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Drones and the Hamas-led Attack of 7 October 2023: Innovation and Implications

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Abstract: The Hamas-led attack against Israel on 7 October 2023 marked an important watershed in non-state actor/terrorist capability with its sophisticated and integral use of innovated drones in concert with related technologies as part of a combined arms assault. Although combined arms are typically associated with conventional forces, closer attention to Hamas-led forces' combined arms use demonstrates that terrorist groups are increasingly able to employ them to considerable effect. Hamas-led forces' combined arms use differs from ISIS' preceding use in important respects, including drones' central and integral role, the drone-related innovations demonstrated, and its particularly devastating effects. Hamas-led forces demonstrated two key drone innovations: (1) the use by a non-state actor of small drones to precisely strike sensitive, high-value defences with a novel drone-delivered munition (featuring smoke-emission/target marking and delayed detonation); (2) the use of drones as a central part of a combined-arms assault by a non-state actor. A further possible innovation is the first use of a particular modification to (small commercial) drones by a non-state actor to help enable them to evade electronic countermeasures. Hitherto, important details about Hamas' drone-related innovations, and the significant implications arising from them, have remained substantially unaddressed. Therefore, this article endeavours to fill these lacunae. Consequently, conclusions are drawn regarding the threat posed by Hamas-led forces and other non-state actors who can or might employ drones and related technologies, and what might be done to effectively address them. Moreover, because these technologies and associated training and techniques are likely to continue to rapidly proliferate.

Keywords: Drones, Hamas, combined arms, terrorism, counter-terrorism

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Introduction

Drones[1] played a leading, and often daring, role in the 7 October 2023 Hamas-led[2] surprise attack against Israel (termed by Hamas "Al-Aqsa Flood"[3]). Consequently, considerable political,[4] media,[5] and scholarly attention[6] followed. A severe attack by a terrorist[7] or insurgent group using drones against a state had long been 'feared' by analysts,[8] academics,[9] media,[10] policymakers,[11] and members of the public.[12] The attack was triply shocking and significant because (a) it caught off-guard arguably the world's leading drone state[13] [14] that is also a leader in counter-drone technology,[15] (b) the attack was savagely conducted by a terrorist group,[16] and (c) drones had a leading, integral, *and* central role.[17] Furthermore, Israeli Defence Force (IDF) drones neither forewarned of the attack nor were they able to help bring it under swift control. (However, IDF drones later proved helpful in pursuing assailants.[18]) Moreover, on 7 October 2023, IDF air-defence and associated counter-drone technology proved largely ineffectual despite their sophistication.[19]

Particularly concerning are what Hamas-led forces were able to achieve on 7 October 2023 with innovation[20] and novelty,[21] including with drones and related technologies. This was further to the support these terrorist groups[22] are known to have received largely from Iran,[23] including for Hamas' drone programme, as part of a collection of proxy forces that possess growing transnational influence.[24] Consequently, the question arises: how did Hamas-led forces employ drones and related technologies that day, and what are the implications of this, including for preventing and combatting them? The attack's political significance is underlined by its having resulted in the third largest recorded loss of life from a single terrorist attack, and the largest loss of life in a single attack against Israel since its modern (re-) establishment, and by being the deadliest known terrorist attack assessed by the number of fatalities per capita.[25] Furthermore, it occurred despite Israel possessing cutting-edge counter-terrorism,[26] drone,[27] and counter-drone capabilities[28,29] that, combined, might have been considered to have protected Israel from an attack of the size, scale, and scope of that on 7 October 2023- but did not.

Considering this question - and the issues it raises - reveals that Hamas-led forces demonstrated the ability to execute offensive operations utilising small ground units employing small drones in a combined arms assault. This constitutes a major step in Hamas' and associated forces' capability that others, including various terrorist groups, may now seek to emulate.

Leo Blanken et al. have recently argued that "Hamas' surprise operation [on 7 October 2023] … is best understood as a non-state version of a raid" and involved "strategic" and "doctrinal surprise." Regarding the latter, they assert: "Hamas achieved this by combining many elements of what the military refers to as a multi-domain operation – and did so with a level of precision, coordination, and planning that shocked observers." These are significant points. Nonetheless, I argue that it was not only Hamas that was part of the 7 October attack; personnel from other groups participated, too. Also, although Blanken et al. refer to the US Department of Defence's (US DoD) conceptualisation of "multi-domain operation[s] [MDO]" regarding non-state actor drone use that in turn refers to "combined arms", both MDO and combined arms (as defined by the US DoD) are considerably less analytically precise, informative, and revealing than the more specific conceptualisation of combined arms developed and employed in this article that is drawn from historical usage.[30] This conceptualisation is also more specific than that offered by Kerry Chávez and Ori Swed regarding the 7 October 2023 attack and helps to identify its significance more specifically. I also argue, in effect, that Hamas-led forces' use of combined arms has implications that go beyond those entailed in Blanken et al.'s definition of "special operations".[31]

Austin C. Doctor and James I. Walsh have importantly observed "militant[t]…combined arms capability" involving drone use by ISIS in Iraq and Syria.[32] However, their use of the term "combined arms" is rather broad and equated by them with "theatre air attacks to support ground force operations" and "close air support", as conceptualised by Robert Pape.[33] Consequently, I find Hamas-led forces on 7 October 2023 demonstrated a considerably more sophisticated capability than what Doctor and Walsh or Thomas Maurer[34] have termed "combined arms" regarding ISIS. Hamas-led forces' combined arms assault[35] comprised: indirect fires utilising rockets, missiles, and possibly loitering munitions;[36] and direct and indirect fires utilising drones, powered paragliders, and sea and ground units. Indeed, by various measures, Hamas-led forces demonstrated substantial sophistication and achieved considerable tactical and strategic effects despite significant limitations.

Two of the most important innovations demonstrated by Hamas-led forces on 7 October 2023 were: (1) the use of a novel drone munition enabling precision strikes against IDF observation and communication towers, which were key to the assault (and arguably its success); (2) the use of combined arms by a terrorist group, in which drones possessed a central and integral role. To date, no other terrorist group has demonstrated combined arms capability in which drones had such a critical role and to such political effect.

Detailed attention to Hamas-led forces' 7 October 2023 assault also further reveals the importance of the threat posed by smaller drones and loitering munitions, including from non-state actors, that in the scholarly literature, and more broadly, have received considerably less attention than state-employed Medium Altitude Long Endurance (MALE) drones (such as the Predator).[37] Furthermore, it shows that the use of these technologies can also occur on a large scale, result in large numbers of dead and wounded (including civilians) with high-profile results,[38] and have a major political effect when used by non-state actors.[39] These aspects underline the serious threat and challenge these technologies now pose, including to states with advanced air-defence, including counter-drone, capabilities. Moreover, although technologically based defences and countermeasures will need to be improved against all drone-types and loitering munitions, the 7 October attack paradoxically demonstrates the need for *less* reliance on high-technology to combat them and re-establish deterrence. Nonetheless, improvements in counter-drone and counter-loitering munitions technology are clearly necessary.

Article Outline

To respond to the above questions and issues concerning Hamas-led forces' use of drones and related technologies on 7 October 2023, this article proceeds in three parts. In doing so, it endeavours to separate drone-related developments of enduring importance from those that are ephemeral. This is important because counter-drone and counter-loitering capabilities are becoming increasingly important and challenged as drone and loitering munition development and use, including by non-state actors, rapidly develops. Indeed, with the 7 October 2023 attack, drone use as part of combined arms conducted by non-state actors has become increasingly evident, sophisticated and lethal. This stands in notable juxtaposition to the United States',[40] among a growing number of other states',[41] desire to effectively employ drones to address terrorist threats (in addition to those of a more conventional character[42]). Consequently, clarity and precision regarding these respective threats, and what can and ought to be done about them, are at a premium.

As a detailed official account of events on 7 October 2023 has yet to emerge, and the few extant accounts providing a detailed reconstruction of events lack sufficient focus on Hamas-led forces' and IDFs' use of drones and related technologies,[43] Part I provides an overview utilising

a wide range of open sources, including: official statements, video footage, news media articles, videos and documentaries, analytical, policy and scholarly articles.

These have been carefully pieced together and cross-checked wherever possible. This constitutes an important evidential basis and contribution to understanding what unfolded that day and preceding it and reveals significant synchronisation and coordination in Hamas-led forces' assault, including their use of drones and other related technologies. It appears unlikely that Israel will hold a public enquiry fully disclosing what unfolded on and prior to 7 October 2023, which underlines the pertinence of this approach.

Accordingly, this article does not aim to recreate or explain every detail of what occurred; as in all accounts of war and conflict, gaps exist in our understanding of events. Nonetheless, important analysis and conclusions may still be drawn from extant evidence as is often necessary. Part II addresses Hamas-led forces' drone use innovations and novelty, and related implications, which includes detailed articulation and analysis of Hamas-led forces' employment of combined arms and its limitations. Part III considers the efficacy of Hamas-led forces' drone use on 7 October in detail and discusses what can be learned from it, followed by the conclusion.

Part I: Hamas' and Associated Forces' Drone Use on 7 October

At approximately 6 a.m.[44] (local time) on 7 October 2023, the initial phase of the Hamas-led attack against Israel commenced. Substantial preparations preceded it; some assailants were disguised as farmers and approached Israeli border defences to check whether IDF foot patrols were nearby.[45] The Hamas-led assault near Kerem Shalom, the most southerly border crossing between Israel and Gaza, reportedly began at 5:50 a.m., when the BBC reported[46] a Hamas commander posted images, and at Kibbutz Be'eri, when Hamas-led fighters were filmed (with a time-stamp) approaching it.[47]

At approximately 6:20 a.m.,[48] the first of an enormous barrage of rockets, missiles, mortars, drones, and possibly loitering munitions was launched against Israel by Hamas-led forces,[49] in what may be regarded as the main commencement of the assault. It is estimated that this initial barrage numbered approximately 2,500 rockets, mainly al-Qassam, and lasted approximately twenty minutes.[50] [51] The initial salvo of this barrage was probably an attempt to: (a) overwhelm Israel's Iron Dome air defence system (widely regarded as one of the most capable);[52] (b) over-stimulate wider Israeli defences; and (c) clear a path for and cover Hamas-led assaults against border locations to maximise shock and sow confusion among defenders or potential defenders.[53]

Concurrent with the initial salvo (and in some locations before and after), Hamas-led forces approached and, in some cases, assaulted Israeli border defences. The fourteen visually confirmed[54] border breach points effected by Hamas-led forces were distributed roughly evenly along the length of the Israel-Gaza border (Israel claims there were approximately 29 border breach points[55]). Initial breaches were made by between 200[56] and 400[57] fighters, either through forcing open gates (e.g. near[58] Kisufim crossing), or by cutting fencing (e.g. near[59] Kerem Shalom crossing and near[60] Nir Oz), or by blasting (e.g. near[61] Be'eri and at Erez[62] crossing[63]).[64] Therefore, these breaches were synchronised with the initial salvo, even if the precise timing of each breach differed, apparently for maximum shock effect. As will be detailed shortly, this is also consistent with a combined arms assault.

Several analyses note that, as a first step, at some border locations small modified commercial drones were employed by Hamas-led forces to drop novel munitions on armed Israeli manned and unmanned observation and communication towers in a coordinated and broadly synchronised manner;[65] four of five IDF defence posts that were filmed being attacked by Hamas featured drones being used to do so. [66] This is thought to be the first time Hamas used drones in this role.[67] It meant unusual activity detected by Israeli agents could not be effectively disseminated to alert and/or activate Israeli border defences,[68] and sensors and remotely operated machine guns in some towers were rendered inoperable.

Analysed footage indicates that over 100 small drones were involved in Hamas' assault [69] and were launched from various locations, and flown into Israel.[70] The numbers are difficult to confirm provided the circumstances and as Israel has not released a detailed account of what unfolded on 7 October; however, it is highly likely that significant numbers of such drones were employed given their utility and extant reports. Meantime, cameras along the Israeli border were targeted by snipers, apparently to further reduce Israel's defences' efficacy.[71]

Reports have also emerged, including video footage, of modified small commercial (DJI and Autel)[72] drones dropping munitions directly on Israeli troops and tanks early in the Hamas-led assault. The former occurred at the IDF base at Nahal Oz,[73] and the latter against one of Israel's most advanced tanks, a Merkava IV Main Battle Tank (MBT),[74] near the Kisufim border crossing.[75] An armour-piercing munition appears to have been drone-delivered in the latter strike. Hamas-released footage, apparently of the latter, features a DJI Matrice 600 drone with what appears to be a modified RPG munition.[76] These strikes appear to have helped enable the breaching of Israeli defence lines in force, and the latter militated against a formidable mobile armoured response to counter such penetrations in the immediate and wider area. Hamas-affiliated media channels have featured another drone type, a Radiolink AT10 II; however, confirmatory evidence of its use on 7 October has not yet emerged.[77]

It is within the above events and associated actions that the most important innovation concerning drone use on 7 October occurred; drone use in combination with other specific actions and (closely related) weapons, which been characterised as "combined arms"[78] by Kerry Chávez and Ori Swed in their detailed article,[79] and others such as Mark Cancian of the Center for Strategic and International Studies, Michael Knights of the Washington Institute in interviews,[80] and the Soufan Center in a briefing report.[81] This will be assessed in further detail after more details regarding what unfolded on 7 October 2023 are presented, facilitating in-depth discussion and analysis.

Significantly, once Hamas-led forces breached the Israeli border fences, 'elite' 'Nukhba' elements proceeded to assault IDF outposts and bases, whence they mostly killed, and in some cases captured, IDF troops and disabled IDF communications and other substantial technological capabilities.[82] Typically, smaller assault forces first concentrated on IDF outposts and bases before attacking civilian dwellings in Israel. Subsequently, Hamas-led assault elements proceeded to other targets deeper into Israel, including sites of strategic national importance such as the Israeli Unit 8200 signals intelligence and fusion centre at Urim.[83] Detailed visualisation of the geography and major locations of civilian deaths can be seen here.[84]

Synchronisation and Further Details about the Attack

The synchronisation of Hamas-led forces - a key aspect of their assault and directly relevant to combined arms - was considerably dispersed over a large geographical area. Further details and evidence of this follow.

Hamas-led forces employed drones to strike Israeli border defences as missile, rocket, and possibly loitering munition salvoes began at approximately 6:20 a.m.[85] This includes, for example, Kibbutz Kisufim,[86] that was assaulted by Hamas-led forces at approximately 6:35 a.m., shortly after the combined barrage began; Hamas-led forces forced open a border fence gate, entered Israel, and subsequently attacked targets.

At Kibbutz Be'eri, Hamas-led forces arrived at 5:55 a.m.,[87] and after the initial barrage, during which they infiltrated the area,[88] commenced their assault at approximately 6:55 a.m.[89] The first shots from this assault were heard at the Nova music festival,[90] the site of the single largest loss of life on 7 October. Therefore, Hamas-led forces used the initial barrage as cover and commenced their main assault on the Kibbutz, as assaults in other locations were unfolding, maximising impact and militating against a swift and robust Israeli response. During the next few hours, Hamas-led forces converged [91] on this area from the north and south,[92] guided by motorised paragliders that had been launched together with early missiles, rockets and possibly loitering munition (MRLM) salvoes.[93]

At 7 a.m., Hamas-led forces attacked Kfar Aza kibbutz, near Nahal Oz that also involved powered paragliders to guide assault forces.[94] At approximately the same time, Hamas forces attacked the largest Israel-Gaza border crossing at Erez,[95] causing extensive damage[96] and enabling numerous fighters to enter Israel.[97]

At 7:19 a.m., Hamas forces were recorded as having penetrated Zikim base[98] from the sea; fighting broke out shortly afterwards.[99] Motorised paragliders were also in the area and were among those earliest recorded to be launched beneath MRLM salvoes.[100] Not far from either Zikim or Erez, at Netiv HaAsera, the Hamas-led attack began with powered-paraglider-borne[101] Hamas fighters,[102] approximately three[103] to six[104] of whom landed in the settlement and began killing. Other assailants later arrived on foot,[105] possibly from or near the breached Erez crossing. At 7:30 a.m.,[106]attacks occurred on the Kerem Shalom kibbutz[107] and the Sufa kibbutz,[108] approximately five kilometres from one another.

Hamas-led forces eventually penetrated approximately 25 kilometres into Israel and attacked Ofakim.[109] On the way, a special Hamas unit successfully assaulted[110] the sensitive and strategically important Israeli 8200 unit signals intelligence and fusion centre at Urim,[111] which was an especially embarrassing blow to the IDF (as were reports that it had ceased eavesdropping on militant networks a year earlier).[112] Targeting of it, and the ability of Hamas-led forces to penetrate this high-value target, was a clear demonstration of the intelligence gathering and planning that went into the 7 October attack and informed its efficacy.

Hamas has claimed that in the barrage preceding the ground assault it employed approximately 35 modified versions[113] of the al-Zouari surveillance drone.[114] These modifications meant it was a loitering munition.[115] Purportedly, they were launched either from the open (as portrayed in their online released video)[116] or from covered structures.[117] However, so far, it has not proven possible to obtain independent evidence or corroboration of these launches.[118] Notably, these loitering munitions can be harder to spot and intercept than rockets or other missiles because they can fly at a lower trajectory and in the littoral[119] or seam between where ground forces operate and jet bombers.[120] Their modification suggests that, as in earlier versions of the al-Zouari drone, these loitering munitions possess surveillance capabilities.[121] Although unconfirmed, these could have helped warn if Israeli forces were in positions along the route that Hamas planned to penetrate the border. Therefore, and as Hamas has claimed, they may have been used to "facilitate[e] the crossing" of Hamas terrorists "into Gaza".[122]

It is also possible that Shehab-2 loitering munitions[123] were launched on 7 October as part of Hamas-led forces' barrages from residential buildings. However, so far, confirmatory evidence of this has not emerged. Notably, these munitions have since been targeted by IDF, as has a leading Hamas commander of its aerial array, Atsam Abu Raffa, who was reportedly responsible for such capabilities.[124] Hamas has published pictures of a supposed drone coordination centre; however, its existence has yet to be verified.[125]

If modified al-Zouari drones or modified Shehab-2 loitering munitions were employed, they might have helped to "clear" further, lower levels of airspace of Israeli drones and manned aircraft that may have been used to defend against them *and* generated intelligence, surveillance, and reconnaissance (ISR), target acquisition (TA), and strike options. Notably, loitering munitions, drones, and missiles can be difficult to electronically jam, depending on their sophistication (as has been seen in Ukraine[126]). If IDF did detect them, they could have added to the strain on IDF air defences, such as Iron Dome, including detection and targeting functions and ready supplies of missiles. Should Hamas or other terrorist groups use such munitions in the future as part of a similar attack, it could prove even more destructive and difficult to repel.

Part II: Hamas' Drone-Related Innovations and their Implications

According to Don Rassler, Hamas has run a drone programme since c. 2003 with substantial technical support from Iran's Iranian Revolutionary Guard Corps (IRGC).[127] [128] Therefore, Hamas' drone programme is notably older than the drone programmes of most states that are assessed to currently possess one, although their respective scope and scale often differ.[129] Significantly, Hamas has used commercial drones[130] and loitering munitions for military operations since at least 2018 and 2021, respectively,[131] although reports exist of Hamas operating drones over Israel from Gaza in 2012,[132] and intensifying use in 2014.[133] Consequently, it has considerable experience in drone and loitering munition use including in combat conditions.

As Yannick Veilleux-LePage and Emil Archambault have stated, prior to the 7 October attack, Hamas' drone use involved "a variety of types of attacks", as well as drone types and targets. The latter included IDF vehicles, Iron Dome batteries, and a claimed attack against the Israeli Ministry of Defence in Tel Aviv. They note that, Hamas' drone use has neither demonstrated a clear developmental path nor consistent success, regarding which they offer three possible explanations: technical and tactical immaturity, a lack of effectiveness, and prioritising propaganda value.[134] Notably, the IDF began striking Hamas' nascent drone capability before Hamas had used drones in combat operations, i.e. reportedly in c. 2003,[135] which may have been significant in affecting Hamas' drone programme. Together, these details point to substantial improvements in Hamas': drone capability, including significant advances in their technical and tactical capacity; evident success in drone and possibly loitering munition use; and Hamas' keen attention to propaganda value, for example, regarding videos affiliated forces released on social media featuring and celebrating their drone and related technology use on 7 October.

The 7 October attack did not emerge without indication or preparations; prior to it, Hamas utilised drones, missiles, and rockets to test and strike Israel's defences, sometimes intensively. In early May 2021 (and to that date), in a foretaste of what was to occur on 7 October, the largest barrage of missiles was launched by Hamas into Israel, reportedly temporarily overwhelming Israel's renowned Iron Dome air defence system.[136] According to Abu Obaida, the spokesman for Hamas's military wing (al Qassim Brigades), preparations for the 7 October attack began in 2021, when it started to closely study Israel's tactics and strategies.[137] Iran's leadership has sent mixed messages regarding its possible involvement in the 7 October attack. As Phillip Smyth

has stated, "no 'smoking gun' has emerged of direct Iranian involvement in or greenlighting of the October 7 attacks", yet, as he notes, Iran "has always maintained significant sway over its [proxy] network", including Hamas.[138]

In the months leading up to the attack, Hamas conducted ground observation[139] and flew drones to reconnoitre close[140] to the Israeli border. By June 2023, Hamas had produced planning documents, instructions, and maps for dissemination to its ground forces.[141] Hamas also attempted to mask its intentions, for instance, by disguising operatives to operate among farmers[142] and downing IDF drones in the area,[143] thereby reducing (but not completely stopping) the IDF's ability to detect significant changes in Hamas's activity. This may also have helped deter the IDF from more closely inspecting the areas used to mass and launch forces into Israel, out of concern for provoking reaction and possible drone losses. This is not unlikely regarding the atmosphere and prevailing views[144] among Israel's political and military leadership.[145]

In the days and weeks prior to 7 October, Hamas conducted[146] various operations[147] to erode and test[148] Israel's border defences, including attacking observation balloons[149] in the areas that were later assaulted, practising approaching border posts,[150] and stockpiling equipment.[151] Hamas' complex tunnel systems under Gaza were undoubtedly used to enable this, too, for example to infiltrate fighters and supplies to locations proximate to the border.[152] During this formative period, unrest in the West Bank acted as a decoy, effectively diverting Israeli troop deployments and their attempts to address this.[153]

Instances of Innovation

The Hamas-led 7 October attack on Israel has been characterised by leading terrorism scholar Professor Audrey Kurth Cronin as "an old-fashioned attack with hang gliders, motorbikes, bulldozers, explosives."[154] However, the attack involved: powered paragliders and drones for ISR and TA; drones for direct fires, including use of a novel explosive freefall munition, or bomblet, dropped by drones on key IDF border defences; the novel combination of powered paragliders and drones under cover of indirect fires employing rockets, missiles, and likely loitering munitions; and these in concert with small-unit based ground manoeuvre. Consequently, the attack possessed more advanced characteristics and thus implications (as will be discussed shortly) than Cronin's comment suggests or that many analyses have so far identified or clearly articulated.

Regarding the question posed above: "how did Hamas-led forces employ drones and related technologies" on 7 October, "and what are the implications of this, including for preventing and combatting them?" this logically leads to the question: "what more precisely were the innovations that Hamas-led forces demonstrated on 7 October?" In response, considering Part I and the related analysis above, the munition used by Hamas-led forces-operated small drones to attack observation and communication towers – key IDF border defences - constitutes an important innovation.

As assessed from multiple published videos that feature Hamas-led drone strikes on these targets, it is evident that the drone-delivered bomblet/munition used to strike these defences emitted smoke after hitting the target and incorporated a considerable delay prior to detonating/exploding. Two main facilities follow from these features. First, the emitted smoke after hitting the aimed for target clearly facilitates target-marking (and was insufficient for a smoke screen). The use of smoke-releasing munitions to mark targets is long-established. This feature also provided a clear indication of the crosswind(s) the targets were subject to, regarding their significant height and exposure that might divert the munition from its aiming point, which made this feature particularly apt and notable. This feature would also enable

targeting correction, for example by a subsequent drone to drop another munition with more accuracy on the target after the wind drift became evident because of the initial munition use, i.e. with correction. This is also a well-established practice in warfare, for example by artillery.[155] Second, the delayed detonation enabled the drones to move particularly close to the target and get away swiftly after dropping the munition so that the explosion would not damage the drone or back-up drones. Again, this feature has already been used in munitions. What makes this munition novel is that it is the first known recorded example of a munition with these combined features that was apparently designed for and clearly launched from a drone by a non-state actor in combat, and against such sensitive military/security targets. On 7 October, it proved potent in combination with the small drone platform, including because it was able to evade IDF defences.

The use of innovated small commercial drones to directly attack observation towers is not novel.[156] This can be observed regarding the use of small commercial drones modified by ISIS to drop munitions on Iraqi military positions in 2017.[157] It can also be identified in the use of modified drones (turning them into loitering munitions) by Ukrainian armed forces to attack a Russian observation tower in March 2023.[158] Therefore, non-state and state actors, respectively, have innovated drones before to strike such targets. The level of coordination demonstrated by Hamas-led forces that day in their (combined arms) assault on Israel had not been demonstrated prior by another terrorist group or non-state actor as will be demonstrated shortly.

A further apparent innovation has been identified in some of the small DJI Phantom drones that Hamas-led forces employed on 7 October. These drones appear to have incorporated modifications to their settings, enabling them to avoid electronic countermeasures. According to *DroneSec*, which examined footage of their use that day:

> *DJI drone icons appear on the left-hand-side of the screen, showing a 'Land' and 'Home point' icon, with the 'Return to Home' icon greyed out. This could signal the operator has disabled RTH-mode, a common counter-counter operational security measure.*

This may help to explain the ability of Hamas-led forces' drones to operate effectively on 7 October, despite advanced Israeli electronic warfare capabilities, which has been a considerable source of curiosity.[159] An additional factor appears in the disclosure in December 2023 that:

> *Israel had at least one [counter-drone] system on the Gaza border on Oct. 7 specifically designed to counter drones, but it was not yet operational. The final stages of testing were scheduled a few days after the surprise attack, according to Sentrycs, which developed it.*[160]

Regarding other non-state actor use of these modifications, no other recorded examples have been found although other modifications have been made, for example by ISIS.[161] State actors have been observed using such modifications, for example Russian and Ukrainian state forces earlier in the ongoing Russo-Ukrainian war (2022-).[162]

Hamas' Combined Arms Use

Various comments have occurred regarding Hamas' coordinated use of drones combined with other offensive actions during the 7 October attack on Israel, however, so far it has not received in-depth analysis regarding it or its implications.[163] Perhaps the most detailed extant analysis is that by Kerry Chávez and Ori Swed, who observe that (1) Hamas' forces appeared to operate like a (conventional) army, particularly in their use of a "massed and combined arms approach,"[164] and that (2) although earlier similar endeavours were pioneered by ISIS, Hamas'

actions on 7 October differ because Hamas' forces demonstrated two innovations. Therefore, while Chávez and Swed draw important attention to the matter of combined arms, they do not note the innovations articulated above, nor do they go into detail about Hamas-led forces' use of combined arms with drones. These represent significant lacunae that this article aims to address, among others.

Regarding the first point Chávez and Swed note, Thomas Maurer's research is helpful because it details ISIS' use of combined arms. He states ISIS "organized [weapons] into categories, [employed] purposeful combination of these forces in keeping with the concept of combined arms combat, and [utilized] hierarchical command and control executed by experienced commanders." Maurer further notes that "ISIS combat groups combined the elements of formation and firepower as well as movement and mobility." [165] Therefore, for clarity it is worth considering what constitutes "combined arms".

In its contemporary conception, combined armes can and has been dated from the latter part of the First World War.[166] Jonathan House[167] identifies its existence several years earlier in Major Gerald Gilbert's, *The Evolution of Tactics* published in 1907. The latter is significant because it pertains to a context where non-state actors were of major concern,[168] and because combined arms are currently almost exclusively associated with state forces, contrary to what unfolded on 7 October 2023. Combined arms are largely associated with conventional forces because of their reputation for complexity, the difficulty of competently conducting them, and the level of organisation and training required.[169] Quite recently, combined arms have also been observed in earlier historical periods stretching back to ancient history, indicating increasing awareness of it but also considerable variation in understanding what it entails.[170]

Consistent with what William S. Lind, Jonathan House, and latterly, Stephen Biddle have asserted, in essence "combined arms" is the use of various combat arms and weapons in concert to maximise overall efficacy and mitigate individual weaknesses.[171] It usually requires that the actions an enemy would take to defend against one element of combined arms use would result in vulnerability to another,[172] and, typically, both direct and indirect fires are employed combined with considerable force manoeuvre. In addition to concern about its strategic implications,[173] recently the concept of combined arms has seen an emphasis on information operations, including propaganda,[174] and even AI.[175]

Although Maurer does not explicitly note ISIS's use of direct and indirect fires and manoeuvres *in concert or synchronicity*, he does state direct and indirect fires and manoeuvres were combined and "coordinat[-ed] "taking into account time and space" by ISIS (pre-2018).[176] Thus, Maurer's assessment of ISIS's use of combined arms is broadly congruent with the combined arms' essence, although less specific. Maurer notes ISIS's use of drones for ISR but does not discuss drone use for launching direct strikes in this context.[177] This provides an important comparison with Hamas-led forces' innovative use of drones as part of combined arms whereby drones were used for direct and indirect fires, pre-attack ISR, and almost certainly TA. Moreover, drones were used in concert with other arms as part of a synchronised assault of substantial size, scope, and sophistication. Doctor and Walsh have asserted ISIS employed "combined arms" in Syria, which they equate with "theatre air attacks to support ground force operations" and "close air support", as conceptualised by Pape.[178] However, they do not remark upon key elements of combined arms, such as synchronicity, nor do they provide clear details of ISIS's combined arms use, including how drones were employed. Indeed, ISIS is not known to have conducted a combined arms attack with drones possessing such an integral role or on such a scale as Hamas-led forces did on 7 October.

Regarding Chávez's and Swed's first point about Hamas-led forces' use of drones on 7 October, they state that Hamas "simulat[-ed] mass with off-the-shelf drones that can be deployed in multiple ways, including being equipped with bombs and repurposed into weapons of war." Part I of this article provides substantial detail that corroborates this observation. It also furnishes further insight that it was the combination of drones, including those employing direct fires, together with other munitions (including those used for indirect fires using rockets, missiles, and possibly loitering munitions) that "simulated mass" and not only drones. This is an important corrective.

Chávez's and Swed's second point is that on 7 October, Hamas was responsible for "pioneering a new combined arms model with commercial drones that is unusual for terrorist organizations."[179] While evidence corroborates this, they do not specify why and how. Neither do they clearly conceptualise the "combined arms model" they refer to nor note its limitations. They are nonetheless correct that the description and label of "combined arms" are less frequently applied to terrorists or insurgents.

As Part I above details, Hamas-led forces were able to take advantage of the difficulty air defences often have in detecting small drones before they deliver strikes against targets, including defences.[180] Regarding small drone use and combined arms, Hamas-led forces conducted drone strikes using small drones with a novel munition and in concert with, and under cover of, a barrage of massed indirect fires comprising missiles, rockets, and possibly loitering munitions. Concurrent with this, and at multiple locations (as detailed in Part I), Hamas-led forces breached and assaulted Israeli border defences at multiple strategic points with small units in a synchronised manner, including with follow-up forces involving substantial command-and-control.

Hamas-led forces subsequently infiltrated Israeli territory and attacked a variety of locations, including military and civilian military installations. This has been well documented (see Part I). Powered paragliders launched in concert with the initial indirect fires salvo, were subsequently observed helping to coordinate Hamas-led forces' manoeuvre. They also attacked Israeli targets from the air, and 'dismounted' fighters assaulted civilian targets (such as at Netiv HaAsera).[181] In addition to paragliders, during the assault drones were also used for ISR (and prior to it), TA and strike. An unmanned balloon has also been claimed by a Hamas-affiliated account, however, it has not been confirmed.[182]

Accordingly, Hamas-led forces "pioneer[-ed] a new combined arms model with commercial drones that is unusual for terrorist organizations" and demonstrated a novel innovation on 7 October with the sophistication of their drone use as part of a combined arms assault, which included ISR, TA, and strike. Although paragliders were also used in these ways, Hamas-led forces' drone use was comparatively more sophisticated in these regards, both technically and in practice.

Accordingly, drones were used for direct fires and to facilitate direct and indirect fires. Drone-facilitated indirect fires, for example ISR prior to the assault and during it, almost certainly added to the pressure on Israeli air defences because further projectile salvoes were unleashed by Hamas-led forces. It is highly probable that these salvoes helped further enable Hamas-led forces' drone use and their combined arms assault. This is because Israeli air and ground defences' ability to respond was almost certainly hampered; for example, IDF took cover and was prevented from mounting a coordinated or clearly targeted response resulting from these indirect and direct fires (including by drones).

Novel counter-jamming modifications (for non-state actors) that were detected in Hamas-led forces' small modified commercial drones, enabled them to target key IDF defences, including armed border observation posts and communications towers, and IDF troops and tanks, as did their use of a novel munition when attacking the former. Representing highly significant innovations for Hamas and non-state actors, including terrorist groups, are the use of small drones, technical innovations to them, and munitions used by them, and the central role drones had in a combined arms assault. Indeed, no other terrorist group has so far demonstrated this range of capabilities, which are more usually associated with a state actor. Furthermore, no state actor has demonstrated this particular use of drones in an assault.

Part III: Drone Use Efficacy Against Israel: What can be Learned?

The Efficacy of Hamas-led Forces' 7 October Drone Use

During the assault, IDF personnel frequently did not (and arguably could not) directly combat breaches of Israeli defences in a concerted or highly organised manner. Reviewing numerous reports, including video footage of the assault, this was not least because of the need for IDF to take cover from rocket, missile (and possibly loitering munition) salvoes launched by Hamas-led forces in the initial attack, in concert with drone strikes, and static and mobile small arms fire (detailed in Part I). Therefore, rather than the 7 October attack being one of "supporting arms"[183] Hamas-led forces' combined arms assault proved especially effective in suppressing, breaching, and assaulting thinly manned high-tech static defences and overwhelming light concentrations of mobile IDF defences that were deployed that day. The specific and successful targeting of communications by Hamas-led forces using drone-launched novel munitions also meant that IDF were unable to coordinate a rapid and sufficiently robust response to repel and stem breaches in border defences and the infiltration of larger groups of Hamas-led fighters. The effect of this was to amplify the initial success of the Hamas-led attacks on Israeli border defences and the overall scale and scope of the assault (as detailed in Part I).

In consequence, the ability (and likelihood) of IDF effectively marshalling a swift response to initial Hamas-led attacks against Israeli border defences before Hamas-led forces broke through in substantial numbers, seized defences/strong-points, and fanned out - including striking civilian targets - was militated against by Hamas-led forces' use of combined arms.

Indeed, Hamas-led forces' use of combined arms, and drones as part of it, included utilising drones' strengths as an ISR, TA and strike platform against the specific defensive capabilities that IDF had developed, including as part of its high-technology border defences. Hamas-led-forces' use of rocket, missile, and possibly loitering munition salvoes during the assault provided cover for their drone use and the ground units operating them as they approached, assaulted, and in some instances held positions, and in other instances, continued to infiltrate Israel (see Part I).

If more IDF personnel had been available on 7 October, it is improbable that they could have effectively combatted this combined arms assault because of its scale and scope, including its suppressive and disorientating effects, for instance its precise targeting of key components of IDF defences, i.e. observation and communication towers, strong-points, IDF high-tech ISR, and related communications capabilities. This meant that IDF border defences, including automated weapons to detect, initially repel and enable swift reinforcement, and mobile forces such as tanks, were rendered largely ineffective. Thus, the structure of IDF defences and their vulnerability to combined arms assaults involving drones and other weapons require careful

reconsideration regarding what is known to have unfolded on 7 October. This further underlines the efficacy and threat posed by Hamas-led forces evidenced combined arms capability.

Additional salvoes of rockets, missiles, and possibly loitering munitions also made it more difficult for IDF aircraft, including drones, to interdict Hamas-led forces, as did the increasing numbers of assailants that flowed through the breached defences and their subsequent manoeuvre into urban and more open terrain. Hamas-led forces' use of motorised paragliders, launched under the cover of the initial barrage, to help guide Hamas-led forces and partake in attacks, is a further innovation demonstrated by them on 7 October as part of a combined arms assault. The use of motorised (and armed) paragliders can also be regarded as potentially compensating for the potential vulnerability of drones to electronic warfare, as they can and were used to help coordinate attacks. Hamas-led forces' drones' limited strike capabilities also meant these paragliders provided additional mobile attack capability with personnel in them able to fire onto targets and to land, dismount and assault locations (such as at Netiv HaAsera),[184] as well as the propaganda effect of their use both visually and historically *vis-à-vis* "Night of the Gliders".[185]

An important aspect of Hamas-led forces' use of combined arms on 7 October is "it reinforces the shift in the dominant characteristic of war[-fare] from maneuver to decision" (alteration of war to warfare mine);[186] in the case of the 7 October assault IDF and Israel's political leadership were placed in a very difficult decision-making position where it was much less a question of manoeuvre than of deciding what to do. This was despite Israeli doctrinal, infrastructure, equipping, policy and political investments in technology-driven ISR and quick-reaction capabilities,[187] [188] which proved inadequate. Hamas-led forces demonstrated detailed knowledge of Israeli defences, which were directly and effectively targeted by them on 7 October,[189] including communications within defence structures on the border and the communications towers struck by drones. This extended to the highly important and sensitive signals intelligence facility at Urim.

The apparent limited objectives of the Hamas-led attack on 7 October (within an unlimited political and military goal of the eradication of Israel that Hamas has asserted numerous times before and since the 7 October assault[190]) included demonstrating their capability to: shock, maim, torture, kill, and capture Israelis; undermine the IDF's reputation; destabilise the Netanyahu government (that is highly critical of Hamas and Iran); obtain propaganda; and take military and civilian hostages for political and military concessions. These were in broad alignment with and further to Hamas-led forces' use of combined arms. That Hamas-led forces were unable to seize and hold territory for more than approximately one day indicates the significant limits of Hamas-led forces' combined arms capability. However, although they were limited in their ability to seize and hold territory, they were still able to penetrate deep into Israel, strike sensitive facilities, and capture and remove a large number of hostages. Indeed, it appears hostages were used instead of holding territory (after doing so) to try to obtain political concessions. Thus, although Hamas-led forces' actions indicated the use of limited war, this occurred as part of the war that Hamas has expressed in unlimited terms.

What Can Be Learned?

Hamas-led forces' demonstration of a potent if "unorthodox" combined arms capability, with drones and possibly loitering munitions at its centre, breaks new ground. This includes, in terms of non-state actors, capabilities that have been demonstrated so far, including in the ongoing conflict between Israel and Iranian proxy forces. Hamas-led forces' development of drone-related combined arms capability is occurring as part of the shift[191] that is unfolding, involves drones moving from being almost exclusively employed by states to find, fix, and, in

some cases, strike terrorists, insurgents, and other non-state actors,[192] to their utilisation by terrorists and insurgents to attack state forces and civilians.[193] This shift has been characterised as democracies using drones to combat terrorism to its inverse.[194]

The seizure of hostages by Hamas-led forces, further to their combined arms assault instead ,of protracted land-seizure may be regarded as a substitution, albeit a distasteful one, which is highly morally, ethically, and legally objectionable. Arguably, this has shown considerable political efficacy in the short to medium term. It also provides a counterpoint to Hamas' objections to Israeli settlements in occupied areas.[195] Consequently, Hamas may be able to translate combined armed use (with drones having a central role) into a more strategic and political tool. However, in the medium and long term it may attract strong and counter-productive responses.

Hamas appears to have learned from ISIS' technical drone innovation and drone use, including its innovation in drone munitions, although the precise links between them are not yet fully clear. Ukrainian and Russian armed forces also probably provided a significant source of innovation inspiration to Hamas[196] and possibly technical insights towards the alteration of DJI commercial drone safety configurations. However, more details are needed to establish why and how Hamas innovated as it did. It remains likely that other terrorist and insurgent groups will also seek to emulate the combined arms capability and elements thereof that Hamas-led forces demonstrated on 7 October.

Beyond Israel-Gaza, there is growing evidence that non-state actors are seeking to develop drone-related capabilities, including to target highly trained state forces. Perhaps the latest example of this is in the Red Sea, where Houthis have launched loitering munitions and drones against international shipping, including naval forces from the US, UK, France, Netherlands, and others.[197] This strongly suggests that states will need to become far more vigilant regarding the threat such groups with drone and loitering munition capabilities pose. As Hamas-led forces' drone-related capabilities proved central to the efficacy of their attack on Israel on 7 October, that possessed highly advanced drone and counter-drone and counter-airborne munition capabilities, this serves as an important warning to other states.

Regarding non-state actors' combined arms capability - including drones, loitering munitions, and missiles- it is conceivable that this could develop rapidly especially with state assistance, including in contexts in which training can be provided, weapons and weapon systems can be transported or smuggled, and expertise and experience communicated or transferred. This can be inferred from the development of Hamas' drone and related technologies capability.[198] Therefore, vigilance will be needed regarding non state actors' training facilities and weapon supplies, including so-called "dual use" technologies,such as commercial drones.

In addition to drone-related developments in Ukraine,[199] improved counter-drone capabilities against state and non-state actors appear increasingly essential. They are no longer niche capabilities and are necessary across a wide range of armed forces, including for basing and the manoeuvre of forces at small-unit level and above. Although Israel was in the process of deploying and integrating technology to assist its troops to target and shoot down drones, missiles, rockets and possibly loitering munitions, this came too late to prove effective.[200]

In the future, the use of drones by small units to infiltrate an adversary's territory is likely to be an area of substantial threat because small drones can act as a significant force-multiplier, including to enhance the lethality of their attacks, and help to preserve small units by forewarning

of defences and/or interdiction by larger or superior forces. In turn, this markedly increases the damage non-state actor assault teams could cause state, non-state actors, and civilians in material, political, military, and psychological terms.

Hamas' and associated forces' use of drones in combined arms has also demonstrated the limitations of border walls, fences, and wider defence complexes even with high technology enhancements. Arguably, it has shown the need for troops to be deployed to defend territory or strategic and tactical points in considerable depth and with more resilient communications links that were in place in Israel on 7 October. Although this runs counter to the assumptions and tenets incorporated in Israel's 2015 military strategy and the "Decisive Victory" operational concept - and despite the temptation to regard this as more of a glitch than a fundamental challenge – these will need to be revisited and reappraised. This is especially so given: previous failure (2006), the scale and scope of the 7 October failure, and increasing Hamas and other terrorist and other non-state actors' technological capabilities, including drones, loitering munitions, rockets, and missiles. Moreover, now that the 7 October attack has proven to be a successful operation and template. This also implies that Israel will need to keep a closer eye on training camps and possible preparations for other such attacks against it, as will other states.

Conclusion

On 7 October 2023, Hamas-led forces demonstrated substantial drone-related innovations. From a technical standpoint, the most novel innovation was not of a drone itself but that of a drone-delivered munition which possessed two main novel features: (1) the emission of smoke upon hitting the target area, and (2) delayed detonation. These combined attributes in a drone-delivered munition have not been identified as in previously employed by either a terrorist or non-state actor. These munitions were employed highly effectively by what appear to be modified small commercial drones against Israeli high-technology observation and communications towers. The observation towers incorporated sensors and interlinked machine guns but proved unable to effectively detect or combat small drones. The smoke emitted by and delayed explosion of the novel drone-delivered munitions utilised by Hamas-led forces proved effective in achieving drone precision strikes and drone survivability. The former feature also offered the possibility of corrected drone strikes if crosswinds significantly affected the accuracy of the initial strikes, which could have proven particularly helpful given the combined arms context in which synchronisation is highly important.

A further possible novelty is also evident in the apparent incorporation of technical modifications to DJI Phantom small drones used in strikes against Israeli targets that would have helped prevent them being jammed. This is the first time such a modification has been detected in non-state actor-employed drones. Together, these constitute substantial innovation in non-state and terrorist drones and their use because neither one nor all these innovations has so far been identified in other non-state actor and terrorist drones or their use.

The most important drone-related innovation and capability that Hamas-led forces demonstrated on 7 October was the use of combined arms, in which drones had a central and integral role. While some may regard their combined arms use in historical terms as unorthodox, it is not in view of the historical origins and context of the concept. Hamas-led forces' combined arms involved and exhibited shrewd and synchronised use of missile, rocket, and possibly loitering munition-based mass, in concert with small drone precision strikes (enabled through novel innovations to small drones). The assault occurred across various geographically and functionally interlinked defence points in close succession. The overall size and scale of the combined arms assault by Hamas-led forces may also be regarded as a novel feature; it is

almost certainly the largest recorded combined arms assault in combat by a non-state actor. It was also able to comprehensively breach sophisticated bespoke air and ground defences with devastating tactical, operational, strategic, and political effects.

Consequently, the Hamas-led assault on 7 October 2023 constitutes substantial innovation according to both measures of "innovation" asserted by, on the one hand Williamson Murray, and on the other Theo Farrell and Michael C. Horowitz, as detailed above. That is, and respectively, changes in capability that have occurred in a period of peace (i.e. in preparation for the assault), and in a major change in the conduct of warfare. It also draws attention to what Nina Kollars regards as the overlooked area of adaptation during conflict, provided the blurring that occurs between conflict statuses and, in turn, respective leading conceptualisations of "adaptation" and "innovation".

Given the importance of at least Iranian knowledge transfer for the development of Hamas' drones and loitering munitions,[201] remaining questions about Iran's role in the 7 October attack may help spur further attention to the role and importance of what Brown et al. term institutional actors "in enabling or enhancing adaptation at the lowest level."[202]

Regarding border defences and those of sensitive sites, the direct targeting of Israel's border defences, and in particular key elements of their high technology composition (with its underpinning assumptions including light staffing), should serve as a warning to Israel and other states that such defences may prove either an insufficient deterrent or defence or both to a combined arms attack.

A combined arms attack including armed and unarmed drones and related technologies, and as a *modus operandi*, is likely to be attractive to many non-state actors and even states. While the technological and employment capabilities of terrorists and other non-state actors are rapidly improving, concerningly, counter-drone capabilities, particularly against small drones and loitering munitions, lag.[203] This adds urgency for further developing the latter. As Liran Antebi and Matan Yanko-Avikasis state, drones (and, in effect, loitering munitions) should be considered "a new layer" and should be dealt with specifically, "and not necessarily in conjunction with other aerial threats such as manned aircraft or missiles and rockets."[204]

Although respective terrorist and insurgent group drone, loitering munition, and counter-drone and counter-loitering munition capabilities are often considerably less sophisticated than those of states, the 7 October assault by Hamas-led forces demonstrated that the latter, and potentially other non-state actors, can incur serious military and political blows against states. This includes against arguably the state with the most advanced capacities fielded for defending against these technologies.[205] Although states often rely on MALE drones, for various reasons they have largely neglected the importance of smaller drones, including those utilised by small units, and counter-drone capabilities to defend against such use.[206] This is despite the increasing importance of the "littoral" or "seam" between the ground and where manned (ground-attack) jets operate.

Paradoxically, in addition to high-tech solutions, a premium should be placed on the early detection of suspicious human activity to prevent the build-up of capacities and forces for such an attack. An attack such as that on 7 October 2023 requires detailed and complex planning, so human intelligence is vital to detect it despite the difficulty in developing and sustaining it. The temptation for 'cleaner' and more calculable forms of intelligence gathering and response belies the countermeasures that state and non-state actors can take against signals intelligence and high-technology-based intelligence gathering and related forewarning. Moreover, technological

innovation and adaptation are almost certain to continue, which means this dimension will see alterations in capabilities as well as opportunities that can and will be exploited by state and non-state actors alike.

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Endnotes

1 Drones are defined in accordance with that provided by James Page: "unmanned, remote controlled powered aircraft (with varying degrees of autonomy) capable of changes in direction, height and speed, which are designed to be and typically are reusable." This accords with Boyle's observation in his substantial book about drones: "[a]mong the key characteristics that most drones share is that: (1) they are flown remotely: (2) they are capable of flight manoeuvres; and (3) they are typically intended to be reused, unlike missiles and other disposable projectiles." This has important analytical and wider implications; see: James M. Page, "Loitering Munitions and Drones: The Urgent Need for Clarity," *Royal United Services Institute*, Newsbrief, April 26, 2024, https://www.rusi.org/explore-our-research/publications/rusi-newsbrief/loitering-munitions-and-drones-urgent-need-clarity ; Michael J. Boyle, *The Drone Age: How Drone Technology Will Change War and Peace* (Cambridge: Cambridge University Press, 2020): 7-8, https://academic.oup.com/book/36688/chapter-abstract/321730595?redirectedFrom=fulltext . All accessed July 9, 2024.

2 While Hamas was the largest group involved and is widely regarded as having planned and led the 7 October assault (with external support), other groups were also involved, including (but not necessarily limited to): Palestinian Islamic Jihad (PIJ), the second largest militant organisation in Gaza and a widely proscribed terrorist group (as is Hamas); the Mujahideen Brigades, and; Al-Nasser Salah al-Deen Brigades. See, e.g.: BBC, "How Hamas built a force to attack Israel on 7 October," *BBC*, November 27, 2023, https://www.bbc.com/news/world-middle-east-67480680 ; USIP, "Israel-Hamas War: Comments by Hamas & PIJ," The Iran Primer, *US Institute of Peace*, October 11, 2023, https://iranprimer.usip.org/blog/2023/oct/11/israel-hamas-war-comments-hamas-pij . All accessed July 9, 2024.

3 This was announced in a pre-recorded message by a Hamas spokesman several hours after the attack began. See: Samia Nakhoul and Laila Bassam, "Who is Mohammed Deif, the Hamas commander behind the attack on Israel?," *Reuters* October 11, 2023, accessed July 9, 2024, https://www.reuters.com/world/middle-east/how-secretive-hamas-commander-masterminded-attack-israel-2023-10-10/ .

4 Seung Mim Kim and Matthew Lee, "Biden decries the 'unconscionable' Hamas attack and warns Israel's enemies not to exploit the crisis," *Associated Press*, October 8, 2023, https://apnews.com/article/israel-hamas-palestinians-gaza-rockets-airstrikes-biden-0b6abb762dabd46aa826af891591b392 ; Times of Israel, "UK PM Sunak slams 'barbarity' of Hamas attack on Israel," *Times of Israel*, October 8, 2023, https://www.timesofisrael.com/liveblog_entry/uk-pm-sunak-slams-barbarity-of-hamas-attack-on-israel/; Nahal Toosi, Phelim Kine and Andrew Zhang, "China's soft message on Hamas is part of a much bigger strategy," *Politico*, October 12, 2023, https://www.politico.com/news/2023/10/11/israel-hamas-china-middle-east-policy-00120995 . All accessed July 9, 2024.

5 Regarding media attention about the attack, see for example: Jordyn Beazley, "'Israel declares war': What the papers say about the surprise Hamas attack and its aftermath," *The Guardian*, October 8, 2023, https://www.theguardian.com/world/2023/oct/08/israel-declares-war-what-the-papers-say-about-the-surprise-hamas-attack-and-its-aftermath ; Karl Vick, "A Surprise Attack Upends Israel and the Middle East," *TIME*, October 8, 2023, https://time.com/6321849/israel-attack/ ; Patrick Kingsley and Isabel Kershner, "'We Are at War,' Netanyahu Says After Hamas Attacks Israel," *New York Times*, October 7, 2023, https://www.nytimes.com/2023/10/07/world/middleeast/israel-netanyahu-hamas-attack.html ; Yolande Knell, Raffi Berg and David Gritten, "Israel attack: PM says Israel at war after 250 killed in attack from Gaza," *BBC*, October 7, 2023, https://www.bbc.co.uk/news/world-middle-east-67036625.amp ; James Rothwell and Nataliya Vasilyeva, "Hamas terrorists butcher civilians as stunned Israel suffers '9/ moment'," *Telegraph*, October 7, 2023, https://www.msn.com/en-gb/news/world/hamas-terrorists-butcher-civilians-as-stunned-israel-suffers-9-11-moment/ar-AA1hQGFb ; Dan Williams, "How the Hamas attack on Israel unfolded," *Reuters*, October 7 2023, https://www.reuters.com/world/middle-east/how-hamas-attack-israel-unfolded-2023-10-07/ ; Washington Post, "Maps and videos show how the deadly surprise attack on Israel unfolded," *Washington Post*, October 7, 2023, https://www.washingtonpost.com/world/2023/10/07/israel-gaza-timeline-videos-maps/ ; Haaretz, "Gaza Declares War: Surprise Infiltration, Massive Barrages Shock Israel; Over 250 Israelis Killed, 1,590 Wounded; Civilians and Soldiers Held Hostage in Gaza," *Haaretz*, October 7, 2023, https://www.haaretz.com/israel-news/2023-10-07/ty-article-live/israel-under-attack-terrorists-infiltrate-from-gaza-amid-massive-rocket-barrages/0000018b-088b-dae9-adcb-abbff50f0000 . All accessed July 9, 2024. Notably, none of these leading media reports mentions drones, but rather concentrate on more familiar weapons that were more immediately in evidence, such as rockets and missiles in addition to small arms. Media attention about drones' role in the attack followed shortly after, particularly after videos taken by Hamas of their use were published, see, e.g.: Samuel Oakford, Evan Hill, Joyce Sohyun Lee and Meg Kelly, "Videos show how Hamas achieved its unprecedented surprise attack on Israel," *Washington Post*, October 8, 2023, https://www.washingtonpost.com/world/2023/10/08/israel-gaza-videos-border/ ; Mia Jankowicz, "How Hamas likely used rudimentary drones to 'blind and deafen' Israel's border and pave the way for its onslaught," *Business Insider*, October 10, 2023, https://www.businessinsider.com/hamas-drones-take-out-comms-towers-ambush-israel-2023-10?op=1 ; David Hambling, "How cheap drones helped Hamas ambush Israel's sophisticated weaponry," *Forbes*, October 9, 2023, https://www.forbes.com/sites/davidhambling/2023/10/09/how-hamas-leveraged-cheap-rockets-and-small-drones-to-

ambush-israel/; Aric Toler, "How Hamas Attacked Israel's Communications Towers," *New York Times*, October 10, 2023, https://www.nytimes.com/2023/10/10/world/middleeast/hamas-israel-attack-gaza.html ; Justin Ling, "The Dangerous Mystery of Hamas' Missing 'Suicide Drones'," *WIRED*, October 21, 2023, https://www.wired.com/story/hamas-drones-israel-war/ ; Sean Rayment, "The danger of Hamas drone attacks," *Spectator*, November 6, 2023, https://www.spectator.co.uk/article/the-danger-of-hamas-drone-attacks/ . These videos can be seen at: Younis Tirawi سنوي @ytirawi, X formerly known as Twitter, October 7, 2023, https://twitter.com/ytirawi/status/1710622183670608064 ; SamuleBendett @sambendett, X formerly known as Twitter, October 8, 2023, https://twitter.com/sambendett/status/1711004280654635512 . All accessed July 9, 2024.

6 In general, see, e.g.: Daniel Byman and Alexander Palmer, "What You Need to Know About the Israel-Hamas War," *Foreign Policy*, October 7, 2023, https://foreignpolicy.com/2023/10/07/hamas-attack-israel-declares-war-gaza-why-explained/ ; Lawrence Freedman, "What comes next in Gaza: Israel was wrong to think it could contain Hamas so easily," *New Statesman*, October 8, 2023, https://www.newstatesman.com/world/middle-east/2023/10/israel-gaza-what-comes-next ; Matthew Levitt, "The War Hamas Always Wanted How the Group's Attack Could Disrupt the Emerging Order in the Middle East," *Foreign Affairs*, October 11, 2023, https://www.foreignaffairs.com/israel/war-hamas-always-wanted . Regarding drones, see e.g.: Kerry Chávez and Ori Swed, "How Hamas innovated with drones to operate like an army," *Bulletin of the Atomic Scientists*, November 1, 2023, https://thebulletin.org/2023/11/how-hamas-innovated-with-drones-to-operate-like-an-army/ ; Liran Antebi and Matan Yanko-Avikasis, "Life and Death in the Hands of the Drone: The Small, Cheap Devices Early in the Swords of Iron War," *INSS Insight*, No. 1772, October 26, 2023, https://www.inss.org.il/wp-content/uploads/2023/10/No.-1772.pdf . All accessed July 9, 2024.

7 Hamas is designated as a terrorist organisation by the US, UK, Canada, Australia, Japan, Egypt, Paraguay, the EU, Organization of American States, and the United Nations. See: Linda Gradstein, "Explainer: How Hamas Ended Up on US List of Terrorist Groups," *VOA*, February 7, 2024, https://www.voanews.com/a/explainer-how-hamas-ended-up-on-us-list-of-terrorist-groups/7478227.html; Sergio García Magariño, "What is Hamas? Seven key questions answered," *The Conversation*, October 11, 2023, https://theconversation.com/what-is-hamas-seven-key-questions-answered-215391. Regarding labelling see: Ronit Berger Hobson and Assaf Moghadam, "Terrorism, Guerrilla, and the Labeling of Militant Groups," *Terrorism and Political Violence,* March 9, 2023, DOI: 10.1080/09546553.2023.2183052. All accessed July 9, 2024.

8 See, for example: Jay Mandelbaum and James Ralston, Project Leaders Ivars Gutmanis, Andrew Hull and Christopher Martin, "Terrorist Use of Improvised or Commercially Available Precision-Guided UAVs at Stand-Off Ranges: An Approach for Formulating Mitigation Considerations," Institute for Defense Analyses, IDA Document D-3199, October 2005, https://apps.dtic.mil/sti/pdfs/ADA460419.pdf ; Ulrike Franke, "Drone Proliferation: A Cause for Concern?" *ISN*, ETH Zurich, November 13, 2014, https://www.files.ethz.ch/isn/187855/ISN_185404_en.pdf . All accessed July 9, 2024.

9 Dennis Gormley, "Unmanned Air Vehicles as Terror Weapons: Real or Imagined?" *Nuclear Threat Initiative* Report, June 30, 2005, https://www.nti.org/analysis/articles/unmanned-air-vehicles-terror-weapons/ ; Michael J. Boyle, "The costs and consequences of drone warfare," *International Affairs*, 89, (2013), 1-29, https://doi.org/10.1111/1468-2346.12002 ; Boyle, *The Drone Age,* Ch.5; Håvard Haugstvedt and Jan Otto Jacobsen, "Taking Fourth-Generation Warfare to the Skies? An Empirical Exploration of Non-State Actors' Use of Weaponized Unmanned Aerial Vehicles (UAVs—'Drones')", *Perspectives on Terrorism*, 14, no. 5 (October 2020), https://www.universiteitleiden.nl/binaries/content/assets/customsites/perspectives-on-terrorism/2020/issue-5/haugstvedt-and-jacobsen.pdf ; Ash Rossiter, "Drone Usage by Militant Groups: Exploring Variation in Adoption," *Defense & Security Analysis* 34, no. 2 (April 3, 2018), 113–26, https://doi.org/10.1080/14751798.2018.1478183 ; James Rogers, "Future Threats: Military UAS, Terrorist Drones, and the Dangers of the Second Drone Age," Matthew Willis, André Haider, Daniel C. Teletin, and Daniel Wagner (eds.), *A Comprehensive Approach to Countering Unmanned Aircraft Systems* (Kalkar, Germany: NATO Joint Air Power Competence Centre, 2021), https://www.japcc.org/wp-content/uploads/A-Comprehensive-Approach-to-Countering-Unmanned-Aircraft-Systems.pdf . All accessed July 9, 2024.

10 See, e.g.: CBS, "NYPD scanning the sky for new terrorism threat," *CBS*, October 29, 2014, https://www.cbsnews.com/news/drone-terrorism-threat-is-serious-concern-for-nypd/; Jack Nicas, "Criminals, Terrorists Find Uses for Drones, Raising Concerns," *Wall Street Journal*, January 28, 2015, https://www.wsj.com/articles/criminals-terrorists-find-uses-for-drones-raising-concerns-1422494268 ; Alyssa Sims, "How do we thwart the latest terrorist threat: swarms of weaponised drones?" *Guardian*, January 19, 2018, https://www.theguardian.com/commentisfree/2018/jan/19/terrorists-threat-weaponised-drones-swarm-civilian-military-syria . All accessed July 9, 2024.

11 See: Boyle, *The Drone Age,* Ch.5; BBC, "Warning over drones use by terrorists," *BBC*, 12 January 2016, https://www.bbc.com/news/technology-35280402 ; UN, "Preventing Terrorists from Acquiring Weapons: Technical guidelines to facilitate the implementation of Security Council resolution 2370 (2017) and related international standards and good practices on preventing terrorists from acquiring weapons," United Nations Office for Counter-Terrorism, n.d., accessed July 9, 2024,

https://www.un.org/securitycouncil/ctc/sites/www.un.org.securitycouncil.ctc/files/files/documents/2022/Mar/technical_guidelines_to_facilitate_the_implementation_of_security_council_resolution_2370_2017_and_related_international_standards_and_good_practices_on_preventing_terrorists_from_acquiring_weapons.pdf .

12 Comparatively little polling has been done regarding public perceptions about the threat of terrorist drone use. However, views have been ascertained as part of wider polling, see, e.g.: Philip Boucher, "'You Wouldn't have Your Granny Using Them': Drawing Boundaries Between Acceptable and Unacceptable Applications of Civil Drones," *Science and Engineering Ethics* 22 (2016), 1391–1418 ; UK Government, "Public dialogue on drone use in the UK," London: HMSO, 2016, https://assets.publishing.service.gov.uk/media/5a7f97a2ed915d74e622b672/drones-uk-public-dialogue.pdf ; Marina Miron, David Whetham, Margaux Auzanneau, Andrew Hill, "Public Drone Perception", Technology in Society 73, 2023, https://doi.org/10.1016/j.techsoc.2023.102246 . All accessed July 9, 2024.

13 Regarding Israel's position as a leading 'drone power' see: Seth J Franzman, "How Israel became a leader in drone technology," *Jerusalem Post*, July 13, 2019, https://www.jpost.com/Israel-News/How-Israel-became-a-leader-in-drone-technology-595209 ; Peter Bergen, Melissa Salyk-Virk, David Sterman, "World of Drones," *New America Foundation*, July 30 2020, https://www.newamerica.org/future-security/reports/world-drones/ . Israel has been particularly secretive regarding its development of drone capability and comparatively few in-depth publications exist regarding this. Detailed sources include: Thomas P. Ehrhardt, "Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation," Ph.D. thesis, Johns Hopkins University, 2000, https://www.proquest.com/docview/276148273/previewPDF ; David Rodman, "Unmanned Aerial Vehicles in the Service of the Israel Air Force: they Will Soar on Wings Like Eagles," *Middle East Review of International Affairs*, 14, no. 3 (September 2010), 77-84; David Rodman, *Sword and Shield of Zion: The Israel Air Force in the Arab–Israeli Conflict, 1948–2012* (Eastbourne: Sussex Academic Press, 2013). Regarding Israel's development of drone capability and theoretical arguments, see: Moritz Weiss, "How to become a first mover? Mechanisms of military innovation and the development of drones," *European Journal of International Security*, 3, part 2, 187–210, esp. 198-201, doi:10.1017/eis.2017.15. All accessed July 9, 2024.

14 Notably, Israel has long used drones, at times intensively, to help keep Iranian-proxy forces such as Hamas and Hezbollah at bay. See: Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services"; Rodman, "Unmanned Aerial Vehicles in the Service of the Israel Air Force"; Rodman, *Sword and Shield of Zion*. This is not least because these terrorist groups and their main sponsor have repeatedly sworn to eradicate Israel. See, e.g.: MEMRI, "Israel's Eradication – An Ideological And Practical Goal Of Iran's Islamic Revolution Regime," *MEMRI*, Special Dispatch No. 7682, September 25, 2018, https://www.memri.org/reports/israels-eradication-–-ideological-and-practical-goal-irans-islamic-revolution-regime ; Bruce Hoffmann, "Understanding Hamas's Genocidal Ideology," *Atlantic*, October 10, 2023, https://www.theatlantic.com/international/archive/2023/10/hamas-covenant-israel-attack-war-genocide/675602/. The IDF have sought drones to help prevent surprise attacks and to minimise the loss of life, for example in response to attempts to intimidate and attack Israel preceding the 1967 six-day war, the 1973 Yom Kippur war, and the Second Lebanon war in 2006. See, e.g.: Guy Laron, *The Six-Day War: The Breaking of the Middle East* (New Haven: Yale University Press, 2018); Michael B. Oren, *Six Days of War: June 1967 and the Making of the Modern Middle East* (Oxford: Oxford University Press, 2002); Simon Dunstan, *The Yom Kippur War: The Arab-Israeli War of 1973* (Oxford: Osprey Press, 2007); Insight Team of the London Sunday Times, *The Yom Kippur War* (London: iBooks, 2016); Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services"; Rodman, "Unmanned Aerial Vehicles in the Service of the Israel Air Force"; Rodman, *Sword and Shield of Zion*. All accessed July 9, 2024.

15 See, e.g.: Tamir Eshel, "Israel's Counter-UAV Technologies: Securing the Skies," *European Security and Defence,* June 28, 2023, accessed September 10, 2024, https://euro-sd.com/2023/06/articles/31808/israels-counter-uav-technologies-securing-the-skies/; Seth J. Frantzman "Israel Is Slowly Become a Drone Superpower," *National Interest*, July 20, 2020, accessed September 10, 2024, https://nationalinterest.org/blog/buzz/israel-slowly-become-drone-superpower-165149 ; Arthur Holland Michel, "Counter-Drone Systems," 2nd Edition, Center for the Study of the Drone at Bard College, 2019, accessed September 10, 2024, https://dronecenter.bard.edu/files/2019/12/CSD-CUAS-2nd-Edition-Web.pdf

16 See, e.g.: Julia Frankel, "Israeli video compilation shows the savagery and ease of Hamas' attack," *Associated Press*, October 17, 2023, accessed July 9, 2024, https://apnews.com/article/israel-palestinians-hamas-attack-military-war-a8f63b07641212f0de61861844e5e71e .

17 As we will see, drones were part of the initial and ongoing assault; they were also used to strike key Israeli border defences and provide intelligence before and during the assault, as well as propaganda, including as part of "information operations".

18 Antebi and Yanko-Avikasis, "Life and Death in the Hands of the Drone: The Small, Cheap Devices Early in the Swords of Iron War"; Seth J. Frantzman, "In the war against Hamas, Israeli drones are

key. Here is why," *Long War Journal*, October 20, 2023, accessed July 9, 2024, https://www.fdd.org/analysis/2023/10/20/in-the-war-against-hamas-israeli-drones-are-key-here-is-why/ .

19 See, e.g.: Vikram Mittal, "The Challenges Of Counter-Drone Technology As Seen In Recent Conflicts," *Forbes*, October 18, 2023, https://www.forbes.com/sites/vikrammittal/2023/10/18/the-challenges-of-counter-drone-technology-as-seen-in-recent-conflicts/ ; Seth J. Frantzman, "Lasers, integration and mobility: Israel races to stop growing threat from drones," *Defense one*, May 24, 2021, https://www.defensenews.com/unmanned/2021/05/24/lasers-integration-and-mobility-israel-races-to-stop-growing-threat-from-drones/ . All accessed July 9, 2024.

20 Regarding innovation and adaptation – concepts that are often intertwined - Williamson Murray helpfully distinguishes them regarding the context in which they respectively occur. Adaptation occurs during conflict when "there is little time, but there is feedback of combat results, which can suggest necessary adaptations", whereas innovation occurs outside of conflict. Neat distinctions between conflict and non-conflict periods can be problematic regarding terrorist groups that are ostensibly involved in ongoing terrorist campaigns over many months or years (as in the case of Hamas), notably prior to the 7 October attack Hamas had agreed and were observing a ceasefire with IDF. Therefore, the period prior to Hamas-led forces' attack on 7 October can reasonably be claimed as a period of innovation rather than adaptation. A different approach is taken by Horowitz and Farrell, both of whom see innovation as a major change in the conduct of warfare, whereas adaptation involves lesser change to tactics, techniques, or existing technologies to improve "operational" performance. Nina Kollars helpfully draws attention to the importance of adaptation (during conflict) and the "less fanfare" and attention it has received. Notably, Brown et al., observe the lack of attention in the scholarly literature to "the role of institutional actors in enabling or enhancing adaptation at the lowest level." This article may help spur further attention to this dimension. See: Kyle Brown, Jonathan Askonas, and T.S. Allen, "How the Army Out-Innovated The Islamic State's Drones," *War on the Rocks*, December 21, 2020, https://warontherocks.com/2020/12/how-the-army-out-innovated-the-islamic-states-drones/; Nina Kollars, "Organising Adaptation in War," *Survival* 57 no. 6, 111–26. doi:10.1080/00396338.2015.1116158; Williamson Murray, *Military Adaptation in War: With Fear of Change* (Cambridge: Cambridge University Press, 2011), 2; Michael C. Horowitz, *Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010), 22; Theo Farrell, "Improving in War: Military Adaptation and the British in Helmand Province, Afghanistan, 2006–2009," *Journal of Strategic Studies,* 33, no. 4 (August 2010), 569.

21 While innovation and novelty are closely linked, novelty can also mean something that has not occurred before and does so here. This distinguishes it from innovation, a term that is used here without implying something that has not occurred previously (although it may not have occurred in the same circumstances or resulted from the efforts of the same organisation/entity).

22 Yasmine Salam, "Hamas group explained: Here's what to know about the group behind the deadly attack in Israel," *NBC*, 10 October 2023, accessed July 9, 2024, https://www.nbcnews.com/news/investigations/hamas-know-group-deadliest-attack-israel-decades-rcna119628 .

23 Don Rassler, "Remotely Piloted Innovation Terrorism, Drones and Supportive Technology," *Combating Terrorism Center Sentinel at West Point United States Military Academy,* 2016, https://ctc.westpoint.edu/remotely-piloted-innovation-terrorism-drones-and-supportive-technology/ ; Andrew Hanna, "Iran's Drone Transfers to Proxies," *United States Institute of Peace, Iran Primer,* June 30, 2021, https://iranprimer.usip.org/blog/2021/jun/30/iran's-drone-transfers-proxies ; Dion Nissenbaum , Sune Engel Rasmussen and Benoit Faucon, "With Iranian Help, Hamas Builds 'Made in Gaza' Rockets and Drones to Target Israel," *Wall Street Journal*, May 20, 2021, https://www.wsj.com/articles/with-iranian-help-hamas-builds-made-in-gaza-rockets-and-drones-to-target-israel-11621535346 . All accessed July 9, 2024.

24 Regarding Iranian proxy forces and their relationship with these groups, see, e.g.: Ashley Lane, "Iran's Islamist Proxies in the Middle East," *Wilson Center*, September 12, 2023, https://www.wilsoncenter.org/article/irans-islamist-proxies ; Neil MacFarquhar, "The Proxy Forces Iran Has Assembled Across the Middle East," *New York Times*, October 27, 2023, https://www.nytimes.com/2023/10/27/world/middleeast/iran-proxy-militias.html ; Nakissa Jahanbani, "Reviewing Iran's Proxies by Region: A Look Toward the Middle East, South Asia, and Africa," *CTC Sentinel* 13, no. 5 (May 2020), 39-49, https://ctc.westpoint.edu/reviewing-irans-proxies-by-region-a-look-toward-the-middle-east-south-asia-and-africa/ ; Shahram Akbarzadeh, William Gourlay and Anoushiravan Ehteshami Iranian proxies in the Syrian conflict: Tehran's 'forward-defence' in action, *Journal of Strategic Studies* 46, no. 3, 683-706, DOI: 10.1080/01402390.2021.2023014 ; Stephen Johnson, "Iran Is Working Hard to Revive Anti-U.S. Operations in Latin America," *Foreign Policy*, June 1, 2020, https://foreignpolicy.com/2020/06/01/iran-venezuela-alliances-latin-america/ . All accessed July 9, 2024.

25 Daniel Byman, Riley McCabe, Alexander Palmer, Catrina Doxsee, Mackenzie Holtz, and Delaney Duff, "Hamas's October 7 Attack: Visualizing the Data," *Center for Strategic and International Studies*, December 19, 2023, accessed July 9, 2024, https://www.csis.org/analysis/hamass-october-7-attack-visualizing-data .

26 See, e.g.: Daniel Byman, *A High Price: The Triumphs and Failures of Israeli Counterterrorism* (Oxford: Oxford University Press, 2011); Boaz Ganor, *Israel's Counterterrorism Strategy: Origins to the Present* (New York: Columbia University Press, 2021).

27 Regarding Israel's drone capacities, see, e.g.: Michael J. Boyle, *The Drone Age: How Drone Technology Will Change War and Peace* (Oxford: Oxford University Press, 2020), 47-49, 63-68, 94,140,151-155, 162, 191-193, 237-266; Uri Sadot and Ulrike Franke, "Proliferated Drones: A Perspective on Israel," *Center for a New American Security*, May 12, 2016, https://drones.cnas.org/reports/a-perspective-on-israel/ ; Seth J. Frantzman "Why Israel Waited until Now to Reveal Armed Drones," The Jerusalem Post, July 21, 2022, https://www.jpost.com/israel-news/article-712757 **;** Kerry Chávez and Ori Swed, "A Case Study On Integrating Tactical Drones: Israel," *Modern War Institute at West Point*, June 28, 2024, https://mwi.westpoint.edu/a-case-study-on-integrating-tactical-drones-israel/ . All accessed September 19, 2024.

28 See: JTA, "Hamas' attack on Israel was the deadliest day for Jews since the Holocaust," *Jewish Telegraphic Agency*, October 8, 2023, https://www.jta.org/2023/10/08/israel/was-hamas-attack-the-bloodiest-day-for-jews-since-the-holocaust ; Aaron Boxerman, "What We Know About the Death Toll in Israel From the Hamas-Led Attacks," *New York Times*, November 12, 2023, https://www.nytimes.com/2023/11/12/world/middleeast/israel-death-toll-hamas-attack.html . All accessed July 9, 2024.

29 Notably, drone and counter-drone capabilities have developed unevenly, including as part of the "hider-finder" dynamic, see: Antonio Calcara, Andrea Gilli, Mauro Gilli, Raffaele Marchetti, Ivan Zaccagnini, "Why Drones Have Not Revolutionized War," *International Security* 46, no. 4, 130-71, DOI:10.1080/01402390500137259. Smaller drones (which Calcara et al. do not consider in detail) have further complicated this dynamic; see, e.g.: André Haider, "Countering Unmanned Aircraft Systems," in *De Gruyter Handbook of Drone Warfare*, ed. James Patton Rogers (Boston/Berlin: De Gruyter, 2024), 399-417. Although drone and counter-drone capabilities involve different endeavours and technologies, notably leading drone states are also often leaders in counter-drone technologies, e.g., the United States and Israel, see, e.g., Boyle, *The Drone Age.*

30 Leo Blanken, Ian Rice, and Craig Whiteside, "Al-Aqsa Storm Heralds the Rise of Non-state Special Operations," *War on the Rocks*, November 2, 2023, accessed July 9, 2024, https://warontherocks.com/2023/11/al-aqsa-storm-heralds-the-rise-of-non-state-special-operations/ . Regarding the US Department of Defense official definition and conceptualisation of US Multi-Domain Operations and combined arms as referred to by Blanken et al., see: Andrew Feickert, "Defense Primer/ Army Multi-Domain Operations (MDO)," *Congressional Research Service*, IF11409, January 2, 2024, https://crsreports.congress.gov/product/pdf/IF/IF11409; US Department of Defense, "DoD Dictionary of Military and Associated Terms," Joint Publication 1-02. Washington, D.C.: U.S. Department of Defense (DoD), January 2024, https://www.hsdl.org › c › view?docid=886178; US Department of Defense, "Joint Security Operations in Theatre," Joint Publication 3-10. Washington, D.C.: U.S. Department of Defense (DoD), 25 July 2019, Validated on 6 August 2021, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_10.pdf?ver=tWS6OVNLUUD2EOPwDE4pAw%3d%3d ; US Department of Defense, "Joint Forcible Entry Operations," Joint Publication 3-18. Washington, D.C.: U.S. Department of Defense (DoD), 11 May 2017 Incorporating Change 1 09 January 2018, Validated on 09 July 2021, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_18ch1.pdf?ver=A9WjEOdmKtKqabuKPDGu_g%3d%3d ; US Department of Defense, "Joint Land Operations," Joint Publication 3-31. Washington, D.C.: U.S. Department of Defense (DoD), 03 October 2019 Incorporating Change 2 31 March 2023, https://csl.armywarcollege.edu/content/docs/jp3_31ch2.pdf . All accessed September 20, 2024.

31 This because Leo Blanken et al's conceptualisation of "special operations" pertains to those that are "in general… small unit actions that generate effects that directly support campaign outcomes and are often associated with bespoke training, equipment, and tactics that allow small units to achieve outsized results." However, combined arms are not necessarily or even typically limited to "special operations". Notably, what constitutes "outsized results" is also open to broad interpretation. Furthermore, "outsize results" may not be what some special operations forces are intended or used for, such as discrete intelligence-gathering, liaison, training and advising, and where overall results that they importantly contribute to are difficult to clearly assess and quantify. Therefore, this conceptualisation of "special operations" may not be the most apt. See: Blanken et al. "Al-Aqsa Storm Heralds the Rise of Non-state Special Operations."

32 Craig Whiteside and Vera Mironova have observed ISIS' use of drones in 2017, and drawn attention to the importance of this, however, they do not note combined arms use with drones by ISIS. Craig Whiteside and Vera Mironova, "Adaptation and Innovation with an Urban Twist," *Military Review*, November-December 2017, 79-85.

33 Austin C. Doctor and James I. Walsh, "The Coercive Logic of Militant Drone Use," *Parameters*, 51, no. 2 (Summer 2021), 73-84, 81, doi:10.55540/0031-1723.3069. A similar argument is made by them in: Austin C. Doctor and James I. Walsh, "The Militant Drone Playbook," *War on the Rocks,* August

12, 2021, https://warontherocks.com/2021/08/the-militant-drone-playbook/ ; Robert A. Pape, *Bombing to Win: Air Power and Coercion in War* (Ithaca, NY: Cornell University Press, 1997). All accessed September 20, 2024.

34 Thomas Maurer, "ISIS's Warfare Functions: A Systematized Review of a Proto-state's Conventional Conduct of Combat Operations," *Small Wars & Insurgencies* 29, no. 2, 20 March 2018, 229-244, 229, DOI: 10.1080/09592318.2018.1435238 .

35 Specific details of what combined arms entail are discussed in detail later in this article. It may be helpful to note that here it is employed congruent with the following conceptualisation offered in this article: "'combined arms' is the use of various combat arms and weapons in concert to maximise overall efficacy and mitigate individual weaknesses. It usually requires that the actions an enemy would take to defend against one element of combined arms use would result in vulnerability to another, and typically both direct and indirect fires are employed combined with considerable force manoeuvre. In addition to concern about its strategic implications, recently, the concept of combined arms has seen an emphasis on information operations, including propaganda, and even AI."

36 Unlike drones, loitering munitions are designed to be non-reusable and non-recoverable munitions.. See also, e.g.: Page, "Loitering Munitions and Drones: The Urgent Need for Clarity;" Brennan Deveraux, "Loitering Munitions in Ukraine and Beyond," *War on The Rocks*, Commentary, April 22, 2022, https://warontherocks.com/2022/04/loitering-munitions-in-ukraine-and-beyond/ ; Ingvild Bode and Tom F.A. Watts, "Loitering munitions: legal rules for autonomy in weapon systems," *ICRC Humanitarian Law & Policy* Blog, June 29, 2023, https://blogs.icrc.org/law-and-policy/2023/06/29/loitering-munitions-legally-binding-rules-autonomy-weapon-systems/ . This is more specific than many extant conceptualisations of drones and loitering munitions, the advantage of which is that it is more precise and acknowledges the different physical attributes and resultant political implications of drones, loitering munitions, ballistic missiles and other technologies, as well as their relatedness. All accessed July 9, 2024.

37 This is the focus of, for instance, the long running "drone debate". Drones that fit in this widely used categorisation include the US Predator and Reaper and the Turkish Bayraktar TB-2. Regarding drone classification, for a simple, helpful, and widely applied example based on NATO standards see: Dan Gettinger, "The Drone Databook," *Bard Center for the Study of the Drone*, October 2019, iv-v, accessed July 9, 2024, https://dronecenter.bard.edu/files/2019/10/CSD-Drone-Databook-Web.pdf . Also see more broadly, e.g.: Roland E. Weibel, "Safety Considerations for Operation of Different Classes of Unmanned Aerial Vehicles in the National Airspace System," (master's thesis, Massachusetts Institute of Technology, 2002), https://dspace.mit.edu/bitstream/handle/1721.1/30364/61751476-MIT.pdf?sequence=2 . regarding the "drone deate" see, e.g.: Avery Plaw, Matthew S. Fricker and Carlos R. Colon, *The Drone Debate: A Primer on the U.S. Use of Unmanned Aircraft Outside Conventional Battlefields*, Lanham, MD: Rowman & Littlefield.

38 Regarding the importance of the use of small drones and loitering munitions recently in Ukraine see, e.g.: James M. Page, "Drones in Ukraine: Claims, Concerns and Implications," *Royal United Services Institute (RUSI) Newsbrief,* June 10, 2022, accessed July 9, 2024, https://rusi.org/explore-our-research/publications/rusi-newsbrief/drones-ukraine-claims-concerns-and-implications ; Dominika Kunertova, "The war in Ukraine shows the game-changing effect of drones depends on the game," *Bulletin of the Atomic Scientists* 79, no. 2, 95-102, DOI: 10.1080/00963402.2023.2178180 ; Dominika Kunertova, "Drones have boots: Learning from Russia's war in Ukraine," *Contemporary Security Policy* 44, no. 4, 576-591, DOI:10.1080/13523260.2023.2262792.

39 Brown et al., "How the Army Out-Innovated The Islamic State's Drones," offer a particularly well-informed and insightful article regarding the threat posed by non-state actor drone use (particularly smaller than MALE drones) against state actors and what has been done, especially by the US, to counter them since c. 2011. Several other authors have offered informative assessments of the terrorist threat posed by drones from non-state actors, including designated terrorist groups. However, Hamas' attack, of which drones were an integral part, was unprecedented in scale, scope and high-profile political effect. Arguably, it also calls for a rethink, at least by Israel if not others, of their counter-drone and counter-loitering munition endeavours. Regarding the non-state actor drone threat, see, e.g.: Kerry Chávez and Ori Swed, "Off the Shelf: The Violent Nonstate Actor Drone Threat," *Air & Space Power Journal,* Fall 2020, 29-43; Ryan Jokl Ball, The Proliferation of Unmanned Aerial Vehicles: Terrorist Use, Capability, and Strategic Implications," *Lawrence Livermore National Laboratory*, LLNL-TR-740336, October 17, 2017; Robert, J. Bunker, *Terrorist and Insurgent Unmanned Aerial Vehicles: Use, Potentials, and Military Implications* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2015); Dennis Gormley, "Unmanned Air Vehicles as Terrorist Weapons: Real or Imagined?" *Nuclear Threat Initiative,* June 30, 2005. All accessed September 20, 2024.

40 Regarding the US use of drones for counter-terrorism, helpful overviews regarding US targeted killing campaigns are provided by: Avery Plaw, Matthew S. Fricker and Carlos R. Colon, *The Drone Debate: A Primer on the U.S. Use of Unmanned Aircraft Outside Conventional Battlefields* (New York: Rowman & Littlefield, 2016). 27-50; Boyle, *The Drone Age*, 55-97. Regarding the US's continued use

and even reliance on drones, for example, after its withdrawal from Afghanistan in the summer of 2021, see: James M. Page, "Zawahiri's Assassination Proves the War in Afghanistan Is Far From Over," *The National Interest,* September 11, 2022, accessed July 9, 2024, https://nationalinterest.org/print/feature/zawahiri's-assassination-proves-war-afghanistan-far-over-204691 .

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203 See: Vikram Mittal, "The Challenges Of Counter-Drone Technology As Seen In Recent Conflicts," *Forbes,* October 18, 2023, accessed September 20, 2024 , https://www.forbes.com/sites/vikrammittal/2023/10/18/the-challenges-of-counter-drone-technology-as-seen-in-recent-conflicts/ . Notably, in an important scholarly article Calcara et al., cast doubt on drones' ability to evade air defences, however, their focus was on MALE or medium altitude, long endurance drones; these are much larger than many of the small drones used by Hamas in the October 7 attack. See: Calcara et al., "Will the Drone Always Get through?"

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About

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