, lightweight, capable of carrying significant loads, and can achieve rapid takeoff without infrastructure by facing into the wind, jumping, or being towed by a vehicle (USHPA, n.d.).

The powered paragliders used by Hamas terrorists included both single- and tandem models, the latter comprising a pilot and a gunner who used simple equipment such as mobile phones for communication and navigation, as well as grenade drops and light firearms. Due to the simplicity of the equipment and technology, the cost of a powered paraglider ranges from $1,500 to $5,000, depending on configuration, engine type, material quality, and performance capabilities.[3] These characteristics make powered paragliders effective for both military and civilian applications, such as aerial chemical spraying, low-speed and low-altitude photography, and serving as relay stations for radio communication (Goodrick et al., 1973).

Military forces around the world have recognized the potential of paragliders, which are currently used primarily by special forces units, including those in the IDF (Keinar, 2013). Traditionally, paragliders have been deployed in

2 For further insights into helicopters' features and their versatility as combat platforms, see Alex Dan's article, "Should Israel Equip Itself with Attack Helicopters?" which can be found in the current issue, p. 45.

3 For example, see the costs of powered paragliders in the civilian market based on purpose, materials, technology, and more: https://tinyurl.com/48ywdw7c

covert commando operations, launched from planes or helicopters (Weeks, 1978). In recent years, however, there has been a notable shift towards using powered paragliders as a low-cost alternative for border defense or as a means of deploying large raiding forces in countries that cannot sustain a large air fleet (Yonhap, 2017). Western militaries are also investing in this capability, working to develop advanced powered paraglider models with expanded functionality. In the United States, for instance, the Army is advancing a personal air mobility system aimed at supporting small assault units in complex, densely populated areas, thereby freeing helicopters for other essential missions (Marines, 2024; Trevithick, 2024). Additionally, in preparation for high-intensity conflict, U.S. Special Forces recently conducted an exercise simulating the use of powered paragliders to detect and neutralize swarms of drones (Altman & Trevithick, 2024).

The Threat of Parachuting and Gliding by Terrorist Organizations against Israel

Israel has a long history of dealing with the threat posed by parachuting and gliding infiltrations and has unique features that make it particularly vulnerable to these types of attacks. In April 1981, for example, there was an unsuccessful infiltration attempt from southern Lebanon using a hot air balloon (Tovi, 2019, p. 356, footnote no. 107). Three years later, a Palestinian terrorist from Lebanon entered Israel using a glider and surrendered himself. In 1987, two terrorists crossed from Lebanon using gliders, with one attacking a military base and killing six IDF soldiers in what became known as the "Night of the Gliders" (Vilnai, 1987). Two decades later, during Operation Defensive Shield (2002), paragliders intended for an attack were discovered in the city of Hebron (Globes, 2002). During Operation Protective Edge (2014), a Hamas operative from the Izz al-Din al-Qassam Brigades was arrested in Gaza and revealed that he had joined a covert unit of around ten operatives who trained in paragliding in Malaysia and Gaza (Leong, 2023; The Meir Amit Intelligence and Terrorism Information Center, 2015). These parachuting systems were likely smuggled into the Gaza Strip from Egypt, possibly with Iranian involvement (Sela, 2023; Smyth, 2023).

Over time, a series of events prompted Hamas to concentrate on developing air assault capabilities that could exploit vulnerabilities in Israel's defense system. Operation Northern Shield (2018) along the Lebanese border, during which the IDF destroyed Hezbollah tunnels, the construction of a ground and underground barrier around Gaza (Roff, 2023), and the IDF's significant disruption of Hamas's naval capabilities (Zeitoun, 2021) all underscored the

strategic value of powered paragliders for Hamas as part of the Izz al-Din al-Qassam Brigades' aerial attack strategy. The October 7 attack demonstrated that this capability had been extensively developed and integrated into Hamas's structured approach to building its air attack capability. A formal document from Hamas outlining its vision for an air force revealed plans to promote powered paragliding as a civilian sport. This approach would allow for military experimentation and training under a civilian guise, effectively pushing the enemy to accept their operational use (Weinthal, 2024). Accordingly, Hamas worked to establish a civilian paragliding sector to train its operatives for quiet infiltration into Israeli territory. The civilian cover for this activity served to reduce experimentation costs and allowed access to civilian parachuting and gliding clubs, which provided valuable skills and knowledge in these methods.

What Makes Israel Particularly Vulnerable to the Threat of Parachuting and Gliding?

For decades, terrorist organizations have persisted in their attempts to carry out a high-impact air assault against Israel. The incentive to develop assault capabilities using these relatively simple means stems, in part, from the combination of territorial control and the unique geographic and topographic features along Israel's borders.

Israel faces a lack of territorial depth, leaving its entire sovereign area under constant threat. Numerous strategic assets, including civilian infrastructure and military bases, are situated close to vulnerable border regions—along the Gaza border, near Lebanon, and in the West Bank area—where the proximity of Arab communities to Israeli towns provides fertile ground for terrorist activity (Sadeh, 2023).

On Israel's northern border, Southern Lebanon is characterized topographically by steep mountains, deep river valleys, dense vegetation, and civilian road infrastructure connecting villages. Hezbollah has taken advantage of this challenging terrain to establish a network of hidden military infrastructure in areas that are difficult to detect by radar or where it identifies gaps in IDF force deployment and intelligence coverage (Shapira & Beeri, 2024). Similarly, the West Bank is a mountainous region (rising at least 1,000 meters above sea level) that overlooks critical areas in central Israel and includes numerous communities adjacent to the border fence. Combined with knowledge sharing and collaboration between terrorist-supporting states and terrorist organizations operating in Israel's strategic environment, these factors have the potential to intensify the aerial threat (Gilat, 2024; Jaspersen & Montibeller, 2020; Kettle & Mumford, 2017; Ortal & Peleg, 2019). Indeed, for a significant period

following the October 7 attack, the fear of hostile paraglider incursions led to numerous reports of sitings to security forces, disrupting daily life for tens of thousands of residents across northern Israel and as far as the central Sharon region due to concerns over potential hostile paraglider operations (Abramzon, 2024; Ynet, 2023).

The Threat Level of Powered Paragliders to Israel

In light of the conditions reviewed thus far, the potential for individuals, organizations, and semi-military groups engaged in promoting terrorism to make extensive use of paragliders in the future remains firm and valid. The impact of this threat can now be measured against Israel's defense capabilities as they stood on the eve of October 7. Until that point, the IDF's defense strategy was based on four key components (Halevi, 2020): (a) intelligence capabilities to provide early warning of enemy intent to carry out a large-scale operation; (b) a ground barrier designed not only to delay or prevent enemy incursions but also to assist in detecting any approach to Israeli territory, both above and below ground; (c) precise interception and attack capabilities; and (d) technological superiority enabling the implementation of these components. However, on the morning of the attack, there was no specific warning of Hamas's intentions. The barrier failed to detect or delay Hamas assault forces. Despite its technological inferiority, Hamas had succeeded in harnessing inexpensive, low-tech solutions to conduct complex, multi-dimensional operations that offset the IDF's technological advantage. In this scenario, the Israeli Air Force found itself without the ability to intercept or strike Hamas forces effectively.

Assessing the potential use of paragliders presents a challenge in evaluating enemy capabilities, as they have dual-use applications in both civilian and military contexts. Therefore, the mere presence of paragliders does not necessarily indicate an operational military capability. It also creates a reality where the civilian sphere can be exploited for military advantages, making paragliders less conspicuous and increasing the difficulty of intercepting them.

Regarding intelligence warnings based on enemy movements indicating paraglider use before takeoff, powered paragliders generally have a minimal logistical footprint. Requiring almost no preparation, their deployment time from command to execution is extremely short. There is no need to store these units at a central base, as operatives can keep the system at home or even in their car, eliminating the need to position them near the front line. If deployment is necessary, the system can be concealed and transported in any vehicle, making it challenging to identify preparations for a paraglider-based operation.

In terms of detection during flight, paragliders have a low radar cross-section (RCS), making them difficult to detect via radar, which is the primary tool in aerial detection systems. Additionally, since communication between the parachutist or the vehicle and a ground station is unnecessary, signal intelligence is unlikely to detect them.

Indeed, in the documented cases of paraglider operations mentioned above, reports often came from civilians who spotted them or from ground observation units rather than from the aerial detection system. Moreover, the low cost of paragliders enables the easy deployment of multiple decoys for deception or distraction and explosive-laden units in large numbers, which further strain detection and interception systems. In addition, paragliders (like drones) operate close to the ground, at the boundary of responsibility between the Air Force and the ground forces, allowing terrorist organizations and militant groups to exploit this gap and the Air Force's focus on strategic fire threats (Heller & Shelah, 2023).

Israel's technological superiority led to the perception that certain actions, including air assault operations, were beyond the enemy's capability due to their technological inferiority. Lessons from past events and developments in aerial threats in recent decades seem to have led to the dismissal of paragliders as a minor, sporadic phenomenon. According to this view, airborne assault operations (involving planes, helicopters, or parachuting) aimed at deploying large numbers of fighters beyond enemy barriers require aerial platforms that are inherently expensive. They also demand ground infrastructure and maintenance systems, making this capability typically available only to organized militaries of resource-rich nations. However, the addition of a propulsion system to paragliders, enabling them to take off without ground infrastructure and travel long distances without high-altitude drops, transformed them into a low-cost alternative to traditional air mobility platforms. This adaptation provides a capability for large-scale assault or covert infiltration, allowing special forces to be deployed deep within enemy territory.

Discussion and Conclusions: Is the IDF Prepared to Counter the Threat of an Air Assault Raid?

Faced with constraints in building conventional air capabilities, Hamas has used powered paragliders to exploit the airspace as an additional combat domain. Their approach aligns with modern theories on the agility and adaptability of terrorist organizations and their ability to innovate under pressure. By leveraging the unique advantages of paragliders, Hamas has transformed them into autonomous, lethal combat systems. Much like helicopters, paragliders add strategic value

to air assault operations, with their use adhering to key principles essential for success: force concentration, surprise, and combat effectiveness.

The democratization of terror and Hamas's demonstration of air power capabilities using low-tech solutions have turned the threat of powered paragliders into a new challenge for nations worldwide, as the danger of air assault by terrorist organizations is not unique to Israel alone. Other countries with limited territorial depth that need to protect border-adjacent communities or strategic assets near their borders are also vulnerable. The widespread availability of knowledge, the exchange of tactics between terror-supporting states and terrorist organizations, and the "civilianization" of paragliders make them a potentially lethal tool for undermining national security across a range of scenarios, quickly elevating them from a secondary to a primary threat. Such scenarios could include seizing or damaging strategic assets such as nuclear facilities and sensitive military bases, targeting government institutions, and carrying out large-scale attacks and hostage-taking in civilian areas—actions that inflict serious harm to national sovereignty and could constitute a *casus belli*. Currently, the threat of air assault using parachuting and gliding is a very real concern for Pyongyang and Seoul (Eun-Jung, 2023; The Korean Times, 2024). Moreover, in recent years, North Korea has developed a combat strategy involving air assaults on South Korea using powered paragliders and has conducted training for such scenarios. It has even supported Hamas with weapons procurement and tactical guidance for these operations (U.S. Department of the Army, 2020).

The October 7 attack revealed that relying solely on advanced technology for aerial defense is ineffective for intercepting low-tech threats such as paragliders, particularly in the absence of additional backup systems that provide redundancy also under extreme conditions. The challenge is to create conditions that allow for effective responses across a variety of scenarios at any given moment. Israel's primary airspace defense strategy currently relies on a multi-layered system designed to intercept targets using missiles and planes (Ministry of Defense, 2024). However, due to the detection difficulties and unique flight characteristics of paragliders, it appears this defense system is not sufficiently prepared to counter the threat of an air assault raid. In fact, in previous isolated incidents requiring a response, attack helicopters were often scrambled to intercept parachutists, as happened over the skies of Karmiel in November 2018 and near Zikhron Ya'akov in September 2019 (Kubovich, 2019; Maariv Online, 2018).[4]

4 In both cases, these were criminal events, later determined to be unauthorized flights along civilian air routes, conducted without coordination and in violation of Israel's civil aviation laws.

On October 7, however, the IDF's combat helicopters were occupied with other missions and did not intercept the threat, as the Air Force had reduced its fleet of attack helicopters over the years (Kan News, 2023). Moreover, they can be deployed rapidly because paragliders require no takeoff infrastructure and can be covertly or stealthily advanced to the front lines. As a result, detection and interception systems are too often unable to respond effectively, especially if these systems are engaged in other operations.

The IDF Ground Forces already possess optical equipment capable of detecting paraglider infiltrations (Cohen & Spiegel, 2015). However, this equipment is primarily intended for ground rather than aerial border defense. When it comes to intercepting paragliders, the ground forces lack suitable tools, especially for large-scale interception (Winter, 2022). The limited systems they do have are mainly designed to counter a relatively small number of drones, with their primary role centered on force protection rather than on intercepting aerial threats (Cohen, 2023). These gaps stem from a force-building approach that divides responsibilities between the Air Force, which is tasked with defending the nation's airspace—including low-altitude zones—and the ground forces, responsible for land defense (Ein-Dar, 2020; Finkel, 2022). Thus, while the IDF and Air Force appear prepared to counter a limited manned aerial infiltration by a terrorist organization or a large-scale assault involving drones, missiles, and rockets, as demonstrated in the events of April 14, 2024,[5] they are less equipped to handle a large-scale air assault raid by terrorists or semi-military groups.

In conclusion, while powered paragliders do present a potential threat, countering it does not require the IDF to implement major changes or develop new advanced technologies. The first crucial step is to acknowledge the reality of this threat and its potential to escalate into a strategic risk—not only in extreme scenarios, such as the events of October 7—a lesson that might otherwise be missed. Second, a reassessment and, if necessary, adjustments in Israel's border defense strategy should be undertaken, particularly in defining responsibilities between the ground and air forces. Such adjustments include bolstering detection and interception capabilities and increasing the autonomy of the ground forces, as suggested by Assaf Heller and Ofer Shelah (2023). Existing optical detection technologies, including artificial intelligence for automatic and autonomous recognition, are already in use along the country's borders and merely need to be directed toward aerial threats as well. Additionally, a simple, low-cost acoustic detection network could be set up using smartphones mounted along the border barrier or on ground platforms in the area, similar to Ukraine's approach

5 On the night of April 14, 2024, Iran launched an attack on Israel involving hundreds of missiles, cruise missiles, and drones. This event marks the world's first successful interception of one of the most concentrated and rapid missile barrages in history directed at a single country.

for identifying drones and cruise missiles (Barnes, 2024). The anticipated deployment of laser interception technology should provide a low-cost solution for simultaneously intercepting multiple targets, including paragliders (INSS Israel, 2023). In the meantime, until laser technology is fully developed and operational, a mobile cannon system, which has already been proven effective against multiple low-altitude targets, could be reinstated (Phocas & Mitchell, 2024).

References

Abramzon, A. (2024, June 22). After the scare: The Civil Aviation Authority to further restrict and enforce regulations on paraglider operators in the Sharon region. *Israel Hayom*. (Hebrew) https://tinyurl.com/mrpyyzbb

Altman, H., & Trevithick, J. (2024, May 8). Marine special operations paragliding capabilities emerge at demonstration in Tampa. *The Warzone*. https://tinyurl.com/ysh88mdb

Babinsky, H. (1999). The aerodynamic performance of paragliders. The Aeronautical Journal, 103(1027), 421–428.

Barnes, J. (2024, March 26). How Ukraine is using mobile phones on 6ft poles to stop drones. The Telegraph. https://tinyurl.com/3p5deewt

Bergema, R., & Kearney, O. (2020). Rise O Muwahhid, wherever you may be: An analysis of the democratization of the terrorist threat in the West. ICCT. https://tinyurl.com/68hr678h

Brown, A. (2023). Terror, tech, and transformation: Will emerging technologies revolutionize terrorism? Comparative Strategy, 42(2), 308-320. https://doi.org/10.1080/01495933.2023.2182113

Chairman of the Joint Chiefs of Staff (CJCS) (2021). *Dictionary of military and associated terms*. https://tinyurl.com/yn55nk57

Cohen, G., & Spiegel, N. (2015, October 25). An Israeli Arab crossed into Syria via parachute, likely to join the fighting there. *Haaretz*. (Hebrew) https://tinyurl.com/mb735hry

Cohen, S. (2023, December 5). With a smart targeting system for moving targets, the IDF is trying to counter Hamas drones. *TheMarker*. (Hebrew) https://tinyurl.com/yx35xs5z

Dougherty, K.J. (1999). The evolution of air assault. *Joint Force Quarterly*, 22, 51–58. https://tinyurl.com/2tkwaarf

Durand, E., Michel, B., & Tenenbaum, É. (2012). Helicopter warfare: The future of airmobility and rotary wing combat. Institute Français des Relations Internationales (IFRI). https://tinyurl.com/3t6th5v8

Ein-Dar, A. (2020). Air superiority: Control of the skies—A vital necessity for a winning army. *Bein Haktavim, 28–30*, 43–60. (Hebrew) https://tinyurl.com/3ckx5v3t

Eun-jung, K. (2023, October 17). North Korea appears to be linked to Hamas in arms trade, other military areas: JCS. Yonhap News Agency. https://tinyurl.com/f2k72uan

Finkel, M. (2022). *The Israeli Air Force Headquarters – Designing the Force and Planning its Employment*. Modan and IDF Publishers. (Hebrew)

Gat, A. (2023). The future of battle and the land battlefield. Special publication, Institute for National Security Studies. https://www.inss.org.il/publication/tanks/

Gilat, A. (2024). Victory in the learning race will lead to victory in battle. *Maarachot*, IDF publishers, 501, 4–9. (Hebrew) https://tinyurl.com/mwsj79r

Globes (2002, June 30). The IDF discovered two paragliders in Hebron; Palestinian fugitives were hiding in ambulances. https://tinyurl.com/2d2k5vht

Goodrick, T., Murphy, JR, A., & Pearson, A. (1973). Analysis of various automatic homing techniques for gliding airdrop systems with comparative performance in adverse winds. In 4th Aerodynamic Deceleration Systems Conference (p. 462). DOI https://doi.org/10.2514/6.1973-462

Government of Canada (2016). Chapter 3: Air Attack (B-GA-403-000/FP-001, Canadian Forces Aerospace Shape Doctrine). https://tinyurl.com/yvk7kc9p

Halevi, H. (2020). Multi-dimensional defense. *Bein Haktavim, 30–28*, 254–241. https://tinyurl.com/nsyh6tvy

Heller, A., & Shelah, O. (2023). Land-based air operations: The solution for optimal integration of aerial assets in ground combat. *Strategic Update, 26(2)*, 21–34. https://tinyurl.com/3n9vczdu

INSS Israel. (2023, May 24). Podcastrategy 247: Regional Detente | Laser Beam in Service of the IDF [Video]. *YouTube*. https://tinyurl.com/4vemkb5w

Jaspersen, J.G., & Montibeller, G. (2020). On the learning patterns and adaptive behavior of terrorist organizations. *European Journal of Operational Research*, *282*(1), 221-234. https://doi.org/10.1016/j.ejor.2019.09.011

Jennings, G. (2023, October 9). Hamas uses paragliders to breach Israeli border. Janes. https://tinyurl.com/ye28d2x9

Johnson, D. (2009). Darwinian selection in asymmetric warfare: The natural advantage of insurgents and terrorists. *Journal of the Washington Academy of Sciences*, *95*(3), 89-112. http://www.jstor.org/stable/24536315

Kan News – Israeli Public Broadcasting Corporation (2023, December 21). Where were the attack helicopters on October 7? [Video]. *YouTube*. https://tinyurl.com/3bt8839t

Keinar, N. (2013, March 3). How do you learn to jump from 20,000 feet? *Mako*. https://tinyurl.com/bdzdtajv

Kettle, L., & Mumford, A. (2017). Terrorist learning: A new analytical framework. *Studies in Conflict & Terrorism*, *40*(7), 523-538. https://doi.org/10.1080/1057610X.2016.1237224

Korean Times. (2024, April 30). NIS sees possibility of N. Korean terrorist attacks involving drones, paragliders. https://tinyurl.com/rucukxtz

Krytskyi, D., Karatanov, O., Pohudina, O., Shevel, V., Bykov, A., Pyvovar, M., & Plastun, T. (2023). Information technology for determining the flight performance of a paraglider wing. In M. Nechyporuk, V. Pavlikov, & D. Krytskyi (eds.), Information technologies in the design of aerospace engineering. *Studies in Systems, Decision and Control*, Vol. 507 (pp. 1-42). Springer. https://doi.org/10.1007/978-3-031-43579-9_1

Kubovich, Y. (2019, September 24). The Air Force fights paragliders: Scrambles attack helicopters to a civilian gliding site. *Haaretz*. https://tinyurl.com/b7ek5zdj

Laver, L., & Mei-Dan, O. (2013). Paragliding. In O. Mei-Dan & M. Carmont (eds.), *Adventure and extreme sports injuries* (pp. 247–272). Springer. https://doi.org/10.1007/978-1-4471-4363-5_12

Leong, A. (2023, October 9). Hamas' motorised hang gliders unearth previous claims that Malaysia trained their members in paragliding. *The Rakyat Pos*t. https://tinyurl.com/yu6ujb5e

Lewis, J.A. (2022, April 19). Technology and the shifting balance of power. Center for Strategic and International Studies. https://tinyurl.com/yt784mc8

Maariv Online (2018, November 17). IDF Spokesperson: "Attack helicopters were scrambled after five unidentified paragliders." https://tinyurl.com/yckcjcen

Mann, Y. (2023, October 31). The newest cast member of antisemitic symbols: Hamas paraglider. *Ynet*. https://tinyurl.com/29w88wb9

Marines (2024, August 12). Powered paraglider interim policy message. *MARADMINS 364/24*. https://tinyurl.com/ybtv85hp

Matanya, A., & Sari-Levy, A. (2021). With sling and stone: A strategy of technological reduction. *Strategic Update*, 24(2), 3–15. https://tinyurl.com/y55vmk3n

Meir Amit Intelligence and Terrorism Information Center (2015, May 6). Hamas Activity in Malaysia: The military wing of Hamas recruits students from Judea and Samaria studying in Malaysia. Prior to Operation Protective Edge, military operatives from Gaza were sent to Malaysia for paraglider training in preparation for an attack in Israel. https://tinyurl.com/4j52k57r

Ministry of Defense (n.d.). Multi-layered defense. https://tinyurl.com/mr35ntje Neumann, P. (2009). *Old and new terrorism*. Polity Press.

Oglethorpe, J. (2010). Gliding off to war: The use of gliders as weapons in World War II. *Journal of the Royal United Services Institute*. https://tinyurl.com/2nmpmm6h

Ortal, A., & Peleg, D. (2016). "From small beginnings come great things" – Missed opportunities in the General Staff: The tunnel threat and underground domain as a case study. *Bein Haktavim, 22–23*, 33–61. https://tinyurl.com/55rtv8ex

Phocas, B., & Mitchell, P. (2024, March 14). The return of tactical anti-aircraft artillery: Optimizing the army inventory for the era of small drone proliferation. Modern War Institute. https://tinyurl.com/t4ewdjke

Roff, N. (2023, January 25). One year since the completion of the Gaza barrier: A status report. IDF website. https://tinyurl.com/mrevk3pk

Sadeh, Y. (2023, August 30). Details revealed: The national priority map will expand to cover 53% of the population. *Calcalist*. https://tinyurl.com/4n7vbchx

Sela, A. (2023, November 12). How did Hamas manage to smuggle so much weaponry into Gaza, and who failed to prevent it? *Haaretz*. https://tinyurl.com/36ntw24j Shapira, B., & Beeri, T. (2024, May 16). Hezbollah: Methods and flight modes challenge

Israel's UAV interception capabilities. *Alma*. https://tinyurl.com/5e34n6c9

Shoval, L. (2024, January 26). Defense officials estimate: Hamas has only a few hundred rockets left. *Israel Hayom*. https://tinyurl.com/2h2abfwt

Shurkin, M. (2014, October 17). France's war in Mali: Lessons for an expeditionary army. Rand Corporation. https://tinyurl.com/5rcynddw

Smyth, P. (2023). The path to October 7: How Iran built up and managed a Palestinian 'Axis of Resistance.' *CTC-Sentinel*, *16*(11), 25–40. https://tinyurl.com/4f7y8xje

Theotokis, N. (2020). Airborne landing to air assault: A history of military parachuting. Pen and Sword Military.

Torrisi, S.A. (2000*). Gliders –Rethinking the utility of these silent wings for the next millennium.* Air University. https://tinyurl.com/36ncmp9p

Tovi, T. (2017). Vertical flanking as a military revolution. *Maarachot, 474–475*, 36–43. https://tinyurl.com/bdhf5swm

Tovi, T. (2019). "Anasty perfume, as long as it gets the job done" – Shaping the defense strategy on Israel's eastern border: 1967–1968. *Yesodot, 1,* 327–357.

Treaty of Versailles (1919). Treaty of peace with Germany (Treaty Series No. 4), Articles 198–202. https://tinyurl.com/52nar6h5

Trevithick, J. (2024, August 20). U.S. Army has a plan for paragliding paratroopers. *The Warzone*. https://tinyurl.com/4teve3km

Trevor Steele (2021, March 1). What is a paramotor and how do they work? [video] *YouTube*. https://tinyurl.com/mrra8ewb

UK Ministry of Defence (2020). Joint Doctrine Note 1/16. Air maneuver. https:// tinyurl.com/nkmu9b8k

US Department of the Army Headquarters (2020). North Korean tactics. ATP 7-100.2, P.B-13. https://tinyurl.com/mrx8mujm

USHPA – US Hang Gliding and Paragliding Association (n.d.). What are hang gliding, paragliding, and speedflying? https://tinyurl.com/2srdfa4u

U.S. Marine Corps. (1996). Static line parachuting: Techniques and training (MCWP 3-15.7, FM 57-220). https://tinyurl.com/4zd2cbwkVilnai, M. (1987). Summary of the investigation of the Night of the Gliders. IDF Archive, File 205/1113/1991.

von Rosenbach, A. (2021). Fighting fear and the future of technology-enabled terrorism. *Atlantisch Perspectief*, *45*(3), 31-35. https://www.jstor.org/stable/48638243

Weeks, J. (1978). *Assault from the sky: The history of airborne warfare 1939–1980s*. Putnam publishing.

Weinthal, B. (2024, August 12). *Exclusive: Hamas document reveals devious paraglider terrorism attack plan.* Fox News Digital. https://tinyurl.com/35ws7dhx

Winter, G. (2022). Will tactical anti-aircraft defense make a comeback? The recurring need for ground forces air defense. *Bein Haktavim, 37*, 1–8. https://tinyurl.com/2s4bcfp5

Yekutiel, Z. (1985, December 21). Ibn-Amal: The vertical flanking maneuver that marked a strategic turning point. *Maarachot.* https://tinyurl.com/3s6825da

Yonhap News Agency. (2017, October 10). *N.K. special forces conduct drills to paraglide into Combined Forces Command*. https://tinyurl.com/3mehwuha

Ynet. (2023, October 11). Sirens in the Carmel, fears of terrorist infiltration in the Upper Galilee. https://tinyurl.com/2cccjx35

Zakaria, F. (2003). *The future of freedom: Illiberal democracy at home and abroad*. W.W. Norton & Company.

Aerospace & Defense
Journal of the Elrom Center for Air and Space Studies at Tel Aviv University
No. 1(1) | November 2024

Digital Weapons: How Global Digital Platforms May Potentially Disrupt the Modern Battlefield

Eviatar Matania and Alon Berkman[1]

Abstract

The past thirty years have seen the accelerated development of global digital platforms – invested hugely by commercial companies – penetrating every aspect of our lives. Similarly to the civilian realm, global digital platforms may also be used in the military dimension, in which case we will term the battlefield-adapted product Digital Weaponry**.** These kinds of weapons are usually civilian platforms which have undergone software adaptations and military adjustments in areas such as navigation, intelligence, communications, sensing and warning, psychological warfare, and virtual attacks. The cutting-edge technology on which these apps are based, combined with the simplicity and minimal cost of converting them from the civilian to the military realms, is what lies at the foundation of their potential to wield systematic influence on the battlefield.

Clayton Christensen's theory on disruptive innovation (Christensen, 1997), its adaptation to the military arena by Gautam Mukunda (Mukunda, 2010), and the test cases of the Russia-Ukraine war and the Swords of Iron War between Israel and Hamas in Gaza enabled us to examine how digital weapons have penetrated the modern battlefield, as well as their potential impact on this battlefield and on the global balance of military power. We point

1 **Eviatar Matania** is a professor at the School of Political Science, Government, and International Affairs at Tel Aviv University, with an expertise in national security and technology policy. He serves as the head of the Elrom Air and Space Center and is the editor-in-chief and heads the editorial board of the center's journal. He also heads the master's Program in Security Studies and the Master's Program in Cyber Politics and Government. Matania founded the Israel National Cyber Directorate and led it for six years.
Alon Berkman holds a master's degree in Cyber Politics and Government and is a researcher at the Elrom Air and Space Center.

out that digital weapons could potentially constitute disruptive innovation on the military battlefield; that it is highly likely that the first actors likely to develop and use it in a transformative way on the battlefield will be low-resource organizations, rather than large and technologically superior military-security establishments; and that due to the convergence of these two trends, digital weaponry has the potential to lead to a certain shift of the global balance of power between military powers with technological supremacy, and terrorist organizations or small countries – at least in several aspects of the modern battlefield.

Introduction

Over the past thirty years we have witnessed the accelerated development of digital platforms – invested hugely by commercial companies – penetrating all aspects of our lives: social networks enabling communication between one end of the world and the other, the distribution of knowledge and information, and the connectivity of people and communities in unprecedented ways; global and local information search services; global and local shopping and payment services; travel, restaurant and hotel services; maps, navigation, and transportation services; information storage (cloud) services, and much more. Two years ago, generative AI was made available to the public – in the form of Chat GPT by Open AI. Although it's hard to conceive the scope of revolutions this product and other developments will spark, it is already clear that it is a technology with global impacts in every sector and field.

Similarly to what is occurring in the civilian realm, global digital platforms may also be used in the military arena, and in such cases, we will call the adapted product for the battlefield Digital Weaponry**.** These weapons are mostly based on the civilian platforms whose software and designation have been adjusted for military purposes in areas such as navigation, intelligence, communications, sensing and warning, psychological warfare, and virtual attacks: navigation for military units as they approach their target or for precision targeting of missiles and drones; communication between units; communication with and between weapons as well as command and control of unmanned vehicles through deployed communication networks; free use of high-resolution maps for intelligence or navigation purposes; use of components of cellular systems or the like and existing apps for sensor-related purposes; use of social media for distribution of messages to the population or external propaganda, building or reinforcing a narrative or influencing public opinion; using available cyber technologies and especially the darknet for cyberattacks, and more.

Digital weapons have a number of attributes which grant them an interesting potential impact on the modern battlefield. The first is their state-of-the-art technology, as they are based on constant development and improvement of global digital platforms. The second is their reliability and availability, because they are based on global platforms which serve mass populations and therefore must be available, reliable and immune to flaws and disturbances. The third attribute is the negligible cost – in terms of time and resources – of developing the digital weapon and adjusting it to the battlefield, which allows for procurement and use in massive amounts compared to other technological military developments, thus unlocking advantages in terms of both quantity and quality.

As global digital platforms continue to evolve and thrive, they and the digital weapons based upon them lead us to ponder the extent to which digital weapons may impact the modern battlefield, and how they shall do so. We suggest that these weapons may potentially constitute disruptive innovation in the battlefield. In other words: before they compete with the finest military technology, they will penetrate secondary arenas and battlegrounds, and they will be used by low-budget organizations lacking the ability to acquire or develop the optimal existing military technology, such as terrorist organizations, hybrid organizations or armies that are not technologically advanced. Subsequently, upon their conceptual and technological maturation, digital weapons may penetrate and change some aspects on the primary battlegrounds.

To analyze these impacts, we begin by presenting the theory of disruptive innovation and its adaptation to the military arena, which we employ in presenting the appearance of digital weaponry in the battlefield and how it complies with this theory. We then analyze several test cases demonstrating the appearance of digital weapons in the Russia-Ukraine and Hamas-Israel wars, and, finally, we discuss the implications of this weaponry for the strategic balance in the modern battlefield.

Disruptive innovation

The term "disruptive innovation" was suggested by Clayton Christensen (Christensen, 1997) to describe a process that differed from the regular way in which business companies developed – which was called Supporting or Sustaining Innovation. "Sustaining innovation" describes a process that occurs in existing market-dominating companies: they develop a new generation or alternative for their product, designated for their primary target or market. But alongside this there is a different kind of innovation, aimed at secondary markets, for clients who are content with lower performance levels for lower prices. This

type of innovation, which starts out by targeting secondary arenas, sometimes takes a larger share of the primary market. In such a case we call it "disruptive innovation" because it originates in a secondary market, but later on "disrupts" – or fundamentally changes – the primary market. One example of disruptive innovation is Wikipedia, which began as a source of general information which was inferior in comparison to the world's leading encyclopedias (e.g. Britannica). At its outset, it was aimed at users who needed a cheap, accessible and simple source of information and were willing to compromise on its accuracy, but with time it has become the most commonly used encyclopedia on the market. Digital photography is another example of innovation that began in smaller markets where clients needed a mode of photography that was accessible, immediate, and cheap (without film or development costs), even if its quality was significantly inferior to that of analogic photography on film. Later, as its quality improved, digital photography has grown to dominate the market.

Christensen stressed the fact that companies controlling the market adjust themselves to provide optimal solutions for clients in their primary market, but less so for clients in their secondary markets. As a result, when disruptive innovation that starts out in a secondary market becomes relevant to the primary market, large companies that fail to adopt the innovative approaches and/or technologies and, as a consequence, might discover that they are losing large market shares. Moreover, even when the larger companies are the first to develop some kind of technology, they are often left behind when it comes to efficient and precise use and implementation of the applications of this technology, the creation of markets, or the development of new approaches to the market based on the technological innovation. The classic instance that comes to mind is Kodak, which dominated the global photography industry. Although it entered the field of digital technology on time, its executives continued to see the firm as a chemical company that profited from the sales of film development chemicals and did not realize the complete transformation of the market, leading the company to bankruptcy (Lucas and Goh, 2009). Other former giants like Nokia and BlackBerry have also lost dominance in their primary markets – in this case the cellular market – after failing to respond on time and innovatively to the introduction of the iPhone by Apple (which was not present in the cellular market at all in the beginning).

What is the significance of disruptive innovation in the military arena?

Gautum Mukunda expanded and adapted Christensen's theory to the military arena (Mukunda, 2010). Here the military and security establishments are paralleled

to the companies, with the "market" being the battlefield on which one army must defeat the other ("to conquer the market"). But there is a key difference between the commercial and the military markets: whereas in the commercial market, clients are the target for the companies, who strive to conquer as much of this "target" as possible, in the military arena there are no clients, and the aim is to destroy the enemy. Accordingly, when one of the parties adopts a new approach and/or technology, one or both of the following scenarios ensue: the second party also quickly adopts the new technology (imitation) or finds ways to cope with it (a change in warfare tactics or "opposing" technology).

Mukunda also claimed that like in Christensen's description of the commercial market, in the military market, military entities invest primarily in what they consider to be their primary military arena; there they become increasingly professional while tending to neglect innovation in secondary arenas. "Secondary arenas" may be geographic arenas that are not granted importance, or a lesser enemy that is not the primary enemy in the entity's eyes, or even a secondary field or dimension of warfare. Mukunda gave the example of how Imperial Germany's submarines attacked Great Britain's supply convoys and not the British Navy directly, as the convoys were a secondary arena for the British (Germany was indeed the primary enemy, but to the Royal Navy it was a secondary arena as the convoys were designated for civilians, and there was no intention of facing the German Navy head on); or the Americans' war against the Viet Cong, in which, Mukunda claims, the Americans used practices that had been planned and adapted for war against the Soviets and not against an enemy that dispersed and could disappear (a secondary arena in terms of the type of enemy). We can also apply this to the IDF which perceived (and still perceives) Hamas in Gaza and terrorism in general as a secondary arena in comparison to the threat from Lebanon or Iran (in terms of geography as well as type of enemy).

Meaning that, similarly to the civilian arena, disruptive innovation in the military arena is defined as innovation that originates in secondary arenas, because at its start it is unsuitable for primary arenas. But, unlike in the commercial market, it is not the clients of the secondary market who prefer this kind of innovation because of cost-over-performance considerations, but rather the technologically or military inferior organizations that do not constitute a major threat to the large armies in the primary arena; within the secondary arenas in which they operate, they choose this type of innovation. These can be armies of a nation that is inferior in a certain aspect, like the German fleet in the First World War, or the Viet Cong, or Hamas today, organizations of meager means and technologies in comparison with the armies they face.

If the innovation they choose changes the battlefield significantly over time – even briefly until the large armies adapt to the change – we will call this disruptive innovation. In any case, Mukunda claimed, innovation is never absolutely supportive or disruptive – it depends upon the context of its appearance and the identity of its developer, as well as the primary or secondary arenas as they are perceived by the players at the time.

Digital weapons as disruptive innovation – a theoretical examination

As noted, we define digital weapons as the use of global digital platforms for military purposes. A weapon like this is usually a civilian platform whose software and designation have been adapted for military purposes. Digital weapons are already a solution that has replaced classic military technologies in realms such as navigation (for units and weapons), sensors, alerts, intelligence, or psychological warfare, and they have also created the new military dimension that is cyber-attacks.

Let us first try to understand why this weapon can even be defined as innovation in the modern battlefield. Its primary strength lays in its unique combination of three basic attributes – all of which are derived from its origin as a digital platform for mass-scale use (these platforms themselves have constituted revolutionary changes in many civilian realms and continue to do so). The first of these attributes is the fact that this weapon is based on cutting-edge technology, which continues to be improved upon as time goes by. This means that the digital weapon improves its technological capabilities without any investment on the part of the user. The second is the reliable and accessible service offered by these civilian platforms, having been developed for mass global use: they are built with many redundancies and are durable in the face of weather conditions or other disturbances. In other words, they can be relied upon to function properly and continuously at almost any given moment, so they are suitable for unpredictable settings of war and emergencies. The third attribute is the low cost entailed in developing this weapon for battle – in terms of time and resources – as it is already based on massive investments from the civilian sector, involved in building the global platform to begin with.

This combination makes it possible to attain and use digital weaponry on a mass scale, compared to "classic" technological developments, and to benefit from quality, accessibility, reliability, and quantity all at the same time. Such a combination of attributes is not trivial, which is why this new form of weaponry is ideal for mass supply in the modern battlefield.

However, relying on digital civilian platforms has its limitations. These platforms were initially developed for the civilian sector and its own features. Therefore, at least at this stage they are very immune to disturbances and faults, as we noted when naming the biggest advantages of digital weapons, but on the other hand they were not especially designed to withstand intentional attacks by an enemy who has studied these systems and is specifically trying to damage their use in battle. Therefore, the digital weapon built upon them is vulnerable to blocking, disruption, penetration, surveillance, and intentional influence – meaning it is less durable in battle than weaponry developed specifically for military purposes. Also, reliance on global digital platforms exposes this weapon not only to enemies who are technologically advanced, but also to a dependency on those running and controlling the platform – i.e. tech giants (one example is what Google did in Ukraine regarding access to maps, see below). Finally, the accuracy required in civilian platforms built for civilian needs does not always fit the requirements from digital weapons in the battlefield, e.g. the quality and resolution of maps, or images for reconnaissance or navigation, or location services etc.

Digital weapons today are still inferior to what modern-day armies use in their primary arenas. Therefore, at this point in time, it is suitable for those who cannot compete on the primary arena, and who consequently have to fight on secondary arenas in order to succeed against the larger and more technological forces. These include terrorist organizations, hybrid organizations, small and non-technological armies, and the like.

What supports the hypothesis that the heads of wealthy and institutionalized military forces will not rush to develop and use digital military applications is these larger forces' ecosystems, which maintain themselves with sustaining innovation. Their system is oriented to search for solutions to threats, and it deals with these threats through extra budgets and manpower to strengthen the existing military infrastructure (more planes, more defense systems, more missiles and more soldiers). This natural inclination is also suited to the continued existence of the military ecosystem: politicians grant more funds, military commanders spend these funds on existing systems or on development (sustaining innovation), traditional military industries increase their revenues and collectively they all believe that they are handling the new threats and providing increased security – which is often the case. If so, who could and would want to "think outside the box" about new threats and issues?

The digital weapon is not part of the "sustained innovation" ecosystem these systems use. Although military industries are technological by nature, they are not as strong in the areas in which the civilian world rapidly replaces

equipment and technology. They are more accustomed to large and expensive projects, lengthy development processes, armament over years, standardization, and are much less acquainted with procurement of equipment that is not always standardized and does not always respond to all needs, with rapid turnover (Hankin, 2024). Meaning, beyond the fact that digital weapons are currently inferior to the existing technology used by technologically advanced armies, these armies' sustaining ecosystems are not suited to the use and development of these weapons. The right organizations for these systems are young developers and start-ups, paramilitary organizations and others who are not trapped in a sustaining ecosystem.

But will digital weapons be suitable for use in primary battlefields in the future? To answer this question, we must first examine the areas in which the digital weapon is relevant. Although it does not replace primary battle platforms (air, ground, or sea), it is relevant to key components of the modern battlefield, such as sensors, navigation, communications, control, and influence. These components change the battlefield due to their ability to provide rapid intelligence and alerts, to transmit communication in real time, to conduct precision targeting, to influence the digital environment, and so on. They are also at the core of how battlefields will evolve in the future, and accordingly we can cautiously say that digital weapons will potentially have a significant effect on the evolving modern-day battlefield.

Moreover, in the not-too-distant future, mass AI platforms will enable the creation of digital weapons that will bring new options to the battlefield (Bar-Gil, 2024). For example, intelligence-oriented or operative analysis of very large amounts of information on the battlefield and the drawing of operative conclusions or improving the ability to "hunt down" a specific target out of a large number of targets. We should also note that even in the civilian world, digital platforms have not replaced physical platforms, but their transformative effect is still substantial, especially due to how they are built for widespread global and affordable use – in ways that would have been difficult to imagine twenty or thirty years ago. Additionally, with the necessary degree of caution, we would like to point out a central pillar in the operating concept of digital weapons, which will enable them to penetrate massive use in major battlefields. This is the ability to procure them in very large amounts, allowing for such widespread distribution that sheer quantity will create new dimensions on the battlefield. Finally, we note that the technological breadth and variety of uses of this weaponry increase the likelihood that it, and especially the integration of different types of digital weaponry within itself and with other weapons systems, will lead to a fundamental change on the battlefield.

Therefore, we have pointed out the theoretical attributes which enable digital weaponry to potentially constitute a disruption of the battlefield, pursuant to the methodology of Christensen and Mukunda. The question remains of how well they have been integrated into the battlefield to date, and whether our theoretical approach has been confirmed. To answer this, we shall examine the appearance of digital weapons in two wars being fought in the past two years.

The appearance of digital military applications in the Russia-Ukraine War and the Iron Swords War in Gaza

Immediately after the Russian army's invasion of Ukraine in February of 2022, Ukraine requested widescale military assistance from the West in order to mitigate its inferiority compared to the Russian army (see for instance "US Security Cooperation as of August 2024"). Thanks to this aid, Ukraine was able to stop – and in some cases even push back – the Russian army. Along with their procurement of the finest military technology from the West, which was as much as they could receive and adopt, the Ukrainians also asked for help from global tech giants in the fields of internet and communication networks: Google, Microsoft, Meta and SpaceX (Starlink). The Ukrainians initially relied entirely on these companies and their applications, and later began to develop their own apps that were based on the civilian digital platforms for a variety of military purposes.

In collaboration with the Ukrainian administration, Google blocked the ability to use live maps on the Google Maps app in the Ukrainian area, in practice preventing the ability to see traffic loads in locations or roads, reduced the cost of cloud services, helped with distributing information for refugees, and helped combat Russian propaganda by taking down thousands of channels and propaganda clips that violated YouTube policy. It also adapted its earthquake warning technology to alert against aerial attacks on Ukrainian cities (Matania and Sommer, 2023).

In another area that is not as "soft", a few days after the war broke out, the Ukrainians asked Elon Musk for assistance from the Starlink satellite system for purposes of reliable internet connectivity after the Russian army started blocking national communications. The satellite system's low earth orbit is an advantage as it enables connectivity which is hard to block; it is also completely encrypted. The Ukrainians used this system not only for civilian or government internet requirements but also for encrypted communication between military units, as well as for operation and control of combat aerial vehicles (drones). Ukrainian government and military officials consider the use of Starlink as a pillar of their success in blocking the progression of the Russian army, including

in the difficult battle over Kiev, and later in their ability to organize, attack and accumulate accomplishments on the battlefront. Incidentally, the first request to Elon Musk was written publicly on Twitter (currently X) by the Ukrainian Minister of Digital Transformation, and Musk's initial response was also on that platform. Today, despite American sanctions, the Russians also use this system in the same areas of coverage (Jayanti, 2023; Walsh et al., 2024).

With time, as noted, the Ukrainians themselves began developing digital weapons. For example, the Ukrainian army deployed thousands of cellular devices with open microphones near the Russian border. The sounds picked up by these devices when low-flying drones cross the border is relayed to the state's cellular network and into a system that triangulates their trajectory based on the sounds and aims the aerial defense system to the time and location of the drone, which cannot otherwise be tracked (Barnes, 2024).

Another example is the use of social media for communication between forces, conveying messages to allies or friendly forces and of course, to influence the enemy or to sway public opinion. The nature of social media allows for a variety of uses, more or less covert – from tactical to strategic. When battling the United States Army, ISIS pioneered the use of social media to recruit volunteers or militants and to distribute propaganda for psychological warfare. The Ukrainian government, aided by Meta, was quick to use social media as a tool for improving civilian resilience and resistance, especially in territories conquered by the Russians. This included the distribution of video clips featuring individuals and groups that managed to stop, impede, or embarrass the Russians. These clips were a primary tool for the development of civilian resilience and the encouragement of civilian resistance. Meta came to the aid of the Ukrainian government by encrypting and immunizing its platform, blocking Russian communication channels, emphasizing global empathy with the citizens of Ukraine, offering public services through WhatsApp and Facebook as well as creating an aid center for mental health. The use of social networks increased over time, and designated apps were developed on their platforms that engaged civilians in the war effort, such as a cellular app that enabled real-time reports of cruise missiles or drones in order to help the Ukrainian army shoot them down (Rakov and Feinberg, 2023; Sommer et al., 2023).

Hamas used social media platforms as an especially effective tool through the use of Go-Pro cameras, which documented the atrocities it committed during its attack on October 7th and distributed these for psychological warfare against the Israeli public and to inspire its own supporters. Moreover, the use of Go-Pro cameras also played an operational role of backwards-reporting to the command center and other terrorists who were responsible for the progression of

the attack. On a wider scale, Hamas uses social media as a strategic-diplomatic tool against Israel's success on the operational level: graphic images and clips of the dire humanitarian status and destruction in Gaza, distributed by Hamas and its global allies on social media, contribute to the perception that Israel is conducting an immoral war, although data indicates that the rate of civilian casualties is in fact lower than in similar military confrontations such as with ISIS and Al-Qaeda (Elbaum, 2024).

Discussion: Will we witness a shift of balance in global military-technological supremacy?

Regional and global superpowers have always established their status in the international system through financial and technological supremacy, which provided the resources to maintain absolute military superiority. Thus, throughout the 20th century, for instance, countries able to acquire tanks, war planes and battleships in higher volumes and of better quality than those of their adversaries enjoyed a significant – and often definitive – advantage on the battlefield. On the other hand, less technologically advanced countries or non-state organizations had trouble keeping up with the technological arms race and chose to build strength through several different strategies: by relying on greater quantity as a response to quality, in alliance with nations that had advanced technological tools, or by intentionally preferring cheaper and inferior technology, in a manner that does not try to compete with the rival's technological supremacy. However, the effectiveness of these strategies was limited, and they usually did not lead to significant changes in the strategical status or a shift of in the balance of power (Matania & Seri-Levi, 2021).

Upon the appearance of cyberattacks as a dimension of warfare, some claimed that they would lead to a "horizontal balancing" of the international system as it provided the weaker players with unprecedented opportunities to impact and even threaten stronger players, e.g. through cyberattacks on vital infrastructures (Choucri, 2012). Over time, the balance has not shifted to the extent of equality between the giants and the smaller players, and the superpowers – nations or tech giants – are in control of the dimension, in battle and in defense of it (Sommer et al., 2023). However, smaller organizations that do manage to recruit the suitable manpower and reasonable means can achieve very good offense and defense capabilities in this dimension, albeit not at the level of a superpower (Matania & Yoffe, 2022). Thus, the cyber dimension, which "promised" to shift the global balance, did indeed bring about a certain "levelling of the playing field", but did not spark a significant change in the global balance of power between superpowers and resource-poor organizations.

What about digital weapons? To what extent can they cause a transformation in the global balance of power? Will they, like cyberattacks, cause a certain levelling without bringing transformative change? It's hard to predict, but we can cautiously claim that as disruptive innovation, digital weapons will break out first through the use of resource-poor organizations, and they will lead these weapons to achievements that will challenge the dominance of superior technological entities. We believe that after local losses and downfalls, even the wealthy and well-equipped establishments will have to adopt digital weapons. The extent to which the battlefield is "levelled" and the gap in time for adoption will give the smaller armies an advantage over the larger ones. These factors will also depend on several consecutive processes the wealthy military establishments must undergo: Firstly, on the time it takes to kick off the adoption of digital weapons. The sooner the large army understands the advantages of digital weapons, the sooner they will be able to adopt them. Secondly, it will depend on their speed (which usually does not exist, except in emergencies) in development and implementation of these weapons through simple processes, rather than through the established and customary processes, which are expensive and lengthy (even for smaller projects). Thirdly, the levelling of the playing field and the time gap will depend on the larger armies' abilities to divert from rigid conceptualization of military standards and scale down to simple and more humble requirements for equipment, which will be quickly replaced and some of which won't work perfectly, entirely in contrast with the standard military conception regarding new technologies. Fourth, they must understand that digital warfare is short-term equipment, because most of it changes and is quickly replaced, which is why it isn't prudent to invest too much in a lengthy process of procurement, but rather repeat processes of renewed equipment that changes, is not standardized, and is therefore contrary to the purchase and logistics procedures of established armies; and finally, the military establishments need to develop digital weapons differently from how they are accustomed to developing new technologies: not a few expensive items, but rather inexpensive items at large quantities.

These challenges are not trivial, and there may be some who are left behind to sustain loss or significant defeat, time and again. Digital weapons challenge the very methods of development to which the larger militaries have become accustomed, as well as their ecosystem, which is suited to advanced and expensive weaponry, not to digital weapons. We claim that the extent of global balance created between the nations and the smaller organizations and non-states depends primarily on the processes these superpowers will undergo. The reader is left to determine whether or not these predictions bode well for the world.

Conclusion

In this article we have described global digital platforms as the basis for digital weapons, which are present today in the arenas of location, navigation, communications, control, sensors and alerts, propaganda, and in coming years in applications of AI. The advantages of the digital weapon stem from the strengths of global digital platforms: it is technologically advanced and renews itself periodically, it is accessible and reliable and exceedingly inexpensive to adopt – enabling quantity and quality at once. In addition, it spans a multitude of areas, together enabling the upgrading of platforms on the battlefield in an innovative and widescale way.

Based on the theory of disruptive innovation in the business arena (developed by Clayton Christensen and adapted for the military terminology by Gautam Mukunda) and through test cases from the Russia-Ukraine and Swords of Iron War, we analyzed how digital weapons have the potential to disrupt the modern battlefield in the full sense of disruptive innovation: the growth of innovation in a secondary arena (secondary enemy or secondary dimension) by resource-poor players (terrorist or hybrid organizations, small or technologically inferior armies) and its subsequent penetration and dominance of the primary arenas.

On-ground examples have proven that those developing and using digital military applications in recent years are the smaller states and organizations, which are less technological or established, as shown earlier. They are looking for ways to build a force that does not necessarily compete with the larger technological armies, just as start-ups do not try to use the same tools to compete with the strongest players on the civilian market, but rather look for different ways to penetrate a new technological or operative market and grow. They benefit from an advantage due to their small size, which allows them to experiment and adopt new tools rapidly and in wide scale – which is very suitable for digital weapons.

This is why digital weapons pose such a challenge to the military superpowers, which are accustomed to a developmental ecosystem of sustaining innovation and not the innovation typical of digital weapons: simple, inexpensive, and in large quantities. Therefore, it is our claim that we may very well see a "leveling" of the modern battlefield due to the adoption of digital weapons by resource-poor organizations who will manage to challenge the technologically superior armies over time.

Bibliography

Bar-Gil, A. (2024). Technologies "appear and disrupt" the security world. *The Israeli Journal of Society Military and National Security, 6-7.* 31-5. https://tinyurl.com/bde4cuxc

Barnes, J. (2024, March 26). How Ukraine is using mobile phones on 6ft poles to stop drones. *The Telegraph*. https://tinyurl.com/3p5deewt

Choucri, N. (2012). *Cyberpolitics in international relations*. MIT press.

Christensen, C.M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business School Press.

Elbaum, J. (2024, February 1). *West Point urban warfare expert: IDF 'implemented more measures to prevent civilian casualties than any other military in history*. The Algemeiner. https://tinyurl.com/msk22uu8

Henkin, Y. (2024, February 1). *Floating shoes or: About technology, logistics and large annoying devices.* Maarachot, IDF publishers. https://tinyurl.com/bpdv8yzu

Jayanti, A. (2023, March 9) Starlink and the Russia-Ukraine war: A case of commercial technology and public purpose? Belfer Center for Science and International Affairs, Harvard Kennedy School.. https://tinyurl.com/yc2yzzvb

Lucas, H.C., & Goh, J.M. (2009). Disruptive technology: How Kodak missed the digital photography revolution. *The Journal of Strategic Information Systems, 18*(1), 46-55. https://doi.org/10.1016/j.jsis.2009.01.002

Matania, E., and Seri-Levi, E. (2021). *With a shot and stone: The strategy of technological reduction*. Strategic Assessment, 24. (2) 3-15. https://tinyurl.com/y55vmk3n

Matania, E., & Sommer, U. (2023). Tech titans, cyber commons and the war in Ukraine: An incipient shift in international relations. *International Relations*, *0*(0). https://doi.org/10.1177/00471178231211500

Matania, E., & Yoffe, L. (2022). Some things the giant could learn from the small: Unlearned Cyber lessons for the US from Israel. *The Cyber Defense Review*, *7*(1) 101 110. https://www.jstor.org/stable/48642042

Mukunda, G. (2010). We cannot go on: Disruptive innovation and the First World War royal navy. *Security Studies*, *19*(1), 124-159. https://doi.org/10.1080/09636410903546731

Rakov, D., & Fainberg, S. (2023). The growing impact of the civilian population on the modern battlefield: A glimpse into the Russia-Ukraine war. *Research Report 0123E,* Elrom Center for Air and Space Studies, Tel Aviv University, Elnet, p. 55-56. 0123e2023.pdf (tau.ac.il)

Sommer, U., Matania, E., & Hassid, N. (2023). The rise of companies in the cyber era and the pursuant shift in national security. *Political Science*, 75:2, 140-164. https://doi.org/10.1080/00323187.2023.2278499

U.S. security cooperation with Ukraine (2024, August 23). Bureau of Political-Military Affairs, US Department of State. https://tinyurl.com/yn33v4ym

Walsh, N.P., Marquardt, A., Davey-Attlee, F., & Gak, K. (2024, March 26). Ukraine relies on Starlink for its drone war. Russia appears to be bypassing sanctions to use the devices too. CNN. https://tinyurl.com/4385bwxz

ELROM CENTER FOR AIR
AND SPACE STUDIES
TEL AVIV UNIVERSITY