'Manning' the 'unmanned': reapproaching the military drone through learning the/to drone

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'Manning' the 'unmanned': Reapproaching the military drone through learning the/to drone

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ABSTRACT

A global turn to the drone is underway. While automation creep and the rise of autonomy necessitate critical attention to the non-human, drone labour or 'manning' nonetheless remains a constitutive part of, and limitation upon, the drone assemblage. Situated in a context of personnel shortage, this article pursues an embodied geopolitics of drone labour. Thinking with literature urging the 'witnessing' of drone strikes and understanding of the infrastructures undergirding them, it offers three contributions. First, while cognisant of the access challenges accompanying research into military practice and objects, it introduces two under-examined fieldsites through which it reapproaches the drone. The military conference and industry training course, it argues, offer windows of empiric access and act to widen the methodological toolkit deployed in the drone's critical accounting. Second, reapproaching the drone as such enables contextual and conceptual reflections on the embodied experiences of drone operators, those explored at alternative sites and temporalities and revealing distinct forms of operational strain. Third, in developing a geopolitics of drone labour, it also accounts for the embodied labours of undertaking critical drone research, unpacking different forms of strained research encounter at each fieldsite. The conclusion engages feminist geopolitics as a lens through which to explore connections across and between the article's multiple scales, actors, and experiences (of strain). Collectively, the article contributes insight around military access and methodological adaptation, and an empirically-driven account of the embodied geopolitics of drone labour inclusive of both drone operators and researchers, conceptualising different forms of strain therein.

1. Introduction

Drones have emerged as central tools in the conduct of 'remote' warfare, with over 95 countries reportedly holding drones in 'active inventory' (Gettinger, 2019, p. VIII). Yet, the drone's cementing as a 'contemporary icon' of air power (Wall, 2013, p. 33) has not been smooth. In an established body of literature, interdisciplinary scholarship interrogates the spatial, ethical and legal dimensions of escalating drone deployment (see for example Akhter, 2019; Allinson, 2015; Boyle, 2015; Gregory, 2011, 2011a; Hall Kindervater, 2017; Wilcox, 2017). Therein, the drone is examined as a 'dispersed and distributed apparatus' comprised of human and non-human actors and agencies alike (Gregory, 2011, p. 196). Scholars have drawn attention to the entanglement of human operators and communities living below drones, with machinic non-human objects and 'planetary infrastructures' that 'integrate' to configure the drone's functioning (Chandler, 2020; Richardson, 2022, p. 9, p.3). Alongside examining the impacts and lived experiences of life in/under the drone's crosshairs (Edney-Browne, 2019; Living Under Drones, 2012; Richardson, 2022a, pp. 1–10; Schuppli, 2014), work has interrogated crew bodies and drone 'labour' (Asaro, 2013; Clark, 2018; Lee, 2018; Williams, 2011), as well as the evolving role of the non-human in the context of growing automation and the advent of autonomy (Schuppli, 2014a; Sharkey & Suchman, 2013).

Yet, while it is recognised that the drone ushered a 'transformation' of 'traditional' military labour (Asaro, 2013, p. 197), there remains scope to chart a fuller, fleshier, geopolitics of drone labour and its 'making' (Klauser & Pedrozo, 2015). For example, while an increasingly global enterprise, the United States (US) pioneered and popularised the military drone as surveillance and strike platform. From its historical operation (Chandler, 2020; Hall Kindervater, 2016) to contemporary acceleration to reach over 4 million combat hours (US Air Force, 2019), the US remains a notable arbiter of the drone age. Yet, the US drone programme has experienced turmoil. Alongside ongoing debates around the future of US drone fleets, the US Air Force (USAF) continues to face periods of personnel shortage (Government Accountability Office, 2019, 2020), with successive headlines describing drone pilot and sensor

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operator shortage (Bowman & Leitzke, 2022; Chow, 2013; Drew & Philipps, 2015; Losey, 2020). While the droning apparatus outpaces its ability to attract and retain the personnel required to staff it, we are reminded of the centrality of so-called 'manning'[1] as both constitutive of, and limiting to, the drone assemblage.

Pursuing a geopolitics of drone labour, this article foregrounds the tensions of 'manning' the 'unmanned', highlighting and explicating different forms of strain that punctuate the drone programme. In first introducing the article's underpinning methodology, it recognises that, like other military practices and objects, the drone remains bound to various barriers to access. It argues that in the drone's wider study there remains a methodological focus on particular data collection techniques and sources, and a predominant temporal focus on the drone as it 'functions' and flies. In contextualising the article's multi-sited exploration, it presents the fieldsites of the military conference and industry-authored training course as both windows of empiric access to 'witness' the drone (Richardson, 2022), methods necessitating adaptation, navigations and negotiations; and fieldsites revealing different forms of operational strain impacting drone labour and the researcher alike. In its account of an embodied geopolitics of drone labour, the article thus highlights and interrogates diverse forms of strain, while reflecting reflexively on their conceptualisation. Second, the article empirically foregrounds two encounters with the military drone. In first approaching the drone through the site of the military conference, it foregrounds the underexamined temporality of the 'employment pipeline',[2] namely the recruitment and retention of drone operators. Punctuated by operator shortage, this fieldsite offers insight into the experiences of strained drone personnel, while simultaneously opening the researcher to strained research encounters. In second approaching the drone through industry-authored training courses, or *learning to drone*, it interrogates (learning) the techniques through which military drones engage targeted peoples. In learning (about) the drone's scopic regime, alternative forms of operational and operator strain are rendered visible. Alongside drone vision as strained by interruptive lags and operators experiencing psychological and physiological strains, so too is the researcher's experience of learning to drone punctuated by ergonomic and emotional strain.

As is outlined in the conclusion, in its account of the embodied geopolitics of drone labour, this article offers both contextual and conceptual contribution through its identification and elucidation of diverse forms of operational strain. While existing literature highlights the stresses drone crew face, these are predominantly narrated in specific, individuated terms, in relation to both 'disjointed' working patterns, and the impacts of witnessing violent combat footage (Asaro, 2013; Chappelle et al., 2014; Hijazi et al., 2019). Turning to the alternative sites, spatialities and temporalities of the military conference and training course, this article reveals distinct forms of strain - at once communal, bodily, and machinic. In so doing, it offers methodological contribution around the study of military objects and practice, while also recognising the enrolment and engagement of the researcher's body, which in the drone's critical accounting encounters and encompasses different forms of strain. Through its conception of strain, the article's conclusion calls for further attention to the drone's relational entanglement of diverse actors, agencies and experiences.

2. Methodology: approaching and accessing the military drone

The study of military practice and technology is often confounded by issues around access and secrecy (Belcher & Martin, 2020). The drone remains a tricky object to research, at once 'redacted, hidden in plain sight, present but opaque' (Coley & Lockwood, 2015, p. 3). While understood as a 'system of illumination' (Noys, 2014), the drone nonetheless remains comparatively invisible, difficult to 'empirically ground' (Klauser & Pedrozo, 2015, p. 289). In seeking to 'navigate and engage' the 'secretive' (Bosma et al., 2020, p. 1) drone, one can turn to the methods underpinning existing critical accounts. To interrogate the drone's distributed infrastructure and 'manning' scholars have largely employed: interviews with drone crew (Clark, 2018; Lee, 2018; Williams, 2011); analysis of existing drone crew/strike testimony (Allinson, 2015; Asaro, 2013; Clark, 2022; Gregory, 2011; Lee, 2018); analysis of 'official' and policy documentation (Boyle, 2015; Hall Kindervater, 2017); visits to military tradeshows and installations (Jackman, 2016; Pugliese, 2016); and analysis of drones in popular culture (Grayson & Mawdsley, 2019; Stahl, 2013). This has been accompanied by 'historical genealogies of the drone' (Hall Kindervater, 2016, p. 224), analytically and archivally tracing the drone's emergence (Chandler, 2020; Gregory, 2011a, 2011b; Hall Kindervater, 2016, 2017). Such work is demonstrative of the multiple actors, sites, networks and 'domains of expertise' through which the drone comes to 'function' (Klauser & Pedrozo, 2015, p. 290).

Yet, while forging passage, scholars have contended that to 'witness' the drone necessitates new 'conceptual techniques' (Richardson, 2022, p. 1). This article argues that so too does approaching and accessing the drone necessitate a widening of *methodological techniques*. Many existing accounts of the drone provide little depth on how the researcher came to select their method; what navigations, negotiations and adaptations were required; and how both their methodological choices and positionality shaped their conceptualisations. In what follows, I thus reapproach the military drone at the under-examined fieldsites of the military conference and training course, presenting each as windows of empiric access into knowledges of 'manning' and the embodied geopolitics of drone operation, and as sites necessitating methodological adaptation and reflection on the position and experiences of the researcher learning to/the drone.

2.1. The military conference

Woodward (2005, p. 719) wrote that while military geographies may 'be everywhere', they remain 'subtle, hidden, concealed … And so it is with their study'. Scholars have nonetheless forged routes to study diverse military practices, objects and experiences. Yet, in undertaking military research, they have encountered institutional requirements, permissions and gatekeepers. As Gray (2016, p. 70) writes of critical research on 'domestic abuse in the British Armed Forces', while beginning 'independently of the institution', she later applied for ethical clearance, seeking permission from the Ministry of Defence Research Ethics Committee. Reflecting on the process, Gray (2016, pp. 73, 74) describes institutional fears (around the 'potential for negative press'), institutional responses (removing 'specific references to PTSD' from interview topic guides), and her own response strategies. Gatekeeping ranges from permission-granting to decision-making, each differently 'delimiting research access' (Bosma et al., 2020, p. 2). Such experiences around access and its navigation are often less deeply and carefully considered within drone research. For example, while offering an important account on the 'experiential' dimensions of drone operation drawing upon 'firsthand' drone crew interviews, Williams (2011, pp. 383, 381, 382) states that access is 'severely restricted' while providing little further detail of how and what took place, and the effects of such restrictions. Similarly, while presenting a powerful account of the

[1] I use the word 'manning' because it is common military terminology, referring to the crewing and staffing of drone platforms. This language is not used uncritically, rather I recognise both the weight of such gendered language that acts to erase women and their service, and that drone warfare remains a 'deeply gendered phenomenon' more widely (Clark, 2018, p. 602; Joyce et al., 2021; Wilcox, 2017).

[2] As per endnote 1, while I recognise 'pipeline' as a common word used by military and adjacent institutions to describe particular phases of military recruitment and retention (Government Accountability Office, 2020), I do not repeat this language, nor its connotations of dehumanised labour subjects or 'products', uncritically.

'gendered implications of armed drones' for their crew, Clark (2018, pp. 602, 613) describes sourcing interviews with operators via 'online professional networking sites' while providing little further methodological detail.

In this article I draw attention to two distinct fieldsites (the military conference and training course) through which I sought and forged access to the drone, while further unpacking the methods, adaptations, and negotiations therein. As Klauser and Pedrozo (2015, p. 290) highlight, the drone is formed, functions, and sustained by diverse 'domains of expertise and sources of authority'. In reflecting on potential alternative fieldsites through which drone 'expertise' gathers and drones are 'put into action' (Klauser & Pedrozo, 2015, p. 290), I came across the military conference. Searching online for military drone-focused conferences, I found and attended two key events, 'UAS Training and Simulation 2014' (8–10th December 2014) at London Park Plaza (henceforth Military Conference 1), and 'UAS 2015' (1–2nd December 2015) at Twickenham Stadium (London) (henceforth Military Conference 2). The conferences were billed as 'leading events' for the international military community operating and aspiring to operate drones. Before audiences of 50–200 attendees (depending on event/day), military personnel presented on drone operations and training programmes, reporting from diverse countries and forces. Programme 'updates' and 'sticking points' were discussed, future actions and acquisitions debated. While held in the UK and recognising that the UK has its own drone programme (Clark, 2018; Lee, 2018), the conferences were premised on international exchange. Each pushed back against a 'platform-centric' focus of debate (Military Conference 2), foregrounding 'manning' and 'human factors'. Attendance thus offered valuable insight into issues around drone operation and labour.

Following those undertaking fieldwork at militarized and securitized sites such as air shows (Rech, 2015), security fairs (Baird, 2017), and tradeshows (Jackman, 2016), I approached the military conference as an empiric site of access. I quickly found this decision was punctuated and shaped by questions around access, method, and positionality. Access, after all, 'shapes the possibilities for research' (Woodward, 2014, p. 47). When initially contacting one conference organizer, I received no reply and was then told I was 'not eligible' to attend. After further discussion, I was informed I could attend but there was no possibility of a reduction in admission price, one costing £500-£2,100 depending on delegate category. The costs presented a research barrier, while confirming that such events are designed to be 'exclusive and limit admission' (Baird, 2017, p. 190) and to shape access to knowledges under particular 'conditions' (Adey et al., 2016). I negotiated, offering a summary 'write up' in exchange for reduced price attendance (from £2100 to £200). I later made the same offer to the second military conference; the organizers obliged. Following the security clearance process typical of 'guarded organizations' (Baird, 2017, p. 190), entry was enabled and my 'write ups' later posted online (e.g. Defence IQ, 2015).

While overt about my role as researcher, as I 'became delegate' tensions emerged around my presence in the space. Here, my positionality as a white, civilian, young woman was notable. As scholars undertaking research in military and security contexts note, gender and its performances variously shape research encounters. While I felt welcome, at times this welcome felt conditional. Questions were repeatedly asked about 'what brought me here', comments made about me 'shifting the demographic', and basic terms repeatedly explained, in spite of efforts to clarify that I understood them. It felt as if my 'femaleness' was interpreted by some as 'knowable and unthreatening' (Gray, 2016, p. 9); my gender felt at once 'helpful' for access while simultaneously conditioned by assumptions of naivety (Cohn, 2006, p. 97). I also grappled with my own navigations of research encounters, struggling with the language I employed in seeking participation. In becoming drone researcher, I learned acronyms and military vocabularies, a lexicon I felt compelled to demonstrate at the military conference. As Cohn (1987, pp. 707, 706) writes of 'the language' of nuclear defence, while initially vowing to 'speak English', she experiences being 'patronized and dismissed', thus opting to deploy a technical vocabulary. However, Cohn (1993, p. 232; 1987, p.711) notes that in adopting such a "cool, dispassionate, and distanced" tone, her very questions shifted, the 'reference point' becoming the 'weapon' rather than the human. In other words, while idealised participant observation may involve the researcher 'becoming the thing they are studying' (Laurier, 2016, p. 3), the military conference and deployment of military jargon therein complicated this – acting to open conversation while foreclosing critical questions. I carefully drafted questions around the embodied experiences and management of drone labour and yet, when seeking to ask them, I stumbled and strained with how to couch them; repeatedly ushered to numbers and figures - timelines of operations, numbers and percentages of operators recruited and leaving.

While cognisant of navigations required in empirically-driven research, I approached the military conference as a site of 'copresence' where military communities gathered to form and 'shape' drone knowledges (McCann, 2011, p. 118). While seeking immersion, it remains that military conferences are short term events. As such, I employed 'event ethnography', a variant of ethnography adapted to suit 'temporary events' (Koch, 2018, p. 2014). Here, it is argued that the event spaces of 'powerful institutional meetings' (Billo & Mountz, 2016, p. 212) represent 'an intensified interaction among individuals' (Koch, 2018, p. 2015). As such, they are understood as 'stages for the performance' of knowledge (Suarez & Corson, 2013, p. 64), and pivotal in the 'setting, shifting and popularizing of issues' (Campbell et al., 2014, p.3).

At a smaller scale, I understood the military conference as 'learning fields' to listen, ask, and understand (Wood, 2016, p. 392). I sought active participation and kept extensive field notes, pursuing a 'thick' description of the content and feel of the events, paying attention to how concepts such as 'manning' were multiply articulated, 'framed, translated, and made sense of' (Koch, 2018, pp. 2014, 2015). However, it's important to note that there were restrictions placed upon recording and citation. Conference chairs evoked the 'Chatham House rule', one providing 'anonymity to speakers and encouraging openness and the sharing of information' (Chatham House, n. d). The performance of access was not limited to entry, rather, it was continuous. Thus, while material confined to the field notebook is frustrating, such off-the-record observations are both 'revealing of knowledge production and circulation' and remain an 'absent-presence' (Belcher & Martin, 2020, p. 39) in my thinking more widely.

2.2. *The training course*

In pursuing a geopolitics of drone labour, I also undertook industry-authored training courses. While the details of military training sat by drone operators remain closed to civilians, when undertaking fieldwork at the military conference, I was informed of a distinct proxy form of training offered by industry providers. Specifically, I was introduced to 'Unmanned Experts', a company then describing itself as a 'world-leading provider of subject matter expertise in unmanned aircraft systems' (Unmanned Experts, n. d). US-based and run by a CEO with over 25,000 military drone flying hours, it offered both 'in-residence and webinar-based courses on tech adoption and UAS utilization' (ibid). While now offering wider services, the company formerly hosted the 'world's first e-learning training program' aimed at military, civilian, and commercial 'students' seeking to develop unmanned 'expertise' (Unmanned Experts, 2014, p. 2). Following correspondence initiated at a military conference, I was kindly gifted six online courses,[3] including

[3] The courses completed included: UAS Introduction IC1, UAS Completion CC1, UAS Market and Careers, 3iC Remote Pilot Authorisation, An Introduction to UAS: The good, the bag, the ugly INT1, and UAS Rules and Guidance update 1 SR1A1. With permission from the company, material from these courses is cited within this article, and is clearly labelled as such through the term 'Training course' within relevant bracketed references.

two foundational courses then retailing at $800 (US). Here, access was 'relational' and 'co-created' (Bosma et al., 2020, p. 2) with conference delegates.

I first understood the training course as an alternative window to access the drone. While often understood as a 'black box' technology, presented in 'terms of its inputs and outputs' rather than 'what goes on inside' it (Winner, 1993, p. 365), the training course opened up various 'inputs' that 'make' and underpin the drone's 'functioning' (Klauser & Pedrozo, 2015). In addition, the training course acts as a site through which drone knowledges are 'constituted and expressed' (Adey et al., 2016, p. 12), 'produced and circulated' (Temenos & McCann, 2013, p. 346), and as an opportunity to learn to drone. Following others who have deployed 'learning as a research method' (Wood, 2016, p. 393), I understand the training course as an opportunity to 'become a technician' of sorts (Chamayou, 2013, p. 15).

Completing the industry-authored training courses involved sitting remotely at my desk, navigating modules and slides guided by pre-recorded narration. A form of online learning, the course enabled 'flexibility' and 'self-pacing', while remaining a learning environment punctuated by 'interruptions' (Babatunde Adedoyin & Soykan, 2020, p. 6); the shared office was noisy, at home the doorbell rang. The courses rendered visible commonly obfuscated knowledges, introducing information about the drone's components and capabilities, perceived operational benefits and limitations. Understanding the training course as an opportunity to *learn to drone*, I reflected on how to methodologically approach this fieldsite, opting for autoethnography. A label for a range of techniques, autoethnography enables the researcher to 'become part of what they are studying' while centring and 'reflectively ruminating' on their experiences (Butz & Besio, 2009, p. 1660). Seeking to build upon my (event-)ethnographic experience at the military conference in which my learning about the drone's 'manning' was punctuated with my own embodied experience, I was wished to reflect on my 'personal experience' (Butz & Besio, 2009, p. 1665) of the training course too. I was interested in how such methods of approaching the drone, in conjunction with my experiences of them, might inform and shape my conceptualizations of drone geopolitics.

Autoethnography urges a 'reflexive effort' to consider how researchers are 'situated' in relation to who and what they are studying, and the 'fields of power' therein (Butz & Besio, 2009, p. 1666). In recognition that our 'situatedness' variously 'conditions' our research (Ackerly & True, 2008, p. 695), scholars stress that knowledges remain 'provisional' and 'partial' (Higate & Cameron, 2006, p.222). As a white, civilian, woman who resides in a country not subjected to drone strikes, I was acutely aware of the privileges I experience and the complexities of the navigating my own position in a research context punctuated by military violence. What did it mean to undertake this training, to 'involve' and 'inscribe' my body to such militarized materials (Adey et al., 2016, p. 9)? What did it mean to do so as someone occupying the 'spaces between', namely engaging with military and militarized actors while seeking to sustain a form of 'distancing' (Gray, 2016, p. 79)? As Rech and Williams (2016, pp. 273, 276) note, while critical military researchers reflect on how the 'personal' and 'intellectual' meet and intertwine, there remains a propensity to 'prioritise critical intellectual perspectives at the expense of the affectual or experiential'. After all, while scholars have reflected on both the bodily experiences and strains of drone operation as narrated by operators (Asaro, 2013; Wilcox, 2017), and the positionality of researchers undertaking military research (Cohn, 1987; Gray, 2016), it remains that 'other aspects' of the researcher's body can 'slip away unnoticed and/or undocumented' (Longhurst et al., 2008, p. 208). Interested in a 'messier' approach, in what follows I grapple with 'experiential knowledges' (Basham & Bulmer, 2017) of learning the/to drone.

3. Encounter 1: a geopolitics of drone labour at the military conference

> 'There's no other part of the Air Force that has 100 percent of their capability engaged 100 percent of the time' (Air Force Times, 2016a)

While the USAF have an established drone programme, it has nonetheless remained confounded by 'manpower' challenges (Government Accountability Office, 2019, 2020), with military officials remarking upon 'growing strains on capacity' (US Air Force, 2015) and personnel challenges surrounding 'keeping apace with demand' (Chappelle et al., 2014, p. 480). In spite of the entrenched nature of such personnel challenges, these remain under-discussed within academic work exploring drone operation. Following delegates repeatedly asserting that 'manning' is an 'often forgotten' yet 'crucial' drone programme issue (Military Conference 1; Military Conference 2), this section argues that encountering the drone at the military conference foregrounded the under-examined 'employment pipeline', a term referring to the processes and practices through which drone personnel are recruited, trained and retained. Reapproaching drone labour through attention to the military knowledges therein extends our attention to the multiple sites, spaces and temporalities that comprise the drone. Further, attention to the 'employment pipeline' acts to reveal distinct forms of operational strain.

Reasserting the drone as an expansive tool 'fulfilling critical demands 24 hours a day, 365 days a year' (US Air Force, 2015), delegates quickly noted the necessity to rapidly expand labour to 'sustain' the drone's operations, with 'everything produced: the people, immediately put into active combat operations' (Military Conference 1). Here, delegates described the drone programme as one 'born in crisis and its growth accelerated through need' (Military Conference 1). Yet, while citing that drone pilot numbers tripled from 2008 to 2013 and continued to grow thereafter (Government Accountability Office, 2014, 2020), delegates nonetheless noted a 'constant scarcity of skilled personnel', stating that only 'half the new pilots needed' are being produced (Military Conference 2). Crucially, conference delegates stressed that these 'conditions' of personnel 'shortage' and the 'stresses, strains of drone flight' were 'interrelated' (Military Conference 1), making connections between the challenges surrounding the 'employment pipeline' and their implications upon drone flight itself.

As described in the previous section on the methodology, extant drone scholarship tends to focus on the in-theatre drone and operator, as they fly, surveil and strike. While pertinent, scholars have nonetheless called for greater attention to the sites, actors and processes through which drones are 'set up and subsequently put into practice', that is the 'making of' the drone (Klauser & Pedrozo, 2015, p. 290). Here further attention is urged to the multiple temporalities constituting and underpinning the drone. These are evidenced in powerful genealogical accounts of the drone sharply demonstrating how the platform's histories undergird its contemporary operations (Chandler, 2020; Gregory, 2011b; Hall Kindervater, 2016). Following that where, when, and how we approach the drone acts to inform our understandings of drone geopolitics, this section draws attention to the specific temporality of the 'employment pipeline', the site of the military conference, and the method of reflexive event ethnography to offer as-yet presented accounts of strained drone operation.

Drone programmes have long been associated with particular forms of strain, with literature highlighting strain as it is experienced by individual operators in combat. Researchers highlight the bodily strains of 'disjointed' shift-working routines wherein operators move 'daily' between 'combat operations and domestic life' (Asaro, 2013, p. 205; Stahl, 2013), and the emotional strains individuals experience as a result of the 'intimate nature of surveillance' and the remote witnessing of violent combat footage (Asaro, 2013, p. 205; Edney-Browne, 2017; Hijazi et al., 2019; Ouma et al., 2011). While important, in empirically re-approaching the drone at the military conference, discussions of

recruitment and retention acted to render visible *distinct* forms, narratives, and experiences of strain.

In response to the personnel shortages in the emergence and cementing of the USAF drone programme, the institution implemented a range of measures to attract, grow and retain drone crew. These included voluntary and involuntary (re-)assignments, alternative designations, and incentives. Beginning with recruitment, while the USAF historically built drone crews through 'handpicking' and re-assigning 'volunteers' from manned aircraft communities (Axe, 2014), this strategy did not yield the pilot numbers needed. The recruitment pool was thus widened to include non-volunteer temporary re-assignments, those initially to be 'rotated back' after four years (Axe, 2014; Military Conference 1).[4] Following disquiet around this decision, in 2010 a further shift occurred whereby some involuntary officers were returned to manned aircraft operations, with the USAF instead introducing a new drone 'pilot career field' and 'speciality code' (Government Accountability Office, 2019, pp. 7, 2020). The '18x' category allowed officers to be 'designated as drone pilots', namely to train to fly only drones (Holloman Air Force Base, 2012). This was echoed in the announcement enabling select officers enlisting to train solely as drone pilots, pursuant to a period of service commitment (Air Force Times, 2016b).

This widening of the recruitment pool can be understood as a marker of a shifting institutional culture. Delegates at the military conferences discussed the 'array of skills' required for drone operation, noting that while some are 'held by existing fighter pilots', there remained a strong desire to 'embrace a different skillset' and build 'a generation of specialist operators, largely from civilian backgrounds' (Military Conference 1). Yet, while delegates discussed the need to articulate and celebrate the skillset of contemporary drone personnel, so too did they describe ongoing challenges around drone operator retention. They noted that alongside recruiting operators, there were issues with keeping them in post, referring to the US drone programme as one in 'exodus' with crew 'leaving the profession in notable numbers' (Military Conference 2). In response, the USAF deployed retention measures including: introducing 'retention bonus' schemes for those committing to remain in service for at least five years (IHS Jane's 360, 2015), a 'critical skills' retention bonus involving monthly pay rises, and/or 'aviation retention bonuses' if personnel agreed to service beyond their commitment period (Air Force Times, 2015; Government Accountability Office, 2020; Finnerty, 2022).

Collectively, this recruitment and retention situation demonstrates that while drone operations continued apace, they remained underpinned by a context of labour 'scarcity' and 'unmet demand' (Military Conference 2). Reapproaching the drone via the 'employment pipeline' thus enables us consider the geopolitics of drone labour anew, and in particular to further develop our conceptualisations of operator strain therein. For example, existing drone scholarship foregrounds individual operator experiences of 'in-theatre' drone operations. Here, two central narratives emerge around the strains that individual operators experience, first in relation to workload and routine, with scholars describing drone operators as a distinct form of 'deployment-on-station' that sees operators jarringly shift between 'combat' and 'daily life' (Asaro, 2013, p. 2015; Lee, 2018) and experience unpredictable shift patterns with minimal periods of rest and 'decompression' (Government Accountability Office, 2015; Ouma et al., 2011). Second, researchers argue that drone operators experience emotional strain related to the witnessing of violent combat footage (Asaro, 2013; Bryant, 2017; Edney-Browne, 2017; Gregory, 2011), with routine exposure resulting in 'psychological strain' (Hijazi et al., 2019). Such accounts reinforce the sentiment that drones cannot be 'separated from the human operator' (Chandler, 2020, p. 53), while reminding us that operator bodies are 'sites of performance' and experience exceeding the bounds of their military profession, rather than solely 'surfaces for discursive inscription' (Dowler and Sharp in Williams, 2011, p. 384).

Reapproaching the drone through the site of the military conference revealed alternative forms of strain. Rather than strain solely 'in-theatre' or at the scale of the individual body, delegates repeatedly described strain as a 'communal' and 'community' 'condition' (Military Conference 1; Military Conference 2). This expanded definition of operator strain took several forms, relating to structures of drone crew employment and retention, as well as to communal stigma. In discussion of issues 'surpassing' those 'for individual operators' (Military Conference 2), delegates quickly cited 'crewing levels' (Military Conference 1), pointing to recruitment and retention as 'key areas of the pipeline that need addressing', given their implications 'down the line' (Military Conference 1). This sentiment is echoed in Government Accountability Office (2015, p.32) reporting that drone operations ran at a level 'below optimum crew ratio'. Referring to a metric both designating 'personnel needs' for aviation units and cognisant of conditions under which 'combat capability would be diminished or flight safety suffer', the Government Accountability Office (2015, p.18, 2014, p. i) found that not only was the USAF operating in shortage, but that it failed to set a minimum crew ratio. Consequentially, the ability of personnel to complete ongoing training was impacted, with reports that around 65% of USAF drone pilots surveyed failed to complete the 'majority' of required continuation training (Government Accountability Office, 2015, p. 16). Troublingly, it was the continuation training for 'air interdiction missions' (the process of 'diverting or destroying the enemy's military potential'), which was most often not completed, with operators focusing on completing surveillance training (ibid, p.17). While important to note that the prioritisation of surveillance-related training may reflect the continued demand for and dominance of surveillance activities (Training Course), reapproaching the drone at the military conference highlighted distinct sites and forms of operational strain, and their knock-on implications. This underscores the importance of considering embodied strain both in more communal terms, and as multiply sited and experienced.

In this vein, fieldwork at the military conference also highlighted a further form of 'communal' strain, instead related to 'stigma' both 'directed at' and 'experienced by' drone operators (Military Conference 1). Following its enaction of a 'new concept in warfighting' (Daggett, 2015, p. 366), drone operation has been derided by some military personnel and scholars as a distanced role without 'physical risk', and/or as 'unmanned' and therefore 'emasculated' (Training course; Chamayou, 2013, p. 99), as well as associated with derogatory labels such as 'armchair warrior', 'cubicle warrior', and the 'Chair Force' (Government Accountability Office, 2014). Here, conference delegates stressed the enduring 'strong Air Force culture of manned aircraft' (Military Conference 1), one based upon 'a military ethos of a sense of sacrifice' (Chamayou, 2013, p. 17). Scholars have similarly argued that in its disavowal of relations of 'reciprocal' risk (Chamayou, 2011), drone operation marks a shift in warfighter tradition, particularly around sacrifice (Baggiarini, 2015; Clark, 2018). Here, an example cited at the military conference is helpful. In 2013 the (then) US Defense Secretary announced the 'Distinguished Warfare Medal', one intended to honour the 'combat achievements' of personnel who 'aren't physically present on the battlefield, but whose actions have a direct effect on combat success' (Stars & Stripes, 2013). The announcement of a medal that could be awarded to drone operators was met with critique, particularly surrounding its 'rank in the official order of precedence above the Bronze star' (Air Force Magazine, 2013). As a result, the medal was cancelled and later revised to a 'distinguishing device' - a small bronze 'R' (for remote) (Military.com, 2016). While the (re-)instating of this award can be understood as a technique to foster retention, and an attempt to 'professionalize' drone crew roles (Asaro, 2013; Government Accountability Office, 2019) through 'making [the crew] feel valued, formally' (Military Conference 2), so too is its tumultuous journey demonstrative of a form of stigmatised strain influencing operator

[4] Collectively, such operators fall under the 'speciality code' of 11U, 12U and ALFA tour pilots.

communities as they are recruited and come to drone.

Just as the pursuit of a geopolitics of drone labour at the military conference led me to questions of operator strain, so did its fieldwork enrol and subject my (the researcher's) body into different forms of strain. For example, following the first day of a military conference, there was an informal drinks reception. As research 'interfacing' often takes place in such 'halfway' spaces (Ortner in Baird, 2017, p. 190), I stayed, engaging in conference-related conversations with several delegates. Discussions of the day's events quickly turned into casual conversation. Nervously laughing at jokes outside my comfort zone, I felt the pulls and strains of 'complex personal positioning' (Parr in Hoggart et al., 2002, p. 270). As the reception wound down, I was approached by a group of male delegates inviting me to a group dinner, I opted to go. Jokes were shared and a song sung. As the only woman at the table, I was welcomed, yet I felt watched. Comments were repeatedly made about my age and whether I could 'keep up' with the group's drinking. A tray of shots was passed around and I passed it on without taking a glass. Two delegates placed shots in front of me. I excused myself to the bathroom, noting in my field diary the words 'fun but jarring, exciting but exhausting' to describe the shift from formal proceedings to evening activities. Of course, attentiveness to 'boundaries and their power to marginalise' remains an important aspect of feminist research practice (Ackerly & True, 2008, p. 696). Here, gendered boundaries were encountered and tested, resulting in a somewhat strained research encounter.

As is shortly explored through the lens of the second fieldsite and is the focus of the article's conclusion, to pursue an embodied account of the geopolitics of drone labour is also to enrol and engage the researcher's body. During this research, I experienced different forms of strain. Following that 'militarization and violence are embodied in multiple ways' (Parks & Kaplan, 2017, p. 9), the article's conclusion brings the diverse and distinct forms of strain into consideration and connection through the lens of feminist geopolitics, an analytic approach that at once attends to and advocates for a 'finer scale of analysis' while attentive to the (uneven and unequal) functioning of power across multiple sites, contexts, and scales (Dávalos & Zaragocin, 2022, pp. 314-315). The identification and imbrication of multiple types, sites and embodied experiences of strain are unpacked further in the article's second fieldsite.

4. Encounter 2: a geopolitics of drone labour at the training course

> 'Learning how to fire Hellfire missiles is more like sitting in a regular college classroom than you might expect' (The Atlantic, 2014)

Richardson (2022, p. 7) writes that to 'witness' the drone (strike) is to 'trace the emergence of the act of violence in and through the media-technological apparatus of the drone'. This section reapproaches the drone through the site of the industry-authored training course, investigating a geopolitics of drone labour attentive to both how the practices of drone operation and drone vision are learned, and to experiences of technological, emotional, and embodied strain therein.

Writing of military labour, scholars highlight that the 'bodies of recruits' are 'corporeally transformed', with 'specific dispositions and competencies becoming inculcated' (McSorley, 2016, p. 104). One way in which military personnel are 'produced' is through both technological 'instruments' and technological 'practice' (Schwarz, 2018, p.4). Here, training remains an important site through which such skills are formed and 'rehearsed' in the 'preparation' (Anderson, 2010, p. 777) and readying of drone crew. Yet, while centrally 'informing military practice', the training techniques through which military personnel learn to 'read' their respective 'landscapes' remain comparatively under-studied (Woodward, 2014, pp. 47-48). As such, this section turns to industry-authored training courses, and in particular their focus on 'symbology', namely the skills to 'read' scenes and identify and assign 'target' status, as a lens through which to explore a geopolitics of drone labour attentive to the 'making' of the drone operator.

4.1. Symbology and strains

Symbology can be understood as a form of 'professional' or 'discipline-specific way of seeing' (Vertesi, 2012, p. 397) that is 'active' in the 'construction' and designation of 'civilians and possible insurgents' (Asaro, 2013, p. 220). In accessing symbology through the training course, insight is gained both into how targeting relations *are taught*, and how they *are learned*. This approach highlighted particular forms of embodied and machinic strain associated with drone operation, as well as reinforcing how researching the drone can itself be a strained process.

Scholars have raised questions of how the 'medial dynamics' of drone assemblages come to produce violent mediation, drawing particular attention to 'processes that cut, target, exclude, define, categorise or classify in harmful ways' (Richardson, 2022a, p. 3). Before turning specifically to the role of symbology therein, it is first useful to provide context on the training process that USAF operators undergo. This includes a screening process (Hardison et al., 2012) followed by several months of training, featuring: flight screening whereby pilots learn to fly small aircraft, instrument qualification in which simulators are used, a 'fundamentals' course teaching academics of flying, formal training units where pilots learn to fly particular platforms, and ongoing continuation training (Military Conference 1; Government Accountability Office, 2015, 2020). Following completion, pilots receive their 'wings'. Just as encounter 1 described drone crew shortage, there are also issues with under-filled 'instructor positions' (Government Accountability Office, 2020, p. 26). Within this multi-stage training process, prospective operators 'learn to target' through processes from academics and simulation (Training Course), to flights over 'mock villages' (Military Conference 1). 'Symbology' also forms an important training component. 'Symbology' trains the operators to capture, interpret, and analyse image, sensor, and video streams in simulated environments, prior to 'live' operations.

Symbology involves learning to approach and apprehend peoples and landscapes in relation to defined components. Per Fig. 1, these include: the FOV (Field of View), the sensor (frequency band), camera settings (moving the camera and sensor), the depression angle (position of sensor in relation to aircraft), slant range (position related to crosshairs), target positor (position in relation to crosshairs/target), crosshairs (central position of view), aircraft position (longitude, latitude), heading (aircraft, degrees true), and azimuth (angle sensor is looking) (Training course). While training participants were not told where, geographically, the scene or wider training was situated, this ambiguity cemented the role of training in the habituation of techniques of power, while erasing the specificities of spaces, cultures, and peoples below military drones.

In this vein, scholars have written powerfully about the uneven violences of 'mediating' practices which view and sense 'vital' or lively bodies, 'plot' individuals on a 'time-space grid', and 'transform' people into targets (Asaro, 2013; Gregory, 2016, p. 131; Richardson, 2022a, p. 4, p.221). In so doing, they highlight that in the drone's capture and translation of peoples into 'legible' and 'actionable' targets (Richardson, 2022a, p. 4; see also Chamayou, 2013), the drone's violence remains inseparable from a racialised logic of threat (Akhter, 2019). Here it is important to note that alongside critical attention to the act and practice of the drone strike, scholars have 're-orientated' (Williams, 2013) attention to centre lived experiences of life below the drone. Foregrounding the testimony of civilians subject to and living amidst drone warfare, research describes 'chronic' fear and multi-faceted forms of trauma, from life-changing injuries, to damage to 'economic, social, and political everyday life' (Schuppli, 2014, p. 383; Living Under Drones, 2012, p. v; see also Edney-Browne, 2019; Alkarama, 2015). It is thus asserted that the drone's presence and 'surveillance constitutes a form of psychological colonization' (Edney-Browne, 2019, p. 1341). While

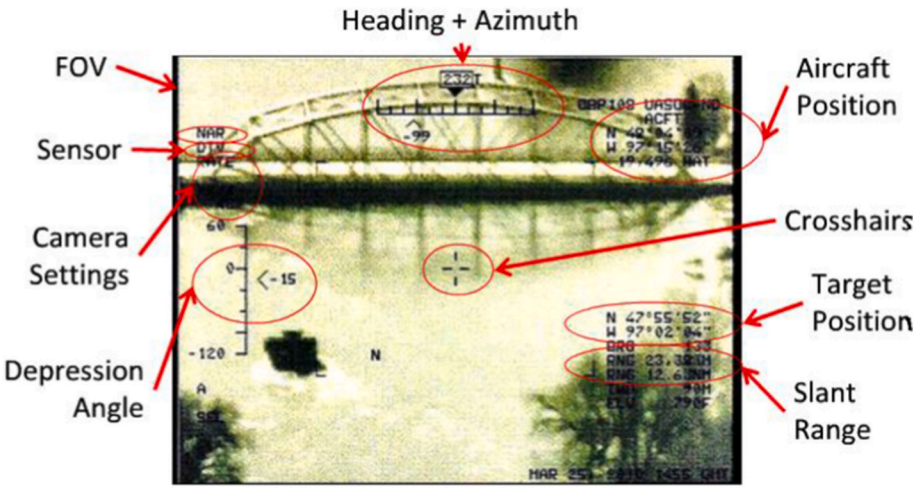

Fig. 1. Drone 'symbology'. Source: Training course (permission granted).

underscoring the drone's unevenly violent drawing of a 'caesura, a cordon around … parts of the population it is acceptable to put to death' (Allinson, 2015, p. 120), in reapproaching the drone through the training course, so too can we equip the building of a critical account of the military drone with further reflection on how it is we come to learn a scene as legible in this way, and what it feels like to do so.

Following the notion that 'people go to war because of how they see, perceive, and picture others' (Der Derian in Amoore, 2007, p. 218), undertaking the virtual training course offered a window into how the operator's eye is 'cultivated and disciplined' (Adey et al., 2011, p. 177). Interestingly, the theme of strain emerged again. Scholars have challenged the drone as 'all-seeing' eye capturing and communicating in 'real time' (Gregory, 2011, 2011b; Hall Kindervater, 2016). The training course somewhat echoed such critiques, highlighting the material infrastructural 'challenges' around 'C2 [command and control] link latency' (Training course). It highlighted that delay at once comprises and envelops the drone. This is echoed in the word of drone operators describing delays of 1.5–2.5 seconds between 'manual control input and video feed' (Avionics International, 2017). The training course described the impact of this on the drone's missile release, noting a waiting period between arming the drone and weapon release, whereby a laser-guided weapon follows the path of a designated 'Laser Targeting Marker' to impact site (Training course). As this path unfolds, a waiting period accrues. As in the previous section, this is an infrastructural observation. The training course emphasised that drone crew are variously trained to navigate this temporal rift, asserting a shift in language from 'real time' to 'near real time'. In negotiating the drone's latencies, drone crew are taught to determine, anticipate and adjust the 'degrees of azimuth' from which to fire (Training course).

Yet, while operators are trained to account for 'control-lag' (Lee, 2018), it remains that the delays of 'near real' time, an infrastructural or processual pause, are reportedly associated with further forms of strain impacting drone crew. That is, operational strain can emerge through the stress of an uncertain waiting period, wherein the parameters of a strike may shift. For example, writing of 'placing crosshairs at the feet of two individuals' before launching 'a missile with 16 seconds of flight time', drone crew describe that a during this period the 'missile hit the speed of sound and, due to the loss of kinetic energy, the sonic boom hit the target roughly 4–8 seconds before impact' (Bryant, 2017, pp. 319, 320). This temporal sequence is significant because those in proximity to the targeted individual(s)/site may run away or for cover upon hearing the sound. The drone crew goes on to describe experiences of a man hit while running towards others upon hearing this boom, blood 'spurting out in the rhythm of his heart' and cooling as he became 'indistinguishable' 'from the ground' (Bryant, 2017, p. 320). That is, in the drone's 'violent mediation', its latencies mean the drone's imagery has 'already passed into pastness', there is a 'belatedness of trauma' (Richardson, 2022a, p. 4).

In recognition that machinic latencies remain both anticipated and associated with operational strain, we can more closely consider how drone crew are trained to navigate and negotiate these infrastructural and processual parameters. As drone crew learn to work with and cater for the drone's latencies, they engage with various forms of non-human assistance. In learning to interpret and follow 'targets', operators engage with a range of software-assisted practices, including 'modes of tracking' aiding full motion video by 'looking for, picking up targets, and following them' (Training Course). This reflects a growing emphasis on 'data-processing capacities and automation' as the drone becomes 'information-processing machine' (Hall Kindervater, 2016, p. 232). While the training course stressed that existing approaches are 'by no means autonomous target-recognition', it nonetheless highlighted that software assistors are designed to aid the operator's understanding and rendering actionable of a scene. Yet while algorithmic assistance is designed to facilitate more 'efficient' operation given the sheer volume of operational data (Military Conference 2), the drone remains 'fragile, riddled with faults and deep contradictions' (Chamayou, 2013, p. 75). As the training course highlighted, algorithmic assistance gets stuck - losing individuals behind trees, subject to issues around 'contrast'. Drone crew are thus trained to rely upon non-human assistance, while also anticipating and negotiating their sticking points. As such, while important and ongoing questions are raised about the role and agencies of non-humans therein (Schuppli, 2014), so too is further attention needed to how automation marks a 'particular configuration of the human', rather than 'its complete removal' (Hall Kindervater, 2017, p. 34).

4.2. *Researcher experience of learning to drone*

While the training courses can be understood as an alternative and under-examined empiric window of access, so too do they invite wider methodological reflections on learning to drone; that is while seeking an understanding of the geopolitics of drone labour, so too was I learning, being trained. Alongside the training course revealing forms of operator and operational strain, so too did undertaking them involve my own strains.

Alongside detailing how the drone operator should approach a scene, the training course described how crew can experience their role. Here, it highlighted the embodied impacts of working patterns, highlighting strains on the operators' 'circadian rhythms' (Training course), namely the rhythms of 'physical, mental, and behavioural changes that follow a

24-hour cycle' (National Institute of General Medical Sciences, n. d). Such a working pattern, the training course added, may result in 'fluctuations in alertness'. This is reinforced in research echoing that 'shift work and poor sleep hygiene' are 'significant contributors to occupational stress' among drone operators (Chappelle et al., 2014, p. 485). Yet, while reinforcing of the ways the military variously 'shapes the bodies that constitute it' (Baker, 2016, p. 122), so too can we consider the ways conducting military-focused research shapes the body of the researcher too.

For example, writing of undertaking fieldwork with UK drone crew, Lee (2018) fleetingly describes 'exiting the building … with an empty bladder and a full bottle of water', those later 'swapping locations.' Just as Lee (2018) mentions becoming momentarily 'preoccupied with bodily functions', so too I did become keenly aware of my embodied experiences when undertaking the training courses. Several hours in, I noted my body was restless, "my neck sore. I keep hunching. My chair isn't comfortable. When fidgeting, I'm concentrating less. I've paused several times to readjust my body" (Field Diary). Here, my experience – of bodily sensations and attempts to manage them - chimes with wider discussions about the very same for drone crew bodies. As Hobbs and Lyall (2016, p. 23) note, 'unmanned aviation presents a unique set of human factors considerations'. Ground control stations remain 'marred by ergonomics problems', with designs 'failing to account for human abilities, characteristics, and limitations' (Waraich et al., 2013, p. 25).

Here we can think back to the site of the military conference, understanding embodied labour and strains as 'connections' between different fieldsites that can be 'brought into the same frame of study' (Cohn, 2006, p. 94). Referring to an applied science designed to increase 'productivity while reducing discomfort' (Humanscale, n.d.), ergonomics emerged as an important aspect of the USAF's wider incentivisation efforts to recruit and retain drone crew. Alongside conference delegates noting that it's 'increasingly important to manage conditions - we need our operators to efficiently and comfortably perform' (Military Conference 1), the USAF launched initiatives dedicated to 'generating efficiencies' through reducing 'risk factors' such as 'awkward positions' and 'repetition' (US Air Force, 2008). The 'bodily inclination' (Adey, 2011, p. 128) of the drone crew thus becomes strategic terrain of the USAF as they seek to manage 'immobile practices of watching, listening and paying attention' (Adey, 2010, p. 194). Underscoring the importance of considering the researcher's own embodied 'encounters with military spaces' as it relates to their wider understandings (Adey et al., 2016, p. 9), I reflected on how my body was enrolled in the research and what my experiences of neck and back pain might mean for my conceptualisation of a geopolitics of strained drone labour.

In this vein, when returning to my autoethnographic field diary, I noticed additional forms of embodied strain. After a few days of the online courses, I noticed that "my eyes are getting dry and irritated. I don't think I'm blinking enough" (Fieldwork diary). Here my body was 'relational, in dialogue' (Woodyer, 2008, p. 353) with the course content and learning environment. These observations resonated with drone crew observations of their 'working environment' harmfully impacting their 'neck, back, eye and hearing' health (Government Accountability Office, 2020, p. 35); their embodied sensation of tired eyes contrasting against, and 'undoing', the enduring notion of the machinic drone as 'unblinking eye' (Williams, 2011, p. 381). This 'humanness' was also again foregrounded in my field diary through notes of sporadic feelings of boredom or temptation to skip ahead. While the course was engaging, it remains that our 'attention skills' can be 'attenuated', distractions demand or divert our attention (Schuurman, 2013, p. 370). As I completed one course, I noted "at times I've felt distracted … drifted off – maybe I am a bit bored as I spent a long time focusing?" (Fieldwork diary). As Anderson (2021, pp. 197, 198) writes, 'boredom is strange', labelled as a 'dimension of being human' that is treated at once as serious and 'dismissed as trivial'. Boredom too is an affect that drone operators contend with, with a training course stating that around '2% of missions are kinetic' and as such, drone operators spend considerable time on surveillance activities that involve 'repetitive monitoring tasks'. Thus, while the drone's stare is often understood as 'unflinching' (Crandall, 2015), so too can its crew be 'bored senseless for hours' (Levitas, 2013).

In drawing to a close, we might ask: what has reapproaching the drone through the lens of the training course compelled and revealed? Alongside acting as an opportunity through which to both learn both *about* the drone and learn *to* drone, reflecting on the researcher's own experience has informed the article's conceptualisation of a geopolitics of drone labour as strained. Following that in turning to the 'corporeal' we can 'develop languages' that 'better speak' of military intervention (McSorley, 2014, p. 108), this article has at once introduced under-examined fieldsites and methods through which to access the drone and explore the embodied dimensions of drone labour, while also highlighting that further attention is required to the embodied experiences of the researcher themselves.

5. Conclusion

This article presents an embodied account of the geopolitics of drone labour, reapproaching the drone through under-examined fieldsites and methods, and attentive to the role and entanglement of the researcher's own body therein. In bringing the article to close and cementing its contributions around access, embodiment, and strain, I'd like to reflect on connecting the distinct fieldsites and encounters described and the recurrent theme of strain therein. Here, we might consider three central questions. First, what might the identification of diverse forms of strain mean for a political geography of drone warfare? Scholars have compellingly approached the drone as an assemblage comprised of 'materials, systems, persons, and ecologies' (Gregory, 2011; Richardson, 2022, p. 5). Therein, attention is paid to the 'limitations' of both the human and non-human. One strand of work critiques claims of omnipresent drone vision, describing shifts from the drone's 'soda straw view' to a 'macro-field of micro-vision' drowning operators in data (Gregory, 2011, p. 194), and the ongoing necessity of the drone's human operator to 'blink' (Williams, 2011). In this vein, work also centres the 'humanness' of drone operation, foregrounding its emotional stresses by reframing the question of limitation to one of individual capacity and/or vulnerability (Hijazi et al., 2019). Yet, when we approach the drone through diverse fieldsites and the military expertise and agendas therein, we see that strain can valuably be understood in *more than individual* terms. We are alerted to additional dimensions of strain, at once communal, structural and machinic. While we can draw inspiration from existing (yet limited) work examining the drone's 'transformation' of military labour and foregrounding the deployment of 'scientific management strategies' reconstituting crew 'within professionalized careers' (Asaro, 2013, p. 196), this article's examination of the geopolitics of drone labour urges a more empirically-driven consideration, raising questions of the sites and spaces through which we approach the study and 'making' of the drone, and highlighting that in doing so, distinct forms of strain that go on to inform the drone's very functioning are made visible.

Second, how can we connect the article's identification and exploration of distinct and diverse forms of strain? In thinking across the article's fieldsites and argumentation around strain, I identify an opportunity to engage with and draw upon feminist geopolitics. While it is argued that drone research largely 'averts feminist perspectives' (Parks & Kaplan, 2017, p. 9; though see Clark, 2018; Jackman & Brickell, 2022; Williams, 2011), in developing a geopolitics of drone labour at once attentive to diverse forms of embodiment and highlighting distinct forms of strain therein, feminist geopolitics acts as a valuable lens through which to think across - and bring into connection - different sites, scales, and experiences. At its core, feminist geopolitics refocuses and diversifies the actors, spaces, and scales at the centre of geopolitical accounts. It examines 'power as it unfolds' (Massaro & Williams, 2013, p. 567) at both the finest geopolitical scale of the body (Hyndman, 2019)

and across multiples scales, from the 'mundane' and everyday, to the national and international (Dowler & Sharp, 2001, p. 171). Just as the drone is understood as an assemblage comprising multiple actors (from operators in Ground Control Stations; to cameras, missiles and data links; to civilians and 'targets' under drones, and/or researchers interrogating these), so too can assemblage thinking 'embed a relational ontology that dissolves the macro/microscalar tensions' (Dittmer, 2014, p. 386). This resonates with calls in feminist geopolitics to at once recognise 'embeddedness within networks of other agents' (Sharp, 2021, p. 994) and consider geopolitical power in 'more relational ways' (Hyndman, 2004, p. 310) while retaining a focus on how it is unevenly and inequitably felt, experienced, and expressed. A feminist interrogation of drone power as it unfolds thus both accounts for the diverse strains emerging from and accompanying it, and enables bringing multiple actors into connection and a 'shared analytical frame' (Moss & Besio, 2019, p. 317).

The final question this investigation prompts is: what might the strains of drone operation tell us about what methods we should employ to research (drone) warfare? By reapproaching the drone at, for example, the military conference, we are afforded a window into the military knowledges and 'beliefs that interact, fuse, emerge and crystallise' (Klauser & Pedrozo, 2015, p. 290) around issues of personnel and 'manning'. While offering access to the deployment and circulation of such knowledges and revealing forms of strain, so too does the fieldwork demonstrate the challenges of articulating drone strains. They are not solely individual, but rather communal, and further, as the researcher seeks a greater understanding of embodied drone strains, she herself strains to ask questions, struggling with their framing in relation to military terminology. In other words, charting a geopolitics of drone labour prompts us to reflect on both how and where we might access the drone (operator) in the diverse sites and spaces in/through which they are 'made', and to consider how we might further tease out bodily experiences of strain therein. It's also important to ask what the methodological reflexivity employed might tell us about drone strains. While wider work exploring military processes and practices reflects on the 'emotional, embodied, sensed and corporeal manifestations' of militarism and militarization (Dyvik & Greenwood, 2016, p. 2), this article urges further attention still to the researcher's own embodied experiences of undertaking such research.

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Declaration of competing interest

None.

References

Ackerly, B., & True, J. (2008). Reflexivity in practice: Power and Ethics in feminist research on international relations. *International Studies Review, 10*(4), 693–707.
Adey, P. (2010). *Mobility*. New York: Routledge.
Adey, P. (2011). Chapter 8: The private life of an air raid: Mobility stillness, affect. In D. Bissell, & G. Fuller (Eds.), *Stillness in a mobile world* (pp. 127–138). UK: Routledge, 2011.
Adey, P., Denney, D., Jensen, R., & Pinkerton, A. (2016). Blurred lines: Intimacy, mobility, and the social military. *Critical Military Studies, 2*(1–2), 7–24.
Adey, P., Whitehead, M., & Williams, A. J. (2011). Introduction: Air target. Distance, reach and the politics of verticality. *Theory, Culture & Society, 28*(7–8), 173–187.
Air Force Magazine. (2013). Pentagon defends precedence of new medal. Available at: https://www.airforcemag.com/pentagondefendsprecedenceofnewmedal/.
Air Force Times. (2015). Contract jobs for drone pilots are often overseas. Available at: http://www.airforcetimes.com/story/military/2015/04/21/drone-pilot-compensation/25837209/.
Air Force Times. (2016a). Wanted: A few good drone pilots. Available at https://www.airforcetimes.com/news/your-air-force/2016/03/21/wanted-a-few-good-drone-pilots/. (Accessed 21 March 2016).
Air Force Times. (2016b). Air Force plans 100 enlisted drone pilots by 2020. Available at: https://www.airforcetimes.com/news/your-air-force/2016/07/06/air-force-plans-100-enlisted-drone-pilots-by-2020/.
Akhter, M. (2019). The proliferation of peripheries: Militarized drones and the reconfiguration of global space. *Progress in Human Geography, 43*(1), 64–80.
Alkarama. (2015). Traumatizing skies: U.S. Drone operations and post-traumatic stress disorder (PTSD) among civilians in Yemen. Available at: https://www.alkarama.org/en/articles/new-report-shows-us-drone-policy-yemen-leads-severe-trauma-among-civilians-and-sets.
Allinson, J. (2015). The necropolitics of drones. *International political sociology, 9*, 113–127.
Amoore, L. (2007). Vigilant visualities: The watchful politics of the war on terror. *Security Dialogue, 38*, 215–232.
Anderson, B. (2010). Preemption, precaution, preparedness: Anticipatory action and future geographies. *Progress in Human Geography, 34*, 777–798.
Anderson, B. (2021). Affect and critique: A politics of boredom. *Environment and Planning D: Society and Space, 39*(2), 197–217.
Asaro, P. (2013). The labor of surveillance and bureaucratized killing: New subjectivities of military drone operators. *Social Semiotics, 23*, 196–224.
Avionics International. (2017). A day in the life of a US air Force drone pilot. Available at: https://www.aviationtoday.com/2017/03/16/day-life-us-air-force-drone-pilot/.
Axe, D. (2014). Air Force drone crews got so demoralized that they booed their commander. Available at : *War is boring* https://medium.com/war-is-boring/air-force-drone-crews-got-so-demoralized-that-they-booed-their-commander-cfd455fea40f.
Babatunde Adedoyin, O., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2020.1813180
Baggiarini, B. (2015). Drone warfare and the limits of sacrifice. *Journal of International Political Theory, 11*(1), 128–144.
Baird, T. (2017). Knowledge of practice: A multi-sited event ethnography of border security fairs in europe and north America. *Security Dialogue, 48*(3), 187–205.
Baker, C. (2016). Writing about embodiment as an act of translation. *Critical Military Studies, 2*(1–2), 120–124.
Basham, V., & Bulmer, S. (2017). Critical military studies as method: An approach to studying gender and the military. In C. Duncanson, & R. Woodward (Eds.), *Palgrave international handbook of gender and the military* (pp. 59–72). Palgrave Macmillan.
Belcher, O., & Martin, L. (2020). The problem of access: Site visits, selective disclousre, and freedom of information in qualitative security research. In M. de Goede, E. Bosma, & P. Pallister-Wilkins (Eds.), *Secrecy and methods in security research: A guide to qualitative fieldwork* (pp. 33–47). London & New York: Routledge.
Billo, E., & Mountz, A. (2016). For institutional ethnography: Geographical approaches to institutions and the everyday. *Progress in Human Geography, 40*(2), 199–220.
Bosma, E., de Goede, M., & Pallister-Wilkins, P. (2020). Introduction: Navigating secrecy in security research. In M. de Goede, E. Bosma, & P. Pallister-Wilkins (Eds.), *Secrecy and methods in security research: A guide to qualitative fieldwork* (pp. 1–27). London & New York: Routledge.
Bowman, B., & Leitzke, B. (2022). *Avoiding empty cockpits: Addressing the Air Force's pilot shortage problem*. Breaking Defense. Available at: https://breakingdefense.com/2022/08/avoiding-empty-cockpits-addressing-the-air-forces-pilot-shortage-problem/. Available at:.
Boyle, M. J. (2015). The legal and ethical implications of drone warfare. *International Journal of Human Rights, 19*(2), 105–126.
Bryant, B. (2017). Letter from a sensor operator. In L. Parks, & C. Kaplan (Eds.), *Life in the age of drone warfare* (pp. 315–323). US: Duke University Press, 2017.
Butz, D., & Besio, K. (2009). Autoethnography. *Geography Compass, 3*(5), 1660–1674.
Campbell, L., Corson, C., Gray, N. J., MacDonald, K. I., & Brosius, J. P. (2014). Studying global environmental meetings to understand global environmental governance: Collaborative event ethnography at the tenth conference of the parties to the convention on biological diversity. *Global Environmental Politics, 14*(3), 1–20.
Chamayou, G. (2011). The manhunt doctrine. *Radical Philosophy, 169*. https://www.radicalphilosophyarchive.com/commentary/the-manhunt-doctrine.
Chamayou, G. (2013). *A theory of the drone. Translated by Janet Llyod*. New York, London: The New Press.
Chandler, K. (2020). *Unmanning: How humans, machines and media perform drone warfare*. US: Rutgers University Press.
Chappelle, W., Goodman, T., Reardon, L., & Thompson, W. (2014). An analysis of post-traumatic stress symptoms in United States Air Force drone operators. *Journal of Anxiety Disorders, 28*, 480–487.
Chatham House (n.d.). Chatham House rule. Available at: https://www.chathamhouse.org/about/chatham-house-rule#sthash.UrMth5bP.dpuf.
Chow, D. (2013). *US air Force facing drone pilot shortage, study finds*. Available at: Yahoo News https://news.yahoo.com/us-air-force-facing-drone-pilot-shortage-study-213220306.html.
Clark, L. C. (2018). Grim reapers: Ghostly narratives of masculinity and killing in drone warfare. *International Feminist Journal of Politics, 20*(4), 602–623.
Clark, L. C. (2022). Delivering life, delivering death: Reaper drones, hysteria and maternity. *Security Dialogue, 53*(1), 75–92.
Cohn, C. (1987). Sex and death in the rational world of defense intellectuals. *Signs, 12*(4), 687–718.
Cohn, C. (1993). Chapter 10: Wars, wimps, and women: Talking gender and thinking war. In M. Cooke, & A. Woollacott (Eds.), *Gendering war talk* (pp. 227–248). New Jersey, US: Princeton University Press, 1993.

Cohn, C. (2006). Motives and methods: Using multi-sited ethnography to study US national security discourses. In B. A. Ackerly, M. Stern, & J. True (Eds.), *Feminist methodologies for international relations* (pp. 91–107). Cambridge University Press.
Coley, R., & Lockwood, D. (2015). As above, so below. Triangulating drone culture. *Culture Machine, 16*, 1–19.
Crandall, J. (2015). Unmanned: Embedded reporters, predator drones and armed perception. https://journals.uvic.ca/index.php/ctheory/article/view/14700.
Daggett, C. (2015). Drone disorientations: How 'unmanned' weapons queer the experience of killing in war. *International Feminist Journal of Politics, 17*(3), 361–379.
Dávalos, C., & Zaragocin, S. (2022). Island feminism meets feminist geopolitics: The spatial dynamics of gender- based violence in the Galapagos Islands. *Area, 54*, 313–321.
Defence, I. Q. (2015). Delegate review: Unmanned aerial systems training and simulation conference 2014. Available at: https://www.defenceiq.com/air-forces-military-aircraft/articles/delegate-review-unmanned-aerial-systems-training-a.
Dittmer, J. (2014). Geopolitical assemblages and complexity. *Progress in Human Geography, 38*(3), 385–401.
Dowler, L., & Sharp, J. (2001). A feminist geopolitics? *Space and Polity, 5*(3), 165–176.
Drew, C., & Philipps, D. (2015). *As stress drives off drone operators, air Force must cut flights*. Available at : New York Times https://www.nytimes.com/2015/06/17/us/as-stress-drives-off-drone-operators-air-force-must-cut-flights.html.
Dyvik, S. L., & Greenwood, L. (2016). Embodying militarism: Exploring the spaces and bodies in-between. *Critical Military Studies, 2*(1–2), 1–6.
Edney-Browne, A. (2017). Embodiment and affect in a Digital Age: Understanding mental illness among military drone personnel. *Krisis, 1*, 18–32.
Edney-Browne, A. (2019). The psychosocial effects of drone violence: Social isolation, self-objectification, and depoliticization. *Political Psychology, 40*(6), 1341–1357.
Finnerty, R. (2022). *US Air Force continues cash bonuses amid multi-year pilot shortage*. FlightGlobal. Available at: https://www.flightglobal.com/fixed-wing/us-air-force-continues-cash-bonuses-amid-multi-year-pilot-shortage/148238.article. Available at:.
Gettinger, D. (2019). The drone databook. Center for the study of the drone. Available at: https://dronecenter.bard.edu/files/2019/10/CSD-Drone-Databook-Web.pdf.
Government Accountability Office. (2014). Unmanned aerial systems: Actions needed to strengthen management of unmanned aerial system pilots. GAO-14-316 http://gao.gov/products/GAO-14-316.
Government Accountability Office. (2015). Unmanned systems: Actions needed to improve DOD pilot training. GAO-15-461 http://www.gao.gov/products/GAO-15-461.
Government Accountability Office. (2019). Unmanned aerial systems: Air Force pilot promotion rate have increased but oversight process of some positions can be enhanced. https://www.airforcemag.com/PDF/Features/Documents/GAO-Report-RPA-Pilot-Promotion-Rates.pdf.
Government Accountability Office. (2020). Unmanned systems. Air Force should take additional steps to improve aircrew staffing and support. GAO-20-320 https://www.gao.gov/assets/gao-20-320.pdf.
Gray, H. (2016). Researching from the spaces in between? The politics of accountability in studying the British military. *Critical Military Studies, 2*(1–2), 70–83.
Grayson, K., & Mawdsley, J. (2019). Scopic regimes and the visual turn in International Relations: Seeing world politics through the drone. *European Journal of International Relations, 25*(2), 431–457.
Gregory, D. (2011). From a view to a kill: Drones and late modern war. *Theory, Culture & Society, 28*(7- 8), 188–215.
Gregory, D. (2011a). The everywhere war. *The Geographical Journal, 177*(3), 238–250.
Gregory, D. (2011b). Lines of descent. *Open Democracy*. https://www.opendemocracy.net/en/lines-of-descent/.
Gregory, D. (2016). The territory of the screen. *MediaTropes, VI*(2), 126–147.
Hall Kindervater, K. (2016). The emergence of lethal surveillance: Watching and killing in the history of drone technology. *Security Dialogue, 47*(3), 223–238.
Hall Kindervater, K. (2017). The technological rationality of the drone strike. *Critical Studies on Security, 5*(1), 28–44.
Hardison, C. M., Mattock, M. G., & Lytell, M. C. (2012). Incentive pay for remotely piloted aircraft career fields. RAND corporation. Available at : https://www.rand.org/content/dam/rand/pubs/monographs/2012/RAND_MG1174.pdf.
Higate, P., & Cameron, A. (2006). Reflexivity and researching the military. *Armed Forces & Society, 32*(2), 219–233.
Hijazi, A., Ferguson, C. J., Ferraro, F. R., Hall, H., Hovee, M., & Wilcox, S. (2019). Psychological dimensions of drone warfare. *Current Psychology, 38*, 128–1296.
Hobbs, A., & Lyall, B. (2016). Human factors guidelines for unmanned aircraft systems. *Ergonomics in Design*, 23–28.
Hoggart, K., Lees, L., & Davies, A. (2002). *Researching human geography*. London: Arnold.
Holloman Air Force Base. (2012). 18X pilots learn RPAs first. Available at : http://www.holloman.af.mil/news/story.asp?id=123289389.
Humanscale. What is ergonomics?. n.d. https://uk.humanscale.com/ergonomics/what-is-ergonomics/. Available at:
Hyndman, J. (2004). Mind the gap: Bridging feminist and political geography through geopolitics. *Political Geography, 23*, 307–322.
Hyndman, J. (2019). Unsettling feminist geopolitics: Forging feminist political geographies of violence and displacement. *Gender, Place & Culture, 26*(1), 3–29.
IHS Jane's 360. (2015). USAF unveils UAV operator retention plan. Available at: http://www.janes.com/article/53020/usaf-unveils-uav-operator-retention-plan.
Jackman, A. (2016). Rhetorics of possibility and inevitability in commercial drone tradescapes. *Geographica Helvetica, 71*(1), 1–6.
Jackman, A., & Brickell, K. (2022). Everyday droning': Towards a feminist geopolitics of the drone-home. *Progress in Human Geography, 46*(1), 156–178.
Joyce, K. E, Anderson, K., & Bartolo, R. E. (2021). Of course we fly unmanned—We're women! *Drones, 5*(21), 1–4.
Klauser, F., & Pedrozo, S. (2015). Power and space in the drone: A literature review and politico-geographical research agenda. *Geographica Helvetica, 70*, 285–293.
Koch, N. (2018). The geopolitics of sport beyond soft power: Event ethnography and the 2016 cycling world championships in Qatar. *Sport in Society, 21*(12), 2010–2031.
Laurier, E. (2016). Participant observation. In N. Clifford, M. Cope, & T. Gillespie (Eds.), *French, S. Key Methods in geography* (3rd ed., pp. 116–131). US: Sage Publications Ltd.
Lee, P. (2018). *Reaper Force: Inside Britain's drone wars*. UK: John Blake Books.
Levitas, E. (2013). Confessions of a drone warrior. GQ. Available at: https://www.gq.com/story/drone-uav-pilot-assassination.
Living Under Drones. (2012). International human rights and conflict resolution clinic at stanford law school and global justice clinic at NYU school of law, living under drones: Death, injury, and trauma to civilians from US drone practices in Pakistan. Available at: https://law.stanford.edu/wp-content/uploads/2015/07/Stanford-NYU-LIVING-UNDER-DRONES.pdf.
Longhurst, R., Ho, E., & Johnston, L. (2008). Publishing ltd using 'the body' as an 'instrument of research': kimch'i and pavlova. *Area, 40*(2), 208–217.
Losey, S. (2020). Air Force doesn't have enough drone pilots or sensor operators, GAO says. AirForceTimes. Available at: https://www.airforcetimes.com/news/your-air-force/2020/06/26/air-force-doesnt-have-enough-drone-pilots-or-sensor-operators-gao-says/.
Massaro, V. A., & Williams, J. (2013). Feminist geopolitics. *Geography Compass, 7/8*, 567–577.
McCann, E. (2011). Urban policy mobilities and global circuits of knowledge: Toward a research agenda. *People, place, and region, 101*(1), 107–130.
McSorley, K. (2014). Towards an embodied sociology of war. *Sociological Review, 62*(2), 107–128.
McSorley, K. (2016). Doing military fitness: Physical culture, civilian leisure, and militarism. *Critical Military Studies, 2*(1–2), 103–119.
Military.com. (2016). Pentagon debuts 'R' award device for drone warfare to mixed reviews. Available at: https://www.military.com/daily-news/2016/01/09/pentagon-debuts-r-award-device-for-drone-warfare.html.
Moss, P., & Besio, K. (2019). Auto-methods in feminist geography. *GeoHumanities, 5*(2), 313–325.
National Institute of General Medical Sciences (n.d.). Circadian rhythms. Available at: https://www.nigms.nih.gov/education/fact-sheets/Pages/circadian-rhythms.aspx#:~:text=Circadian%20rhythms%20are%20physical%2C%20mental,the%20study%20of%20circadian%20rhythms.
Noys, B. (2014). *Drone metaphysics, presentation at "as above, so below – a colloquium on drone culture"*. UK: University of Lincoln, 24 May 2014.
Ouma, J. A., Chappelle, W. L., & Salinas, A. (2011). *Facets of occupational burnout among U.S. Air Force Active Duty and National Guard/Reserve MQ-1 Predator and MQ-9 Reaper operators*. Air Force Research Laboratory. Available at: https://apps.dtic.mil/sti/pdfs/ADA548103.pdf. Available at:.
Parks, L., & Kaplan, C. (2017). *Life in the age of drone warfare*. US: Duke University Press.
Pugliese, J. (2016). Drone casino mimesis: Telewarfare and civil militarization. *Journal of Sociology, 52*(3), 500–521.
Rech, M. (2015). A critical geopolitics of observant practice at British military airshows. *Transactions of the Institute of British Geographers, 40*, 536–548.
Rech, M. F., & Williams, A. J. (2016). Researching at military airshows: A dialogue about ethnography and autoethnography. In A. J. Williams, N. K. Jenkings, M. F. Rech, & R. Woodward (Eds.), *The routledge companion to military research methods* (pp. 268–284). Oxon, UK: Routledge: Oxon.
Richardson, M. (2022). How to witness a drone strike. *Digital War*, 1–15. https://doi.org/10.1057/s42984-022-00048-3
Richardson, M. (2022a). *Drone trauma: Violent mediation and remote warfare* (pp. 1–10). Media, culture & society. https://doi.org/10.1177/01634437221122257
Schuppli, S. (2014). Uneasy listenin. In *Forensic Architecture.Forensis: The Architecture of public truth* (pp. 381–392). Berlin: Sternberg Press.
Schuppli, S. (2014a). Deadly algorithms. *Radical Philosophy, 187*, 2–8.
Schuurman, N. (2013). Tweet me your talk: Geographical learning and knowledge production 2.0. *The Professional Geographer, 65*(3), 369–377.
Schwarz, E. (2018). Flesh and steel: Antithetical materialities in the war on terror. *Critical Studies on Terrorism, 11*(2), 394–413.
Sharkey, N., & Suchman, L. (2013). Wishful mnemonics and autonomous killing machines. *Artificial Intelligence and the Simulation of Behaviour Quarterly, 136*, 14–22.
Sharp, J. (2021). Materials, forensics and feminist geopolitics. *Progress in Human Geography, 45*(5), 990–1002.
Stahl, R. (2013). What the drone saw: The cultural optics of the unmanned war. *Australian Journal of International Affairs, 67*(5), 659–674.
Stars, & Stripes. (2013). Distinguished warfare medal is off to a rocky start. Available at: https://www.stripes.com/distinguished-warfare-medal-is-off-to-a-rocky-start-1.210188.
Suarez, D., & Corson, C. (2013). Seizing center stage: Ecosystem services, live, at the convention on biological diversity. *Human Geography, 15*(1), 64–79.
Temenos, C., & McCann, E. (2013). Geographies of policy mobilities. *Geography Compass, 7*(5), 344–357.
The Atlantic. (2014). A rare look inside the Air Force's drone training classroom. Available at: http://www.theatlantic.com/technology/archive/2014/06/a-rare-look-inside-the-air-forces-drone-training-classroom/372094/.
Unmanned Experts (n.d). What we do. Available at: http://www.unmannedexperts.com/about-us-2/our-mission, 1/March/15.

Unmanned Experts. (2014). Unmanned Experts brochure. Available at: http://www.unmannedexperts.com/wp-content/uploads/140610-UMEX-Training-Course-Brochure-US.pdf, 7.July.14.
US Air Force. (2008). *Air Force smart Operations for the 21st century* (AFSO21). Available at: http://www.au.af.mil/au/awc/awcgate/af/afso21-fact-sheet.pdf.
US Air Force. (2015). Air Force moves to bring about RPA mission relief. Available at: http://www.af.mil/News/ArticleDisplay/tabid/223/Article/589196/air-force-moves-to-bring-about-rpa-mission-relief.aspx.
US Air Force. (2019). MQ-1B, MQ-9 flight hours hit 4 million. Available at: https://www.af.mil/News/Article-Display/Article/1781271/mq-1b-mq-9-flight-hours-hit-4-million/.
Vertesi, J. (2012). Seeing like a rover: Visualization, embodiment, and interaction on the mars exploration rover mission. *Social Studies of Science, 42*(3), 393–414.
Wall, T. (2013). Unmanning the police manhunt: Vertical security as pacification. *The Social Studies, 9*(2), 32–56.
Waraich, Q. R., Mazzuchi, T. A., Sarkani, A., & Rico, D. F. (2013). Minimizing human factors mishaps in unmanned aircraft systems. *Erogonomics in Design*, 25–32.
Wilcox, L. (2017). Embodying algorithmic war: Gender, race, and the posthuman in drone warfare. *Security Dialogue, 48*(1), 11–28.
Williams, A. J. (2011). Enabling persistent presence? Performing the embodied geopolitcs of the unmanned aerial vehicle assemblage. *Political Geography*, 381–390.
Williams, A. J. (2013). Re-orientating vertical geopolitics. *Geopolitics, 18*(1), 225–246.
Winner, L. (1993). Upon opening the black box and finding it empty: Social constructivism and the philosophy of technology. *Science, Technology & Human Values, 18*(3), 362–378.
Wood, A. (2016). Tracing policy movements: Methods for studying learning and policy circulation. *Environment & Planning A, 48*(2), 391–406.
Woodward, R. (2005). From military geography to militarism's geographies: Disciplinary engagements with the geographies of militarism and military activities. *Progress in Human Geography, 29*(6), 718–740.
Woodward, R. (2014). Military landscapes: Agendas and approaches for future research. *Progress in Human Geography, 38*(1), 40–61.
Woodyer, T. (2008). The body as research tool: Embodied practice and children's geographies. *Children's Geographies, 6*(4), 349–362.