Assembling Israeli drone warfare: Loitering surveillance and operational sustainability

Stefan Borg
Stockholm University, Sweden

Abstract
This article examines how unmanned aerial vehicles (UAVs), or drones as they are more popularly known, have changed practices of Israeli warfare. In order to do so, the article proceeds in three steps. First, it traces the emergence and development of the Israeli UAV programme. Second, it examines the main factors that have enabled its expansion. Third, it turns to some of the main implications of UAVs for the way in which the Israeli Defence Force (IDF) wages war. The article argues that the combined tactical use of UAVs employed for intelligence, surveillance and reconnaissance (ISR) tasks has amounted to a strategic effect: by dramatically enhancing the field of perception, UAVs have enabled the IDF to better control the battle rhythm. UAVs in the Israeli context have enhanced the IDF’s operational sustainability, since one’s own casualties have been virtually eliminated and civilian casualties have been stretched out over, rather than concentrated in, time. Throughout the article, the changing character of the UAV is emphasized. To capture this change and to unravel the interactions among technology, warfare and broader societal forces, the article draws on actor-network theory.

Keywords
Actor-network theory, IDF, intelligence, ISR, unmanned aerial vehicles (UAVs), warfare

Introduction
The emergence of unmanned aerial vehicles (UAVs), or drones as they are more popularly known, is one of the most widely discussed developments in contemporary military affairs. To their advocates, UAVs promise precision in targeting, thus allowing wars to be waged with virtually no risks to the lives of one’s own forces and with far fewer civilian casualties than hitherto seen in the history of warfare (e.g. Byman, 2013; Etzioni, 2013). To their critics, UAVs dissolve the Clausewitzian understanding of war as a struggle between wills into pure killing (Chamayou, 2015), where the condition of possibility for ethics in warfare – mutual physical vulnerability – is rendered inoperable (Williams, 2015; Zehfuss, 2018: 81–87). While the use of armed UAVs dates back to the US
In 2001, armed UAVs have been in use for military purposes for some 50 years. However, their use has proliferated in recent years (Boyle, 2015; Franke, 2015). In 2000, 17 countries’ armed forces were in possession of UAVs. By 2016, that number had increased to 90 countries, causing one academic to remark that virtually all armed forces in the world will use UAVs in the not too distant future (Franke, 2018: 341).

There is an extensive body of literature on the employment of armed UAVs, often referred to as unmanned combat aerial vehicles (UCAVs). This literature primarily examines the strategic, technological and legal, as well as ethical aspects of the US UCAV programme and its deployment in the war on terror, often focusing on targeted killings (e.g. Chamayou, 2015; Franke, 2013; Grayson, 2016; Gregory, 2015; Hazelton, 2017; Kreuzer, 2017; Rogers and Hill, 2014; Shaw, 2017; Wilcox, 2017). This article shifts the focus to the Israeli UAV programme. Israel is the first and, arguably, along with the US, still the most tactically advanced user of military UAVs. While military UAVs have even been referred to as ‘an Israeli innovation’ (Sanders, 2002/3: 114), there is little scholarly literature on the Israeli UAV programme.1 The main reason for turning to the Israeli UAV programme is to shed some light on the difference that UAVs make to the conduct of warfare – an academic debate that has so far focused on the effectiveness of targeted killing. In doing so, this article will ultimately go against a fair amount of the existing scholarship that tends to be dismissive of the wider significance of unarmed UAVs. I will instead argue that unarmed UAVs may, as the Israeli experience shows, play a crucial role in how warfare is conducted.

To that effect, this article examines the changing roles played by UAVs in the Israeli Defence Forces (IDF) and the difference that the emergence of UAVs has made to practices of Israeli warfare. The vast majority of UAVs in the IDF are unarmed with the primary function of providing intelligence by means of conducting so-called loitering surveillance. In news media the use of armed strikes has received the most attention, but this is arguably not indicative of the broader significance of UAVs (Tabrizi and Bronk, 2018: 11, 12). The broader importance of the UAV, the Israeli experience shows, is not its use as an armed platform but rather as a provider of intelligence, surveillance, target acquisition and reconnaissance (ISTAR), to assist the targeting process. This article will argue that the combined tactical uses of UAVs for loitering surveillance amount to a strategic effect: by radically enhancing the field of perception, UAVs enable the IDF to conduct slower and less concentrated violent warfare. This, however, is not to say that such warfare is necessarily more humane. In fact, as established by Human Rights Watch (HRW) and other observers, the human costs are still high (e.g. HRW, 2009). Rather, UAVs are, in the final analysis, best understood as socio-technical systems that enable operational sustainability over a long period of time, precisely since both one’s own and civilian casualties may be kept limited and stretched out over, rather than concentrated in, time.

The contribution that this article makes is empirical. However, in order to examine the broader effects of UAVs on the conduct of Israeli warfare, the article draws on actor-network theory, a toolkit of concepts that attune us to, rather than a priori determine, the complexities of the relation between technology and human agency. Actor-network theory, as put to use in this article, is an empirical approach to research that focuses on the interaction between technology and human agency. Instead of examining causal links, actor-network theory alerts us to the effects of a set of enabling technologies and other practices on a wide variety of different scales on the conduct of warfare. To appreciate the significance of UAVs, I suggest, UAVs need to be unpacked, or, in actor-network theory parlance reassembled. That entails a shift away from an exclusive focus either on the platform; i.e. the technology of the aircraft and sensors, or on the tactics deployed, and to instead conceptualize UAVs as part of an actor-network. In this article, the UAV is thus approached as an unstable outcome of an ever-changing set of socio-technical relations instead of as a fixed object. By approaching UAVs in such a way, the article shows how the UAV actor-network ultimately both enabled and was enabled by the kind of asymmetric war that IDF came to wage first on Hezbollah.
in Lebanon and then Hamas on the Gaza Strip. In other words, actor-network theory helps us to appreciate the broader importance of UAVs for the conduct of Israeli warfare, by ‘following the actor’, namely the emergence and development of the ever-changing UAV (Latour, 2005: 32).

The first section situates the article’s research question in relation to the existing literature on UAVs and introduces actor-network theory as the conceptual framework. The second section examines the historical development of the UAV actor-network in the IDF. The third section accounts for the difference that the UAV actor-network has made to the conduct of military operations. The conclusion, finally, briefly summarizes the main argument of the article.

**War studies, technology and the study of UAVs**

The role of technology in warfare has been the subject of several wide-ranging studies. In one of the most classic treatments of the topic, Martin van Creveld argues that the impact of technology on warfare will ultimately not depend on which side possesses the most advanced technology but the one who most skilfully masters it – since war is, in van Creveld’s Clausewitzian understanding, by definition a battle between two wills (Creveld, 1991). In a more recent study, Jeremy Black reaches a similar conclusion: weaponry, in and of itself, means little for how it is put to use in warfare; ‘it is not the technology itself but the response to it that drives change’, he argues (Black, 2013: 53). However, despite the subtle albeit ultimately human-centred understanding of war and technology of such scholars, Antoine Bousquet has recently pointed out that much of the broader war studies literature is plagued by three major shortcomings as to how technology is usually treated (2017). First, scholarship on war tends to overemphasize weaponry at the expense of other technologies and chains of logistics, as well as particular sets of social relations that enable warfare. Second, a particular form of technological determinism has always had a strong presence in the study of war, ‘too often, technologies are treated as *dei ex machina* that seemingly appear from nowhere and induce major transformations in the conditions of war’ (Bousquet, 2017: 8). Third, there is in the war studies literature a tendency to focus on the latest and most advanced set of technologies, neglecting less spectacular but potentially just as important older ones.

The shortcomings that Bousquet has identified have in various ways been addressed by a small but growing group of scholars working at the intersection of war and security studies. This scholarship seeks to rethink the relation between materiality and human consciousness, where matter is ‘given its due’ but without lapsing into material or technological determinism (e.g. Bourne, 2012; Bousquet, 2018; Bousquet et al., 2017; Grove, 2016, 2019; Shah, 2017). Jairus Grove (2016), for instance, seeks to understand the improvised explosive device (IED) by placing the object itself at the centre of the analysis, rather than examining how meaning is ascribed to it, as a social constructivist analysis of IEDs would typically do. The ecological approach that Grove takes assumes that ‘the object cannot be disassociated from its ecosystem because each had to be virtually implied in the other for the actual object to emerge’ and the power of IEDs, then, lies precisely in their ability ‘to wait, to listen, to become part of the road or city’ (2016: 343–344; and see Grove, 2019). In general, weaponry, instead of being understood as passive objects, are in this scholarship understood as ‘technical beings in perpetual formation, transmuting in tandem with their ambient milieux’ (Bousquet et al., 2017: 2). This article takes a similar approach to the study of UAVs, but, as will shortly be explicated, with the aid of some commitments from actor-network theory.

**UAVs and the study of warfare**

While there is a fair amount of work on the legal and ethical issues involved in the use of UAVs, the extant security and war studies literature on UAVs has tended to focus on the causes and
consequences of their rapid proliferation as well as on issues of effectiveness. When it comes to proliferation, several scholars have stressed the ease with which UAVs are produced and diffused since they rely on readily available technology (Down, 2013; Kreps and Zenko, 2014). In contrast, however, Andrea Gilli and Mauro Gilli (2016) have argued that fears over the future spread of advanced and game-changing UAV technology may be somewhat exaggerated, noting that even countries such as the UK and the US have struggled to develop appropriate C4 infrastructure for the effective use of UAVs. The other main strand of scholarship on UAVs may be understood to focus on questions of military effectiveness. More specifically, this literature has examined the effectiveness of targeted killing (e.g. Kaag and Kreps, 2014: 52; Kreuzer, 2017: 61–68). One camp in this debate sees some merit to UAV strikes in terms of tactical utility (e.g. Byman, 2013; Johnston and Sarbahi, 2016). The other camp, however, emphasizes the risk of ‘blowback’ and the role of drone strikes in creating fertile soil for violent insurgents (e.g. Benjamin, 2013; Boyle, 2013). In one of the empirically most compelling studies on the matter, a research team interviewed a large number of civilians and experts in Pakistan and found that not only do drone strikes kill civilians in higher numbers than is usually acknowledged by the US government, ‘evidence suggests that US strikes have facilitated recruitment to violent non-state armed groups, and motivated further violent attacks’ (International Human Rights And Conflict Resolution Clinic, 2012: viii).

Both the proliferation and the effectiveness literature focus either explicitly or implicitly on the difference that armed UAVs make to the conduct of warfare. Michael Kreuzer’s monograph is in many ways symptomatic of the trend to neglect smaller, unarmed, UAVs. Unarmed and smaller UAVs, Kreuzer claims, are ‘unlikely to revolutionize the battlefield by significantly altering military systems’ (2016: 37). In a similar vein, John Kaag and Sarah Kreps, in their wide-ranging book on drone warfare, limit their scope to armed UAVs used for targeted killings, and entirely omit UAVs used for ISTAR (2014: 10). Moreover, the debate on the effectiveness of UAVs, has yet to move beyond attempts to assess the impact of targeted killings. Likewise, previous work drawing on actor-network theory in relation to UAVs has almost exclusively focused on targeted killing and the impact that technology has had on this controversial practice. Anna Leander has argued that the drone itself has wielded a certain amount of agency in the constitution of legal expertise pertaining to UAVs (Leander, 2013). However, such agency has somewhat surprisingly tended to challenge rather than normalize the practice of targeted killing. Moreover, William Walters has noted the emphasis that Human Rights Watch afforded to UAV technology and forensic evidence, rather than human witnesses, in the IDF’s military operations in the Gaza Strip in 2008–2009 and has examined how ‘political controversy is mediated, shaped and channeled by the affordance of things’ (Walters, 2014: 103).

In this article, I examine the importance of UAVs for the conduct of warfare, which is the focus of the more conventional literature in security and war studies. However, I seek to go beyond its narrow focus on targeted killing. The more conventional literature on UAVs clearly seeks to extract UAVs from the wider social forces that enable or disable their use in particular contexts. To examine the ways in which UAVs change warfare, however, my contention is that a different approach is needed – one which is simultaneously historical, technological and holistic, where the UAV is inserted into an assemblage of technology, tactics and wider societal forces. For this purpose, I turn to actor-network theory.

**Actor-network theory**

Actor-network theory is a particular approach within the broader field of science and technology studies, which has recently enjoyed a renaissance in the social sciences in general and international relations and security studies in particular. In security studies, actor-network theory emerged as a
reaction to social constructivist and poststructuralist scholarship that tended to neglect technology and material factors more broadly and solely focus on the discursive constructions of meaning. Studies inspired by actor-network theory are highly diverse in focus and execution. However, at the heart of actor-network theory lies a preoccupation with highlighting and understanding agency in non-human-centric terms, where often conjoined forms of human and non-human agency intermingle in contingent and unpredictable ways (Karatzogianni and Schandorf, 2018). At its most basic, then, taking an approach to the study of war and security informed by actor-network theory emphasizes how ‘matter matters’ in various ways (Walters, 2014).

Actor-network theory is primarily an empirically grounded approach to research. In fact, its analytical vocabulary has been developed precisely in order to impose as few *a priori* theoretical commitments on its objects of inquiry as possible. Actor-network theory, as Bruno Latour puts it, ‘says nothing about the shape of what is being described with it’ where ‘[t]he task of defining and ordering the social should be left to the actors themselves’ (2005: 142, 23). Actor-network theory is thus not a theory that can be applied or tested, but has to be translated into a particular field of inquiry. To conduct a comprehensive actor-network theory-based study of Israeli UAVs goes beyond the scope of this article. Instead, a loose conceptual framework based on actor-network theory precepts will be utilized. The purpose of doing so is three-fold. First, it puts the emphasis squarely on the interactions among technology, human agency and wider social forces. Second, such a framework focuses on socio-technical *enabling relations* rather than causality. Third, and most importantly, it puts the ever-changing character of the UAV itself into focus, and examines how the UAV both enables and is enabled by a changing set of technologies intermingled with human practices.

Over the years, actor-network theory scholars have elaborated upon a rather idiosyncratic conceptual vocabulary in order to unravel the co-constitutive relationship between technology and human agency, and to open up a more comprehensive understanding of agency as fundamentally composed of a multitude of actors, known as *compositional agency*. This dispersed conception of agency is captured by the term *actant*, which Latour simply uses to denote ‘anything that modifies a state of affairs and makes a difference in the course of some other agent’s actions’ (de Vries, 2016: 89–90). An actor-network then, in this particular understanding, is understood as ‘a conglomerate of many . . . sets of agencies’ (Latour, 2005: 44), which the researcher sets out to disentangle. It is important to point out that this understanding of network differs from the ways in which the word is usually used. Network as actor-network theory understands it then, ‘is a tool to help describe something, not what is being described’ (2005: 131). In addition to the notion of actant, three analytical concepts that aid in mapping the emergence and expansion of an Israeli UAV actor-network will be employed in the empirical sections below: associations, translation and enrolment. *Associations* are connections made between human and non-human entities of various kinds. *Translation* is understood as ‘all the negotiations, intrigues, calculations, acts of persuasion and violence’ by which one actor is enabled to speak on behalf of others (Callon and Latour, 1981: 279). *Enrolment*, finally, means ‘the successful placing into designated roles of given entities’ (Michael, 2017: 157). These concepts are employed in the following section to examine the emergence and expansion of the Israeli UAV actor-network. Latour’s famous injunction to ‘follow the actor’ is here understood as a call to identify the builders of the Israeli UAV actor-network, be they human or not, and follow their struggles to enrol others. In other words, in what follows below, the emergence, development and implications of the Israeli UAV actor-network is examined.

Before doing so, however, a note on method is needed. The Israeli UAV programme is surrounded by a relatively high degree of secrecy. The IDF, for instance, neither confirms nor denies that it uses armed UAVs. Since there is little existing material to draw on, the study at hand primarily draws on open-ended, semi-structured interviews with active and retired officers in the IDF.
working with UAVs, including two generals and two colonels; several representatives of one of the most important Israeli manufactures of UAVs, Elbit Systems; and a key expert on the Israeli UAV programme (see Appendix 1 for more details). All of the eight interviews were conducted in Tel Aviv in February 2019 and apart from those with Elie Gamzon, engineer and a key figure in the development of the Israeli UAV programme, and Dr Liran Antebi, expert on the Israeli UAV programme, were conducted on the condition of anonymity in order to elicit frank assessments. To give the reader a better picture of the interviewees, however, they included some of the key figures in the emergence and development of the Israeli UAV programme, at tactical, operational and strategic levels.2 In addition, the study draws on a wide-ranging and scattered body of secondary literature spanning narrow-focus military magazines to more popular accounts of the Israeli Defence Forces, and reports by Human Rights Watch.

The emergence and expansion of the Israeli UAV actor-network

Beginnings

This section traces the interaction between technology, tactics and strategy, and ultimately seeks to account for how Israel has become one of the most advanced users of UAVs. The story, as we shall see, is one of an ever-changing platform that has co-evolved with operational requirements as well as broader societal norms, translated to support the kind of warfare that the UAV was eventually able to enable. An early actant of the Israeli UAV programme may be traced back to another technological innovation: the Soviet SA-2 surface-to-air missile. SA-2 batteries were purchased by Egypt in the mid-1960s, and their presence prevented the Israeli Air Force (IAF) from conducting reconnaissance missions over the Sinai region. Moreover, their presence seemed to invalidate the operational doctrine in the IAF at the time, which centred around the employment of offensive airpower against Egyptian and Syrian airfields in the form of preemptive attacks (Brun, 2011: 155). Following the shoot-down of a few Israeli fighters in 1970, the US agreed to export a number of Teledyne Ryan Lightening Bug UAVs for reconnaissance purposes, as well as a number of cheaper Chukar UAVs to be used as decoys for Egyptian air defence. The first UAV squadron in the IDF was established under the name of Squadron 200 (Interview 2).

Another early actant was the Yom Kippur War in 1973, where the IAF lost some 100 planes and the IDF came close to defeat. The war is often recounted as an Israeli intelligence failure, and led to a high value being placed on intelligence within the IDF (Bar Joseph, 2005). In addition to highlighting the crucial role of intelligence, the suppression of the enemy’s air defences became a ‘national survival issue’ in Israeli military doctrine (Ehrhard, 2000: 211). A few lessons consequential for the future development of UAVs emerged from the war: Soviet-supplied air defence systems were lethal, and UAVs could dramatically bring down human costs in terms of pilot lives (Ehrhard, 2000: 189). Another lesson emerged from the use of the Lightening Bugs themselves. These UAVs took high-quality pictures, and could be pre-programmed to fly at 40,000 feet. However, by the time the pictures taken had been retrieved and developed, two days could have passed – making these of little use for targeting purposes (Interview 2). General Benjamin Peled, commander of the IAF, with a combined background of pilot and engineer, led the process of implementing changes based on lessons from the Yom Kippur War and understood the value of real-time camera feeds, something that the Lightening Bug could not provide (Brun, 2011: 157). As a result of these translations, a new platform was eventually developed to respond to this specific operational requirement: the Mastiff mini-UAV.

The Mastiff is generally believed to be the first operational modern UAV, fully benefitting from the technological innovations of the day, successfully associating the technological state of the art
with the requirements of the IDF. A US-trained engineer, Alvin Ellis, is usually credited for this translation of technology to operational requirement. Ellis’ idea was to employ a radio-controlled model plane as a platform for a camera with real-time transmission capabilities (Lindsey, 1983). In what has been compared to Steve Jobs’ invention of the Apple computer, Ellis built the first prototype in his garage (Sanders, 2002/03: 115). The state-owned Israeli Aerospace Industries (IAI) turned him down, and instead a private electronics company called Tadiran provided the basic necessary resources to build a second prototype that flew in 1973. In another five years, the Mastiff became operational in the IDF. Roughly at the same time, IAI pursued its own model, the more advanced Scout (*Zahavan*). The Scout was not controlled by hand like the Mastiff. Instead, it flew to pre-programmed points, and was able to return automatically to base if contact with its ground station was lost. US-developed payload, data links and composite airframe technology, all of which became widely available in Israel at that time, enabled the development of the Scout and were of decisive importance for the operational utility of the Scout and Mastiff (Ehrhard, 2000: 212). Soon, the Mastiff and the Scout were fitted with US-developed technology and adapted to the IDF’s needs, which included cameras for day and night vision with stabilizers, the ability to collect electronic intelligence and even to carry laser designators to assist target acquisition (Ehrhard, 2000: 195–196). The Scout and Mastiff came to resemble each other since the IDF had at that time quite specific functional requirements, which had to do with locating primarily surface-to-air missiles, but also tanks and infantry units. Becoming official part of the IDF doctrine in 1980, this technology was key to the enrolment of UA Vs (Interview 2).

In the years leading up to the First Lebanon War in 1982, Syria began placing state-of-the-art SA-6 surface-to-air batteries in the Bekaa Valley. In addition to shooting down an Israeli fighter plane, several Scouts and Mastiffs were shot down. However, many years of sustained UAV intelligence gathering enabled the IDF to devise an elaborate plan of attack (Ehrhard, 2000: 197). The Lebanon War began in June 1982, and for the first time ever in combat situations, UAVs provided real-time intelligence at the tactical level to alert IDF commanders of threats ahead (Ehrhard, 2000: 198). Most spectacular, however, was the role that UAVs played in destroying the Syrian air defence system, later on described as ‘a watershed moment’ for UAVs (Ehrhard, 2000: 198). Prior to the strike, UAVs flew in so close to the batteries that the Syrians turned on their radars. Decoy UAVs then simulated a manned attack and the Syrians depleted their missiles on these. Shortly thereafter, manned aircraft eliminated virtually all of the batteries. Even though the role of UAVs in the Bekaa Valley attack was more remarkable, mini UAVs also played an important role in the ground invasion that followed. Not only did they provide ground commanders with accurate over-the-hill intelligence of enemy and own location, they also directed Israeli artillery and performed battle damages assessment tasks (Ehrhard, 2000: 200–201). As Ehrhard put it, ‘[f]or the first time since the early campaigns of Napoleon when a commanding general could survey the length and breadth of the battlefield with his own eyes, the mini-RPVs recaptured the most important information required to exert command and control – the accurate, current location of both enemy and friendly forces’ (Ehrhard, 2000: 201). Finally, UAVs provided real-time surveillance of Syrian airfields, alerting the IAF when Syrian fighters took off (Rodman, 2013: 85). What the significance of the UAV boiled down to, however, was the ‘achievement of true loitering surveillance’ due to real-time camera transmissions capabilities (Ehrhard, 2000: 202). Having examined the emergence of the UAV-network, the next section traces its expansion.

**The expansion of the UAV actor-network**

A perhaps less obvious but arguably decisive event with significant repercussions for the further growth of the Israeli UAV actor-network can be traced back to the mid-1980s. IAI was working on
developing a jet fighter called Lavi (Brun, 2011: 158). The Lavi project took up a huge chunk of the Israeli defence budget. In 1987, despite widespread protests from the Israeli defence industry, the project was cancelled in a 12–11 cabinet vote, in part due to US pressure to purchase F-16 fighter planes instead. Thousands of engineers at IAI lost their jobs, which had the unintended effect of contributing to the Israeli high-tech boom in the 1990s. In addition, spending could be allocated to other defence-related areas. UAVs, it turned out, became key beneficiaries. Such an association was by no means pre-determined, however. In the 1990s, the IAF took a rather sceptical view of unmanned aircraft, since they wanted available funds to be used for manned aircraft (Interview 3). An early proponent of UAVs was Ehud Barak, who served as chief of staff in the early 1990s. Barak became instrumental in getting off the ground the biggest Israeli UAV procurement programme ever, which was formally launched in 1994 and enabled by the availability of resources following the abandonment of the Lavi project. The vision at that time was to develop larger and more advanced UAVs designed for conventional warfare. The trauma of the Yom Kippur War was still present and the perceived major threat was Syrian tanks. The idea was to build a number of UAVs and then to store those, only to be deployed in case of war and then to be manned by reservists. The winner of the tender was, surprisingly to many observers at the time, not IAI but the much smaller, privately owned company Silver Arrow. To fully understand this crucial episode in the expansion of the Israeli UAV actor-network, one needs to go back about a decade in time.

Silver Arrow was established in the mid-1980s and started to develop UAVs on a much smaller scale than IAI. Roughly half of the development team were engineers with a background in the air force and the other half had been building radio-controlled model air planes. The founder of Silver Arrow was a retired air force colonel with a degree in aeronautics and computer engineering, Elie Gamzon. As a former air force colonel, Gamzon could anticipate and to a certain extent also help to shape the IAF’s desires: ‘[w]hen I was in Silver Arrow, my thinking was that of an Air Force Colonel’ (Interview 2). More specifically, Gamzon wanted UAVs to take advantage of the GPS revolution, which would substantially increase the range of UAVs and enable them to fly outside line-of-sight. A second technological innovation of the UAVs that he spearheaded was the use of composite material for airframes, which enabled a much lighter aircraft with room for more fuel and less detectable by radar. Finally, Silver Arrow became the first manufacturer to use microprocessors in their prototypes, thus, in the words of Gamzon ‘riding on the wave of the computer revolution’ (Interview 2). In 1973, there were no computerized systems in the IAF; in the early 1980s, however, almost everything was computerized: aircraft, air defence systems and communication systems.

The UAV that Silver Arrow developed and that eventually won the tender became known as Hermes 450. Hermes 450 is one of the most widely used UAVs in the IDF, and the first to be used jointly by air and land forces. A number of technological innovations enabled its development: improved airframe, flight control, aerodynamics and propulsion. Silver Arrow, later on purchased by Elbit Systems, developed expertise in internal combustion engines. Moreover, they understood that if downlinking of day and night video feeds became possible at the same time, the target could be better analysed (Interview 1). A major debate then followed about whether the UAVs were to be utilized over Southern Lebanon or stockpiled for conventional warfare as originally envisaged. When the IDF left Lebanon in 2000 the debate died down, but it re-emerged in August 2000 when the Second Intifada erupted (Interview 1). Operational requirements now shifted dramatically: the Second Intifada involved typical asymmetric warfare fought in urban settings. During this time and particularly during the Second Intifada, a very powerful actor was enrolled on behalf of UAVs: the internal security service, Shin Bet, which gradually came to realize the value of UAVs in tracking down terrorist suspects (Libel and Boulter, 2015: 71).
Throughout the early 2000s, the UAV actor-network continued to grow. An important event in its further expansion was the establishment of a UAV school in 2002, functioning not only as a formal academy but also as ‘an institution with the informal aim of unifying the individual UAV squadrons’ (Libel and Boulter, 2015: 71). The academy quickly became the main centre for refining the operational deployment of UAVs. A UAV squadron commander explained the importance of the academy in hindsight: ‘[t]ake the DNA of the Air Force and the ground force . . . We live inside the Air Force base; so they get the DNA of the Air Force, but let us train them in a school for a period of time, like the ground forces, and [then] take the best from both worlds. After 17 years, this has worked! This was the solution!’ (Interview 5). Moreover, the Ministry of Defence established their own unit, particularly focused on UAV technological development with export markets in mind. Finally, in the late 1990s the chief of staff decided that the systems should provide services for ground forces but be solely operated by the air force, which entailed the IDF intelligence corps handing over operational control of all UAVs to the IAF.

The Second Lebanon War in 2006, a typical asymmetric war between the IDF and Hezbollah, was a decisive actant for the expansion of the UAV actor-network. This was the first war ever where the number of flight hours of unmanned aircraft exceeded those of manned ones (Antebi, 2018: 75). Although the IDF has neither confirmed nor denied it, much evidence suggests that UAVs were extensively used as strike platforms (Libel and Boulter, 2015: 71). Moreover, UAVs provided real-time intelligence as to the location of Hezbollah forces and continuously searched for rocket launching sites in Lebanon to great effect (Antebi, 2017: 84). The sensor-to-shooter loop was around two minutes, so a target could be destroyed two minutes after having been spotted by a UAV. In this war, the IAF recognized that UAVs were the ‘principal instruments of real-time intelligence, surveillance and reconnaissance (ISR) support for both air and ground commanders’ (Lambeth, 2011: 113). Most of the missions, however, were about guiding the movement of ground forces. Testifying to the crucial role of UAVs, not a single contact situation between troops ever occurred without at least one UAV providing real-time operational intelligence (Lambeth, 2011: 114). As a UAV squadron commander put it, without the ISTAR capabilities that UAVs provided ‘we would achieve half of what we did achieve in Lebanon’ (Interview 5). When accounting for the technological developments that enabled the increasingly prominent role of UAVs in Israeli warfare, the endurance of Hermes 450 and Heron are important. But what mattered most for locating time-sensitive targets such as Hezbollah rocket launchers was the role of electronics in closing the sensor-to-shooter loop (Lambeth, 2011: 116).

Following the Second Lebanon War, the IDF has primarily deployed UAVs in operations against Hamas. The IDF left Gaza in 2005, and, as we will see, due to a number of key enrolments the UAV actor-network evolved into a vital element in its continued control over that territory. The purpose of the IDF’s strategy in Gaza was clearly expressed in 2004 by the former head of the IAF: ‘Our vision of air control zeroes in on the notion of control. We’re looking at how you control a city or a territory from the air when it’s no longer legitimate to hold or occupy that territory on the ground’ (Li, 2006: 48). The Gaza Strip has thus become ‘ground zero’ for more recent Israeli UAV development (Katz and Bohbot, 2017: 70). The three most extensive episodes include Operation Cast Lead (OCL) from December 2008 to January 2009, Operation Pillar of Defence in November 2012 and Operation Protective Edge in July and August 2014. The deployment of UAVs in OCL resembled that seen in the Second Lebanon War (Rodman, 2013: 87; Libel and Boulter, 2015: 71). However, unlike the Second Lebanon War, the timing of OCL was carefully chosen and planned by the IDF. Targeting had been ongoing for at least six months in advance. In the first phase, an extensive number of targets were hit (Esposito, 2009: 75). In the second phase, when pre-selected targets had been eliminated, ground forces began to enter Gaza to seize control over a number of areas where rockets were believed to have been fired at Israeli territory, as well as Hamas’ vital infrastructure,
such as tunnels. The IDF refrained from entering densely populated areas due to concerns over heavy loss of life and civilian casualties, which would provoke international as well as domestic criticism. For the first time, infantry commanders were allowed to direct UAVs without having to go through air force command:

At least a dozen UAVs were kept in the air over Gaza at all times in order to detect Palestinian movements and to direct aircraft, tanks, and artillery (including naval artillery) to the targets. Action time was so quick that Israeli intelligence sources reported that F-16 aircraft could identify and fire air-to-ground missiles within 30 seconds of surveillance data being sent. (Esposito, 2009: 176)

Operation Pillar of Defence began with the killing of the head of Hamas’ military wing, Ahmed Jabari. The operation was conducted over the Gaza Strip in November 2012 and resembled OCL. However, no ground forces were used. Like OCL, an extensive target list had been amassed beforehand with the aid of UAVs. When OCL started, some 1,500 targets were hit within eight days (IDF, 2012). UAVs are reported to have been extensively used as attack platforms. As one observer remarked, ‘[t]he type of surgical warfare fought over Gaza could not have been performed without the massive use of unmanned platforms’ (Egozi, 2012). During Operation Protective Edge in July and August 2014, finally, the IDF entered the Gaza Strip and destroyed 32 of Hamas’ tunnels following about a week of air attacks. Once again, UAVs played a crucial role in the targeting process. Thus, in some 50 years, UAVs have gone from a fringe capability viewed with a considerable amount of scepticism, to become, in the words of a former IAF general, ‘a backbone’ of the Air Force (Interview 7).

**Accounting for the evolving UAV actor-network**

How, then, can we ultimately account for the evolution of the UAV actor-network in the IDF? The angle perhaps most commonly stressed in conventional accounts of the development of military technology is that a perceived security threat from neighbouring countries’ militaries provided the most immediate catalyst, in this case for the Israeli UAV programme, and continued to provide impetus throughout several decades (e.g. Weiss, 2018). However, the actor-network theory-inspired account here, which emphasizes enabling conditions rather than causal relations, enables us to tell a more comprehensive story. At the centre of the story stands the ever-changing UAV, which itself underwent several key translations from the Lightening Bug to the Hermes 450 enabled by high definition cameras small enough to be mounted on an airframe, and with data links transmitting a camera feed in real-time. Technological developments clearly played a key part here. More generally, as Michael Kreuzer has argued, the development of UCAVs should primarily be understood in relation to the so-called ‘information revolution’ – with the invention of the microprocessor at its core – along with the ‘precision revolution’ in the military, with the GPS allowing for precision in navigation as well as targeting, which together formed the first phase of what is usually known as a revolution in military affairs (RMA) (Kreuzer, 2017: 27). An important part of the RMA was that it enabled precision targeting. It thus became possible to strike at fixed targets with an extraordinary degree of precision. Mobile targets, however, were a different matter. The UAV then, was enrolled as a response to the problem of how to strike at targets that are not fixed, and one of the major functions of UAVs became target acquisition. Other major enabling technological innovations, or actants, included the decreased size of the onboard image sensor coupled with high-quality data links. Moreover, the endurance necessary for effective loitering surveillance was enabled by lighter airframes in composite material. Several of these developments were in turn enabled by the technological megatrend
known as miniaturization, which entails several inherent benefits such as higher speed, greater density and lower production costs (U.S. Congress, 1991: 4).

At the same time, and beyond technological developments, a lot more actants of various kinds enabled the growth of the Israeli UAV actor-network, and put it on the path it eventually took. First and foremost were the local weather conditions and the fact that Israel is a relatively small territory, where line-of-sight data links were initially sufficient for many purposes (Ehrhard, 2000: 212). Second, and related to territorial borders and Israel’s geostrategic location, following the Yom Kippur War the IDF increasingly came to appreciate the value of intelligence. Intelligence services in the IDF did not become compartmentalized as in many other armed forces (Interview 4). Rather, the intelligence corps enjoyed a strong position within the IDF and early on came to recognize the importance of UAVs. Moreover, the Israeli start-up scene contained many people with a background in the intelligence corps, who understood the needs of the IDF (Interview 2) and were thus able to associate these needs with the UAV.

The development cycle has also been of crucial significance in the changing character of the UAV. In particular, in the infancy of the UAV, the IDF was willing to enrol systems that were not yet mature, thus closely partaking in and significantly shortening the development cycle, substantially reducing costs. As an Israeli UAV expert puts it: ‘Our battle fields are very close to home. You can bring something from the battlefield; fix it, send it back, in less than 24 hours’ (Interview 4). Moreover, since almost everyone working in the industry has had a stint in the military, and often continues as a reservist, the industry can both anticipate and, to some extent, even help to construct the needs of the IDF. As someone working in the global UAV industry who previously worked for a traditional aircraft manufacturer explained, compared to manned fighter planes, where the air force sets the agenda, the UAV world is much more driven by the industry, which makes capabilities available for the military (Interview 8).

Finally, the ever-adapting UAV also developed in relation to tactical adaptations on the part of Hamas. Hamas operatives soon implemented certain changes when they became aware of the Israeli UAVs: ‘They stopped using cell phones. Started working under ground. Cover places where they are working from. They were really aware of this. Kids were trained to sit on hills and listen and give a call if Zannannah [Arabic name for UAV] . . . is gathering information’ (Interview 4). Moreover, Hamas operatives started to put up clothes to cover alleys and streets in the Gaza Strip. As a response, Israeli sensors became increasingly advanced, developing, for instance, the Chariot of Fire sensor that may detect changes in terrain and help to detect underground rocket launchers (Katz and Bohbot, 2017: 69). Thus, the Gaza Strip became a ‘laboratory’ for the development of Israeli UAVs (Saif, 2014: 42). It was also the operations over the Gaza Strip that eventually transformed the main raison d’être of the Israeli UAV-actor-network from one of perceived military threat to what, in the following section, will be identified as operational sustainability – a concept that incorporates technological developments, tactics and societal norms into an overall military logic.

Implications for the battlespace

What, then, are the implications of the UAV actor-network for the battlespace? Or, to put it differently, how has the UAV actor-network ultimately impacted practices of Israeli warfare? When examining this question, it is once again important to emphasize the ever-changing nature of the UAV in relation to its environment. As discussed above, UAVs did play a spectacular role in the First Lebanon War, which in turn precipitated increased US interest in, and steady global dissemination of, UAV technology. However, and much more importantly, from the Second Intifada and onwards, it was gradually realized that UAVs could become vitally enrolled in asymmetric warfare
in urban settings, due to technological innovations that dramatically increased their endurance. Clearly, the lasting impact of the Israeli UAV actor-network has been in asymmetric rather than in conventional warfare. As former programme director for the IDF’s UAV development and procurement programme in the mid-1990s summarized it, ‘UAVs for [asymmetric warfare] are great. [They can be] [u]nheard, unseen. [UAVs are] long endurance systems; [We can use them] day and night. [In asymmetric warfare] the enemy has a low signature. He may pop up for very short time. [UAVs enable us to] quickly identify and target’ (Interview 1). Or, as a former air force general put it, for the purposes of asymmetric warfare, ‘we don’t need speed, but we need endurance. The whole point about design is actually that we need endurance’ (Interview 2). However, endurance may also be very costly, and a further advantage of UAVs was precisely their cost-effectiveness in use (Interview 5).

The key challenge that the UAV actor-network was assembled to respond to and, more effectively than any other weapon system, evolved into, was target generation, i.e. the ability to produce targets, which were usually very short lived, and then either to cue weapon systems that could engage these targets or eliminate them themselves (Interview 1). If the Second Intifada had not occurred, the Israeli UAV actor-network would have looked very different, and the bigger UAV systems would have been stored and kept for conventional warfare. For the conventional battlespace, however, UAVs were not able to make such strong associations. As former programme director for the IDS’s UAV development and procurement programme in the mid-1990s put it, ‘We used to be afraid of Syrian tanks. Someone had to find the convoys. We could detect them not necessarily with UAVs but with other means’ (Interview 1). So, a platform such as Hermes 450 that had originally been designed with Syrian tanks in mind, could fairly easily be enrolled for the purposes of asymmetric warfare, and, as characteristic of the entire Israeli UAV actor-network, this was facilitated by the forging of close associations between user and industry (Interview 2).

As technology became more advanced, it was gradually realized that the UAV actor-network could fundamentally change Israeli ISTAR capabilities and, more specifically, the targeting process. As the former second in command of the IAF put it: ‘no other platform can give you the amount of intelligence as UAVs’ (Interview 7). The IDF claims that UAVs enable precision in targeting and thus a reduction of collateral damage: ‘fighting against terrorism is not just about winning and targeting . . . but also about how you are being perceived from outside, internationally and domestically’ (Interview 4). Thus, a strategic benefit emerged out of the enhanced ISTAR capabilities in the field of tactics. Israel started engaging in asymmetric warfare at the same time as major shifts in domestic and international public opinion on civilian casualties were occurring. Thus, according to the IDF, the true significance of UAVs was not that they were eventually enrolled to deliver kinetic effects, but that the widened field of perception that UAVs offered enabled more precise targeting which would reduce own and civilian casualties (Interview 5). As one interviewee put it, ‘IDF has many different systems with which to deliver kinetic effects. Armed UAVs [offer] no real advantages over ballistic missiles or long-range diving bombs’ (Interview 2). Rather, the ISTAR that UAVs provided, then, was instrumental in allowing the IDF to control the amount of violence applied, a strategic benefit acutely understood. In the words of an industry representative and IDF reservist, ‘[y]ou can go very violent, but don’t need to. It gives our policy guys much more control over things’ (Interview 6). The UAVs were enrolled as key pieces in enabling the IDF to control the battle rhythm and to choose the level of violence applied. In addition, as a former general and second in command of the IAF reflected, the ISTAR that UAVs provide make for a more drawn out application of force: ‘[i]f you use force in the beginning and cause collateral damage, war could be shorter’ (Interview 7).
The strategic significance of the loitering surveillance that UAVs were enrolled to provide, therefore, has to be understood in the context of the changing international as well as domestic pressure that Israel was increasingly subject to in its conduct of warfare. What is usually called ‘casualty sensitivity’, has been an increasingly important consideration in the IDF since the 1990s (Levy, 2011). In the 2000s, Israeli public opinion became increasingly weary of losses of life, a milieu which contributed to the Second Lebanon War being fought mainly as an aerial war (Levy, 2011: 73). This tendency continued into the 2000s. In Operation Pillar of Defence in 2012, the Israeli political leadership was acutely aware that the ‘grace period’ given to Israel by its allies for its operations in the Gaza Strip would be short (Tzabag, 2013). One of the foremost UAV experts in Israel, Liran Antebi put it thus, ‘The main problem with [fighting] terrorism [is that] you are under such a big criticism so that you cannot continue the war effort . . . We had weapons before; but the question is: how can I hit the house without killing all people in the building.’ As an UAV squadron commander working with UAVs since 2001 explains it in blunter and simultaneously revealing terms: before the internet revolution, ‘We could deal with terrorists how we wanted, since no one would look. We could use whatever means against terrorists. We now need to explain ourselves to Russians, our PM, the Americans’ (Interview 5).

UAVs’ most important contribution to the Israeli war effort, then, should ultimately be understood in terms of increasing operational sustainability, i.e. that military operations could continue in anticipation of pressures from various audiences. Of significant and growing importance for domestic audiences, UAVs could be operated with no risks for one’s own soldiers’ lives. The second component of operational sustainability was that it supposedly kept civilian casualties limited. Whether the IDF’s increasing reliance on UAVs has accomplished this, however, is a much more controversial question. During Operation Cast Lead, for instance, Amnesty International was able to document 48 civilian Palestinian deaths from UAV strikes, but believed that the death toll from UAV strikes was substantially higher (HRW, 2009: 3). Nevertheless, regardless of whether the increased use of armed UAVs killed more or fewer civilian Palestinians as compared to other weapon systems, the ISTAR that UAVs provided enabled the IDF to better control the battle rhythm of its Gaza incursions. This observation is also underscored when comparing the carefully planned Operations Pillar of Defence, Cast Lead and Protective Edge to the Second Lebanon War. Whereas targeting planning had proceeded the Gaza operations for months, Libel and Boulter argue that the intensity of the Second Lebanon War seemed to limit the importance of UAVs (Libel and Boulter, 2015: 71). In the final analysis, operational sustainability is ultimately a broader concept than casualty aversion, and emphasizes that military considerations were paramount in the minds of the actors followed in this study.

Conclusion

This article examined the emergence and development of the Israeli UAV programme, conceptually conceived of as an actor-network. Moreover, it highlighted some of the most important implications in terms of what the UAV actor-network has meant for practices of Israeli warfare. Placing the changing UAV as the focus of the analysis, the article examined the interaction between technological innovation, tactical use and broader strategic effects. The main argument in the article is that the combined tactical use of UAVs enrolled for loitering surveillance has come to amount to a strategic effect: by radically enhancing the field of perception, UAVs have enabled the IDF to conduct slower warfare where casualties are stretched out over, rather than concentrated in, time. The most important contribution of the UAV actor-network to the Israeli war effort, then, should be understood in terms of enhanced operational sustainability, since the ISR that UAVs provide have made it possible for the IDF to more effectively control the battle rhythm. Thus, when approaching
the UAV as a key component in an actor-network that has been growing since the 1970s, we are able to appreciate its crucial role in how the IDF came to wage asymmetric warfare.

Acknowledgements
Many thanks to the head of the Air Operations Section, Department of Military Studies at the Swedish Defence University, Lt Col Rickard Lindborg, who very patiently answered all my questions pertaining to unmanned aerial vehicles and fully supported this project from its inception. Heartfelt thanks are also due to Dan Öberg for extensive and very helpful comments on this manuscript. Moreover, for helpful comments, thanks also to Wing Commander Mike Palmer (retd), Magnus Petersson, Mark Bromley, Karina Shyrokykh and all the participants in the International Relations Higher Seminar at Stockholm University, as well as to three anonymous reviewers and the editors of this journal. Needless to say, I am solely responsible for all the interpretations advanced in the papers.

Funding
The author received no financial support for the research, authorship, and/or publication of this article.

ORCID iD
Stefan Borg https://orcid.org/0000-0002-9398-8382

Notes
1. For important exceptions, see Thomas P. Ehrhard’s doctoral dissertation and David Rodman’s chapter on UAVs, as well as, much more critically, Eyal Weizman’s study, which, like much of the literature on the US UAV programme, focuses on targeted killing (Ehrhard, 2000; Rodman, 2013; Weizman, 2017).
2. Moreover, during most of the interviews, one of Sweden’s most experienced UAV operators was present and helped with the more technical questions.
3. ISTAR refers to intelligence, surveillance, target acquisition and reconnaissance. Reconnaissance is usually understood as ‘obtaining information on the positioning, activities and resources of an opponent [and] basically consists entirely of spot observation, and is an integrated part of most activities at the tactical level.’ Surveillance ‘is about tracking activities and little changes to the everyday situation.’ So, both surveillance and reconnaissance are about gathering information, which in turn may be refined into intelligence, understood as ‘an achieved level of knowledge for a purpose’ (Dyndal, 2018: 109). Target acquisition, finally, is about putting specific pieces of intelligence to use for selecting targets.
4. Starting with the invention of the integrated circuit, the so-called Moore’s law postulates that the number of transistors would double every two years.
5. It was also at this point in time that the IDF began conducting targeted killings. For a thorough examination of the role of the UAV in targeted killings, see (Weizman, 2017: chapter 9).
6. However, beyond increasing operational sustainability from the IDF’s perspective, from the point of view of the Gaza population, UAVs quite clearly enabled what Derek Gregory in other contexts has referred to as an ‘everywhere war’ (Gregory, 2011). Regardless of whether used as strike platforms or simply providing targeting data needed for other platforms, the ISTAR that UAVs provided made it possible to turn the Gaza Strip into a continuous low-intensity battlespace. Beyond civilian casualties during the IDF’s military operations on the Gaza Strip, there is also a set of broader negative consequences for the civilian population directly linked to the IDF’s reliance on UAVs (Saif, 2014; Wilson, 2011).
7. Compare Weiss (2018).

References
Antebi L (2017) Unmanned aerial vehicles in asymmetric warfare: Maintaining the advantage of the state actor. In: Dekel U, Siboni G and Einav O (eds) The Quiet Decade: In the Aftermath of the Second Lebanon War, 2006–2016. Tel Aviv: Institute for National Security Studies, 83–94.
Antebi L (2018) Global changes in the proliferation of armed UAVs: Risks, challenges, and opportunities facing Israel. *Cyber, Intelligence, and Security* 2(3): 73–90.

Bar Joseph U (2005) *The Watchman Fell Asleep: The Surprise of Yom Kippur and its Sources*. Albany: State University of New York Press.

Benjamin M (2013) *Drone Warfare: Killing by Remote Control*. New York: Verso.

Black J (2013) *War and Technology*. Bloomington: Indiana University Press.

Bousquet A (2017) A revolution in military affairs? Changing technologies and changing practices of warfare. In: McCarthy DR (ed) *Technology and World Politics: An Introduction*. London: Routledge.

Bousquet A (2018) *The Eye of War: Military Perception from the Telescope to the Drone*. Minneapolis: University of Minnesota Press.

Bousquet A, Grove J and Nisha S (2017) Becoming weapon: An opening call to arms. *Critical Studies on Security* 5(1): 1–8.

Boyle M (2013) The costs and consequences of drone warfare. *International Affairs* 89(1): 1–29.

Boyle M (2015) The race for drones. *Orb-is* 59(1): 76–94.

Bourne M (2012) Guns don’t kill people, cyborgs do: A Latourian provocation for transformative arms control and disarmament. *Global Change, Peace & Security* 24(1): 141–163.

Byman D (2013) Why drones work: The case for Washington’s weapon of choice. *Foreign Affairs* 92(4): 32–43.

Brun I (2011) Israeli air power. In: Olsen JA (ed.) *Global Air Power*. Washington, DC: Potomac Books, 137–172.

Callon M and Latour B (1981) Unscrewing the big leviathan: How actors macro-structure reality and how sociologists help them do so. In: Knorr-Cetina K and Cicourel AV (eds) *Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies*. Boston, MA: Routledge & Kegan Paul.

Chamayou G (2015) *Drone Theory*. London: Penguin Books.

Creveld M (1991) *The Transformation of War*. New York: Free Press.

de Vries G (2016) *Bruno Latour*. Cambridge: Polity Press.

Down AD (2013) Drone wars: Risks and warnings. *Parameters* 42(3): 7–16.

Dyndal GL (2018) Airborne intelligence, surveillance and reconnaissance. In: Olsen JA (ed.) *Routledge Handbook of Air Power*. London: Routledge, 107–117.

Egozi A (2012) Israeli sources hail UAV contribution to Gaza operation. *RP Defense*, 23 November.

Ehrhard TP (2000) Unmanned aerial vehicles in the United States armed services: A comparative study of weapon system innovation. Unpublished doctoral dissertation. Baltimore, MD: Johns Hopkins University.

Esposito M (2009) The Israeli arsenal deployed against Gaza during Operation Cast Lead. *Journal of Palestine Studies* 38(3): 175–191.

Etzioni A (2013) In defense of drones. *The Diplomat*, 24 October.

Franke UE (2013) On ‘Drones and US strategy: Costs and benefits’. *Parameters* 42(4): 119–122.

Franke UE (2015) The global diffusion of Unmanned Aerial Vehicles (UAVs) or ‘drones’. In: Aaronson M, Aslam W, Dyson T and Rauxloh R (eds) *Precision-Strike Capabilities and International Intervention*. London: Routledge.

Franke UE (2018) Military robots and drones. In: *Routledge Handbook of Defence Studies*. London: Routledge, 339–349.

Gilli A and Gilli M (2016) The diffusion of drone warfare? Industrial, organizational, and infrastructural constraints. *Security Studies* 25(1): 50–84.

Gregory D (2011) The everywhere war. *The Geographical Journal* 177(3): 238–250.

Gregory T (2015) Drones, targeted killings and the limitations of international law. *International Political Sociology* 9(3): 197–212.

Grove J (2016) An insurgency of things: Foray into the world of improvised explosive devices. *International Political Sociology* 10(4): 332–351.

Grove J (2019) *Savage Ecology: War and Geopolitics at the End of the World*. Durham, NC: Duke University Press.
Grayson K (2016) *Cultural Politic of Targeted Killing: On Drones, Counter-insurgency, and Violence*. Abingdon: Routledge.

Hazelton J (2017) Drones strikes and grand strategy: Toward a political understanding of the uses of unmanned aerial attacks in US security policy. *Journal of Strategic Studies* 40(1–2): 68–91.

Human Rights Watch (2009) Precisely wrong: Gaza civilians killed by Israeli drone-launched missiles. June 2009.

International Human Rights and Conflict Resolution Clinic at Stanford Law School and Global Justice Clinic at NYU School of Law (2012) Living under drones: Death, injury, and trauma to civilians from US drone practices in Pakistan.

Israel Defense Forces (IDF) (2012) Operation Pillar of Defense. Available at: www.idf.il/en/minisites/wars-and-operations/operation-pillar-of-defense-2012.

Israel Defense Forces (IDF) (2014) Operation Protective Edge. Available at: www.idf.il/en/minisites/wars-and-operations/operation-protective-edge-julyaugust-2014.

Johnston PB and Sarbahi AK (2016) The impact of US drone strikes on terrorism in Pakistan. *International Studies Quarterly* 60(2): 203–219.

Kaag J and Kreps S (2014) *Drone Warfare*. Cambridge: Polity Press.

Karatzogianni A and Schandorf M (2018) Agency in posthuman international relations: Solving the problem of computer-mediated agency. In: Cudworth E, Hobden S and Kavalski E (eds) *Posthuman Dialogues in International Relations*. London: Ashgate, 89–108.

Katz Y and Bohbot A (2017) *The Weapon Wizards: How Israel Became a High-Tech Military Superpower*. New York: St Martin’s Press.

Kreps S and Zenko M (2014) The next drone wars. *Foreign Affairs* 93(2): 68–79.

Kreuzer M (2017) *Drones and the Future of Air Warfare: The Evolution of Remotely Piloted Aircraft*. Abingdon: Routledge.

Lambeth B (2011) *Air Operations in Israel’s War against Hezbollah: Learning from Lebanon and getting it right in Gaza*. Santa Monica, CA: RAND Corporation.

Latour B (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Leander A (2013) Technological agency in the co-constitution of legal expertise and the US drone program. *Leiden Journal of International Law* 26(4): 811–831.

Levy Y (2011) How casualty sensitivity affects civilian control: The Israeli experience. *International Studies Perspectives* 12(1): 68–88.

Li D (2006) The Gaza Strip as laboratory: Notes in the wake of disengagement. *Journal of Palestine Studies* 35(2): 38–55.

Libel T and Boulter E (2015) Unmanned Aerial Vehicles in the Israel Defense Forces. *The RUSI Journal* 160(2): 68–75.

Lindsey R (1983) Al Ellis: Have drone, will travel. *New York Times*, 9 October.

Michael M (2017) *Actor-Network Theory: Trials, Trails and Translations*. London: SAGE.

Rodman D (2013) *Sword and Shield of Zion: The Israel Air Force in the Arab–Israeli Conflict, 1948–2012*. Eastbourne: Sussex Academic Press.

Rogers A and Hill J (2014) *Unmanned: Drone Warfare and Global Security*. London: Pluto Press.

Saif AA (2014) Sleepless in Gaza: Israeli drone war on the Gaza Strip. *Rosa Luxemburg Stiftung*. Regional Office Palestine.

Sanders R (2002/03) An Israeli Military Innovation: UAVs. *Joint Force Quarterly* Winter: 114–118.

Shah N (2017) Gunning for war: Infantry rifles and the calibration of lethal force. *Critical Studies on Security* 5(1): 81–104.

Shaw IGR (2017) Robot wars: US empire and geopolitics. *Security Dialogue* 48(5): 451–470.

Tabrizi AB and Bronk J (2018) Armed drones in the Middle East proliferation and norms in the region. RUSI Occasional Paper, December 2018.

Tzabag S (2013) Operation Pillar of Defense: Lessons for modern warfare. *Israel Journal of Foreign Affairs* 7(3): 79–93.
Borg

U.S. Congress (1991) Office of Technology Assessment. *Miniaturization Technologies*, OTA-TCT-514. Washington, DC: U.S. Government Printing Office.

Walters W (2014) Drone strikes, dingpolitik and beyond: Furthering the debate on materiality and security. *Security Dialogue* 45(2): 101–118.

Weiss M (2018) How to become a first mover? Mechanisms of military innovation and the development of drones. *European Journal of International Security* 3(2): 187–210.

Weizman E (2017) *Hollow Land: The Architecture of Israel’s Occupation*. London: Verso Books.

Wilcox L (2017) Embodying algorithmic war: Gender, race, and the posthuman in drone warfare. *Security Dialogue* 48(1): 11–28.

Williams J (2015) Distant intimacy: Space, drones and just war. *Ethics and International Affairs* 29(1): 93–110.

Wilson S (2011) In Gaza, lives shaped by drones. *Washington Post*, 3 December.

Zehfuss M (2018) *War and the Politics of Ethics*. Oxford: Oxford University Press.

Stefan Borg is an associate professor in international relations at the Department of Economic History and International Relations, Stockholm University. His current work focuses on security technologies, with a special emphasis on the relation between technology and human agency. His work has recently appeared in *Review of International Studies, Security Dialogue, European Security, Journal of International Relations and Development* and *Journal of International Political Theory*.

**Appendix 1. Interviews cited**

All interviews conducted in Tel Aviv February 2019.

Interview 1. Colonel (Ret.), IDF.

Interview 2. Elie Gamzon, Colonel (Ret.), IDF.

Interview 3. General (Ret.), IDF.

Interview 4. Liran Antebi, Israeli UAV expert.

Interview 5. Lt. Col, army UAV squadron commander, IDF.

Interview 6. Employee at UAS division, Elbit Systems. Former mission commander UAV, IDF.

Interview 7. Brig. Gen (ret).

Interview 8. Employee at UAS division Elbit Systems.