Australian Army
Research Centre

From Tools to Teammates:

Human-Machine Teaming and the Future of Command and Control in the Australian Army

Alex Neads, David J. Galbreath and Theo Farrell

Australian Army Occasional Paper No. 7

Australian Army
Research Centre

From Tools to Teammates:

Human-Machine Teaming and the Future of Command and Control in the Australian Army

Australian Army Occasional Paper No. 7

Serving our Nation

ISSN (Online) 2653-0406
ISSN (Print) 2653-0414

This research was funded under contract no. AARC 13/19, and received ethical approval from the Defence People Research–Low Risk Ethics Committee under protocol number 010-20.

All enquiries regarding this publication should be forwarded to the Director of the Australian Army Research Centre.

To learn about the work of the Australian Army Research Centre visit researchcentre.army.gov.au.

Contents

Abstract

In 2018, the Australian Army launched its Robotic and Autonomous Systems Strategy to capitalise on the military opportunities presented by the much-anticipated 'fourth industrial revolution' in artificial intelligence and machine learning software. The key to realising this potential lies in the effective integration of soldiers and autonomous systems, known as human-machine teaming. Through human-machine teaming, military automation is predicted to radically reshape the conduct of war, with substantial implications for the future of command and control. However, such visions depend not just on the technical capabilities of new autonomous systems, but also on the choices soldiers make about how to use them. This paper explores the compatibility of emerging concepts of human-machine teaming with existing Australian Army culture and practices, drawing on interviews with serving officers and focusing specifically on the implications for military command and control. The paper assesses the risks and opportunities arising from automation for future concepts, doctrine development and organisational change.

Introduction

Since the end of the Cold War, technological advances in information processing and digital connectivity have provided Western armed forces with a substantial battlefield advantage.[1] This has been particularly important in the context of the declining mass of Western militaries. In recent years, however, Western nations have been forced to confront a new set of challenges and opportunities. The profusion of Anti-Access and Area Denial (or A2AD) capabilities among strategic rivals has begun to erode the technological supremacy on which Western forces have come to rely. The much-anticipated 'fourth industrial revolution' in robotics and machine learning software offers the promise of a new source of technological advantage.[2] In 2018, the Australian Army launched its Robotic and Autonomous Systems (RAS) Strategy to capitalise on this opportunity, mirroring similar interest among partner nations.[3] RAS are increasingly viewed as central to future concepts of joint warfighting across the Australian Defence Force (ADF), underpinned by a recent increase of $270 billion in defence expenditure over the coming decade. Of this, $55 billion has been earmarked for investment in land forces capabilities, to provide, among other things, a fleet of new Unmanned Arial Vehicles (UAVs) and enough uncrewed combat vehicles to equip a brigade.[4] If the last revolution in warfare was digitised, it is anticipated that the coming revolution will be automated.

The key to realising this potential lies in the effective integration of soldiers and autonomous systems, known as human-machine teaming (HUM-T). As autonomous systems become more capable, so they are expected to first enhance and then augment existing capabilities, gradually enabling fundamentally new concepts of operation. The ability to usefully interact with the environment independent of human direction—that is, to undertake cognition—will allow autonomous systems to perform functions that only

humans are currently capable of. Consequently, in addition to enabling robotic vehicles and remote weapons systems, autonomy is expected to enable new ways of planning and conducting military activity across time and space. This, in turn, will necessitate existing practices of command and control to evolve. In so doing, autonomous systems will become as integral to the delivery of military effect as the soldiers that operate alongside them; in a functional sense, they will cease to be mere tools and become de facto team members in their own right.[5] However, this vision depends not only on the technical capabilities of autonomous systems but also on how humans use them. As one recent study observed, 'robotic and AI systems will be limited by not only what can be done, but also by what actors trust their machines to do'.[6] Successful HUM-T, therefore, depends in part on understanding and overcoming the social, organisational and cultural barriers to enacting military change.

This paper explores the compatibility of emerging concepts and capabilities of HUM-T with existing Australian Army culture and practices, focusing specifically on the implications for military command and control. Given the emergent nature of military automation, the ultimate implications of HUM-T for the conduct of war remain highly uncertain, with a wide array of possible outcomes conceivable in the long term. Consequently, this study is limited to discussion of the likely near-term effects of HUM-T in the coming decade to 2030, where automation's maturing capabilities are better understood and less speculative. It aims to identify risks and opportunities of greater automation for the Australian Army, by providing an insight into the range of attitudes and expectations held by serving Army officers in relation to HUM-T. It will address the following questions:

- What do Australian officers believe about the potential for military automation?
- How might these attitudes affect the use of automation in future command and control?
- What implications could HUM-T have on the Army's existing organisational preferences?

In so doing, the research is intended to shed further light on the potential consequences of HUM-T for the practice of Australian military command and control, highlighting the potential impediments and opportunities for implementation.

The dire consequences of failure on the battlefield provides armed forces with a powerful competitive imperative to innovate. At the same time, however, the future intentions and actual capabilities of other states are often somewhat opaque, forcing military organisations to navigate profound environmental uncertainties that complicate the ability to discern the potential worth of any novel military technology.[7] Thus, while the threat of failure provides a strong inducement for military change, uncertainty tends to temper this imperative with a degree of caution—especially when it comes to the wholesale adoption of new and unproven military innovations.[8] In theory, therefore, an army's interest in new technology can be understood as the product of a rational cost-benefit analysis, in which the potential military benefits (and risks) of innovation are weighed against the financial and organisational costs of implementation. Michael Horowitz has described this balance as the 'adoption-capacity' of an armed force.[9] Importantly, however, the shared attitudes, expectations and preconceptions that officers hold about military technology in general, and specific innovations in particular, can significantly influence each half of this 'adoption-capacity' equation, shaping collective understandings of both the costs and the benefits of new technology alike. These shared beliefs and values, together encompassing an army's collective identity and accepted ways of operating, are known as *military culture*. Military culture is typically codified in doctrine and regulations and reinforced through training and exercises, as well as through the rituals of barrack life. It exerts a powerful influence on organisational behaviour, by defining how challenges are perceived and the range of available (i.e. acceptable) actions. Here, the corporate attitudes and beliefs of the officer corps are particularly important, because it is typically (though not exclusively) via the leadership function vested in the officer corps that military culture both is perpetuated and becomes translated into organisational behaviour.[10]

Firstly, existing military values and preferences shape an army's perceptions of the potential value of new technology. For example, the French Army's disastrous defeat in the summer of 1940 was in no small measure the result of a failure to recognise the implications of armoured vehicles on the conduct of war. However, the French were by no means ignorant of the technological capabilities of the tank, and French tanks were in many respects technically superior to those fielded by the Wehrmacht. Instead, professional scepticism in the French officer corps—at the ability to conduct offensive operations with short-service conscript soldiers—led the

French Army to dismiss the potential for armoured manoeuvre in favour of apparently tried-and-tested defensive strategies.[11] More recently, existing institutional values consistently shaped the selection and dissemination of battlefield adaptations to counterinsurgency in various International Security Assistance Force (ISAF) armies' lessons learnt processes during the conflict in Afghanistan.[12] Importantly, military attitudes do not always stymie innovation, and can equally facilitate change. For example, Ireland actively embraced the British model of military mechanisation during the interwar period, despite its relative financial unaffordability, primarily because mechanisation comported with the newly founded Irish Army's ideals of corporate professionalism.[13] In like fashion, the partial European adoption of Network-Centric Warfare (NCW) has been described as a form of uncertainty management, driven in part by NATO perceptions of the US military as the yardstick of professional best practice, albeit tempered by shallower financial pockets.[14]

Secondly, and by extension, officers' receptivity to new technology can also significantly alter the *costs* of organisational change, affecting the prospects for successful adoption. Technological innovation typically necessitates accompanying doctrinal and organisational reforms, as new concepts of operation and ways of working displace the old. The advocates of change must therefore overcome factional resistance from threatened professional communities within the military institution, requiring high levels of organisational capital. As Stephen Rosen has argued, the implementation of military innovation is often characterised by bureaucratic power struggles over the levers of funding, structures and doctrine needed to implement reform. Yet success is not simply the product of adept bureaucratic politics; it also reflects ideational cleavages within the officer corps over appropriate visions of future warfare, and all the professional and organisational implications they hold.[15] Consequently, the extent to which new technological visions chime with widespread military beliefs and identities can significantly determine the outcomes of innovation efforts—not least because the effective incorporation of new military technologies typically requires substantial testing and adjustment at the grassroots to work through teething problems, as Eliot Cohen has observed.[16]

The military cultures of advanced states have generally displayed growing techno-centrism.[17] Traditionally navies and air forces have led the way, reflecting their platform-centric structures and cultures.[18] However, armies have caught up with the increasing integration of electronics in battlefield systems since the 1970s.[19] At the same time, as Rosen's work shows, when it comes to *particular* new technologies, officer attitudes are critical to successful adoption. Here the history is complex. For example, analysis of the US Army during the Civil War and the Second World War shows that reactionary senior officers periodically acted as potent obstacles to technological change.[20] Yet this should not imply that younger officers are always more supportive of new technology. Studies of the contemporary US military have found that junior officers are often too preoccupied with learning their trade to be much interested in innovation, while the connections and influence of reformist-minded senior commanders have been pivotal to some recent doctrinal reforms.[21] Thus, careful study is required to uncover and assess officer attitudes in a particular army, at a particular time, to a particular set of new technologies. At present, however, little concerted research exists on the character and variety of Australian military attitudes to new autonomous systems, and less still on their implications for future doctrine and policy. Consequently, this paper seeks to understand the landscape of contemporary Australian officers' attitudes to automation, focusing on an area that is critical to the future conduct of operations: command and control.

This study was funded by the Australian Army Research Centre under the Army Research Scheme 2019.[22] Methodologically, it is based on interviews with serving Army officers, supported by secondary published policy and research material on military automation. In total, 17 serving Australian Army officers were interviewed for this project, ranging in rank from major to major general, together with one senior civilian expert. Existing observations of Army culture by Australian officers have tended to draw cultural distinctions between officers with significant staff experience in higher headquarters and those serving at regimental and formation level.[23] Accordingly, participants were deliberately drawn from command and staff appointments at joint and Army headquarters—and at divisional, brigade and unit level—in order to sample perspectives from officers with a range of backgrounds and experiences, and thereby facilitate comparison within and between different segments of the officer corps.

The remainder of this paper is structured in the following way. In ‘Military Automation and the Australian Army’, understandings of HUM-T as a concept are examined, comparing institutional expectations of potential benefit with perceptions of opportunity and risk present in the wider Australian officer corps. ‘The Architecture of Human-Machine Command and Control’ explores the socio-technical nature of command and control, examining the interdependences between tactics, technology, procurement and military culture in the systemic design of digital architectures, and the challenges this presents for the introduction of HUM-T in command and control. The role of human trust in autonomous systems—and in the doctrines of command and control that will guide their use—is discussed in ‘Trust and Technology in Future Command and Control’, together with associated implications HUM-T will raise for organisation change. In the final section, conclusions as to the offi cer corps’ receptivity to the ideals of an automated military revolution are presented, with specific observations on the likely influence Australian military culture will have on the implementation of future concepts of HUM-T in command and control.

Military Automation and the Australian Army

This chapter explores the strategic and tactical promise of automation for the Australian Army, and the cultural challenges this may present for the Army. Autonomy can be understood as 'the ability of a machine to perform a task without human input', and exists on a spectrum defined by the degree of human direction or supervision a system's information processing and synthetic decision-making capabilities requires to operate effectively. By reducing and eventually removing the necessity for human input, expected advances in artificial intelligence (AI) have the potential to radically remake the costs and conduct of warfare, potentially relieving soldiers of the most 'dirty, dangerous, and dull' tasks. Moreover, this potential extends well beyond the applications of military robotics systems—sometimes referred to as 'autonomy-in-motion'—to include a range of essentially information-centric processes, known as 'autonomy-at-rest'.[25] Indeed, it is the combination of both robotic systems and autonomous processes that defines emerging visions of future warfare—and, with it, HUM-T. This chapter compares the understanding of automation's potential value as presented in official policy and concept documents with the views and beliefs of serving Australian officers, to assess the Army's cultural receptivity to HUM-T. It focuses first on the strategic imperatives for Defence investment in automation, before examining officer understandings of HUM-T and the alignment of these with evolving Australian military culture.

Contemporary conflicts foreshadow the potential for RAS to transform the conduct of warfare. Recent fighting in the Donbas and Nagorno-Karabakh have demonstrated that UAVs can rapidly locate and cue precision fires on armoured and mechanised forces with devastating effect, foreshadowing how next-generation AI-enabled loitering munitions could reshape the conventional battlefield.[26] David Kilcullen has similarly described

the proliferation of small UAVs as akin to the advent of the machine gun in its potential to transform even the most elementary of tactical concepts.[27] Nonetheless, the desirability of greater automation has not been universally accepted, despite warnings that a 'future force that does not have fully autonomous systems may not be able to effectively compete with an enemy that does'.[28] Jai Galliott, for example, has dismissed the battlefield impact of UAVs as overblown, arguing against 'the idea that a semi-autonomous robot arms race is inevitable' as 'a pernicious double negative aimed at establishing that there is a current or future capability gap that warrants sacrificing humans for the hurried adopting of cutting edge technology'.[29] Historically, such disagreements over the ambiguous value of military technology have persisted long after its adoption, continuing to shape battlefield employment even in the face of wartime experience.[30] Consequently, identifying the contextual value that Australian officers place on military automation is essential to an understanding of likely reactions to its future employment.

The Strategic Context of Military Automation

Current Australian interest in military automation must be understood in the light of the recent changes to Australia's geo-strategic environment. Buoyed by decades of economic growth, China's international posture has become ever more assertive, provoking countervailing reactions from regional states. A weakening of the US's engagement with its alliance and international obligations under the Trump Administration has also led allies around the world to reassess the long-term role and reliability of the United States in underwriting regional security. In the words of Australia's 2020 Defence Strategic Update, the Indo-Pacific 'is in the midst of the most consequential strategic realignment since the Second World War', leading to escalating tensions and mounting concern at the potential for strategic miscalculation.[31] In the face of this growing regional uncertainty, the ADF no longer expects to rely on a margin of advanced warning in which to prepare for a strategic crisis, while the Australian Army has stated its intention to become both 'Ready Now' and simultaneously also 'Future Ready'.[32] These challenges are widely recognised as the driving influence in Army policy, especially given Australia's gradual reduction in operational commitments in the Middle East over the last decade. Moreover, participants in this study tended to accept the characterisation of China as a destabilising influence, likening the present situation to that of the 'Roaring 20s' in terms of growing military competition, political contestation, and subversion in the region.[33]

The diffusion of conventional military technology sits firmly at the heart of this sense of strategic unease. Like most Western armed forces, Australia has traditionally relied on qualitative advantages to offset quantitative disadvantages—in other words, on improvements in technology, tactics and training to make up for declining military mass. More broadly, the global military pre-eminence enjoyed by Western forces since the fall of the Berlin Wall has largely depended on American technical dominance in the electromagnetic spectrum, facilitating the surveillance, communication, coordination and precision targeting needed to generate local overmatch in the 'global commons' of land, sea and air.[34] However, the recent acquisition of so-called A2AD capabilities—including satellite communications, electronic surveillance and jamming, and long-range precision strike—by revisionist states like China and Russia has begun to erode the technological foundations of Western military power.[35]

For Australia, this levelling of the technological playing field has radically increased the potential costs of projecting force and reduced strategic options by 'placing Australian military forces at greater risk over longer distances'.[36] Australia now faces challenges from opponents in all operational domains (land, air, maritime, space and cyber).[37] Echoing official Defence statements, multiple participants noted the increasing range, precision and speed of modern weapons systems as an area of particular concern, alongside a fear that advances in adversary capabilities are outstripping their sister Services' ability to the secure maritime approaches to Australia's continental landmass.[38] This creates the logic for new Australian military capabilities to 'hold potential adversaries' forces and infrastructure at risk from a greater distance' in order to safeguard the ability to 'shape Australia's strategic environment, deter actions against our interests and, when required, respond with credible military force'.[39]

Australian interest in military automation should be viewed in this wider context of defence investment to regain strategic advantage. RAS are expected to improve force protection, both directly, by improving the ability to detect and intercept incoming threats, and indirectly, by distancing friendly troops from the performance of high-risk tasks like urban breaching, obstacle clearance and chemical, biological, radiological and nuclear (CRBN) detection. Autonomous systems will also enable the collection, sharing and processing of information at a hitherto impossible speed and scale, reducing cognitive burdens on commanders and staff and improving

the quality and rapidity of decision-making. At the tactical level, automation is expected to drive up tempo and facilitate the rapid concentration and dispersal of force, underpinned by new efficiencies in the use of time, space and logistical resources. Together, expendable robotic systems and scalable information processing will effectively constitute a new form of military mass, facilitating both 'decision superiority' and new forms of physical manoeuvre.[40]

Here, the Australian Army's vision of military automation mirrors that of other comparable Western armed forces. The UK military, for example, views automation as the route to gaining 'information advantage for understanding, decision-making, tempo of activity and assessment' by extending the reach and persistence of information-gathering capabilities, describing the more 'agile' command and control this would facilitate as 'the pre-eminent future force joint function'.[41] The US Army likewise views RAS as the way to 'defeat capable enemies and maintain overmatch' by improving situational awareness, enabling both protection and manoeuvre, and concomitantly reducing the mental and physical burdens placed on warfighters. In the long term, the US Army expects RAS to facilitate 'mission command on-the-move', underpinning 'high-tempo, decentralized operations'—particularly out of area.[42]

Partner armed forces are explicit about the competitive motives driving their interest in automation. The US Army, for instance, has unambiguously stated that it is pursuing HUM-T 'with urgency because adversaries are developing and employing a broad range of advanced RAS technologies ... to disrupt US military strengths and exploit perceived weaknesses'. Similarly, the UK Joint Concept Note argues that 'we are in a race with our adversaries to unlock this advantage. The clock is ticking'.[43] In contrast, Australian officers place less emphasis on military automation for assuring the Army's future capabilities in conventional warfighting. Instead, participants highlighted autonomy's potential utility for countering novel 'hybrid' or sub-threshold threats, especially in the cyber and informational domains, reflecting the view that the regional security competition in the coming decade would largely be characterised by economic competition and 'grey zone' subversion. As one officer bluntly stated, 'I don't see us preparing for threats to Australia in the physical domain'.[44]

Consequently, the Australian officers in this study primarily understood the value of autonomy through its ability to facilitate the Army's longstanding preference for expeditionary operations. As one participant noted,

the 'Australian Army is a light infantry army ... It sees technology as something you've got to carry on your back'.[45] Another criticised the Army's recent shift towards heavier armoured forces, decrying the 'purchasing [of] top-end capabilities that we can't move anywhere in the world'.[46] Thus, while the defence of Australian soil remains the Army's ultimate task, the ability to project force in order to shape Australia's near abroad is seen as the primary means to preclude such a last resort. It was recognised that automation was important to maintaining continued investment in next-generational land forces in the face of inter-service budget competition. At the same time, many interviewees also recognised that the Army's role, vis-à-vis its sister Services, has shifted from being the supported force to being a supporting force.[47] Participants also emphasised the need to acquire 'cross-domain' land capabilities able to support naval and air assets in the defence of Australia's maritime approaches, alongside capabilities for amphibious and littoral operations at distance from Australia.[48]

At the same time, officers recognised that Australian expeditionary operations remain reliant on allied support, given Australia's lack of organic military mass. As one participant noted:

> *… the Australian Army is small and our contributions since World War Two have been at brigade level and below. We're really good at battalion level activities. Moving up above battalion level formations is a bit of a struggle.*[49]

Similarly, as Major General Ryan has observed, '[w]e've always had a bigger brother to take care of strategy and war logistics—e.g., World War I, World War II, Korea, Vietnam'.[50] Consequently, to be strategically useful, Australian forces must also remain interoperable with those of key coalition partners.[51] Indeed, the prospect of falling behind the military capabilities of the US and other Five Eyes partners is a significant strategic concern for Australian officers—particularly in core procedural areas like targeting, where technological capabilities play an important role.[52] This is not to say that Australia lacks national science and technical capabilities per se, as Australian participation in projects such as TORVICE (Trusted Operation of Robotic Vehicles in a Contested Environment) attests.[53] However, in the view of many serving officers, maintaining both interoperability and deployability has nonetheless become an increasing challenge as partner armed forces, and especially the US Army, have become increasingly armoured and techno-centric—a tension reflected

both in the Australian Army's own drive towards heavier platforms in recent years and in individual officers' interest in the US Marine Corps' alternative, lighter-weight littoral concepts.[54]

Interestingly, Australian officers recognise automation's potential to 'mitigate Western military weakness in terms of casualty aversion'. However, here too, this should be understood in relation to Australia's *existing* paucity of combat mass—not simply as a political consideration in wars of contested choice but as a strategic game-changer.[55] As Major General Kathryn Toohey has observed, 'for a modestly-sized force such as the Australian Army, the opportunity to generate greater mass is very appealing'.[56] Similarly, the UK also explicitly hopes to use automation as a surrogate for conventional mass, enabling 'battlefield points of presence increasingly independent of the numbers and locations of human combatants'.[57] Through autonomy, the Australian Army hopes to be tactically sized, lightweight and deployable but still lethal and survivable. In the words of the ADF's recent concept for RAS, autonomous systems potentially provide 'the opportunity to fundamentally alter the structure of Defence from a force of a few large and expensive platforms to one of many small and cheap platforms'.[58]

In the Australian context, therefore, military automation is appealing less because it may allow Australia to go toe-to-toe with a Great Power than for its apparent ability to resolve the Army's present trade-offs between tactical survivability and strategic employability. While, in the words of one serving officer, a 'survivable medium [weight] vehicle is not feasible ... you are either at 30 tons plus or airmobile', autonomous systems would not be bound by the same constraints.[59] Without the need for heavy armour to protect human crew, for example, autonomous vehicles could provide comparable offensive capabilities at a much lighter (and therefore more agile and strategically transportable) platform weight—provided the industrial capacity (and a low enough unit cost) existed to rapidly replace any attrited mass. Moreover, the generation of expendable, deployable autonomous mass is seen as a significant force multiplier. While the Army at its current size is inherently unable to sustain more than a single deployed brigade, large numbers of cheap, light autonomous platforms might allow the Army to sustain a much larger deployed formation with the same number of soldiers. Indeed, this is explicitly recognised in the Army's RAS Strategy: 'teaming humans with RAS machines can significantly increase combat effect and mass without the need to grow the human workforce'.[60] As one participant put it, 'HUM-T can

expand mass effect' and give a battlegroup 'the combat power of what we associated with a brigade'.[61] In this way, HUM-T promises to increase the Army's tactical and strategic utility.

Human-Machine Teaming and Army Culture

Military thinking in Australia, the UK and the US has coalesced around the concept of HUM-T as the best way to integrate automation technologies in ground forces. It is argued that teaming soldiers and machines promises to improve individual and team performance, enable new operating concepts, and ultimately increase national military power.[62] However, there is much to be clarified around HUM-T, including a precise definition as well as implications for future operations and force design.[63] HUM-T is broadly understood to mean the incorporation of autonomous or robotic systems within military teams to achieve tactical outputs that neither machines nor people could deliver independently; as one participant put it, HUM-T is 'in the literal sense human plus machine but teaming so as to play the components to their respective strengths'.[64] Similarly, Major General Toohey has argued that the 'vision here is of a "centaur" concept, where humans partner with machines to produce a better outcome than just a human or a machine on their own'.[65] This view is consistent with emergent doctrine in the United Kingdom, which presents HUM-T as about 'understanding the relative strengths of humans and machines, and how they best function in combination to outperform an opponent'.[66]

HUM-T does offer the potential to realise personnel savings through process automation.[67] However, as Major General Mick Ryan has argued, the concept of HUM-T 'isn't about replacing people, it's about helping them to be more creative'.[68] Indeed, many participants took a human-centric view of HUM-T as about 'the use of machines to make us better at fighting', primarily by 'allowing people to gather the right information and data to improve decision-making efficiency'; ultimately, the 'human is still in charge in control, with machines doing the bidding'.[69] Nonetheless, automation is expected to cause very widespread role displacement in the civilian economy in the decades to come, and there is every reason to expect that machines will displace some human roles in the military sector (in particular, the aforementioned 'dull, dirty and dangerous tasks').[70] This suggests that the success of HUM-T ultimately may be contingent on the extent to which Australian officers are content for soldiers to be supplanted by machines in particular roles and contexts.

In general, officers do not appear comfortable with the prospect of relinquishing core military functions to fully autonomous machines, preferring to talk about HUM-T as 'optimisation' rather than 'replacement', or raising concerns about the robustness of HUM-T under pressure in contact.[71] While HUM-T was seen as theoretically enabling better synergies between soldiers and machines by 'playing the components to their respective strengths', officers also worried that the inherent limitations of autonomous systems compared to humans would inevitably see soldiers simply relegated to those tasks that could not easily be automated.[72] Indeed, the British military has explicitly recognised this danger, warning that 'approaches to human-machine teaming that adopt the 'automate what you can, leave the humans to fill in the remainder' view are likely to build systems that are cheap, but less resilient or effective than approaches deliberately maximising the strengths of each.[73]

Problematically, some of the functions RAS are most likely to perform are those most deeply ingrained in Australian military identities. The organisational culture of the Australian Army privileges dismounted close combat skills, with the Army's warrior culture 'built from the bottom-up' around 'being brilliant at the basics'.[74] Consequently, officers described Army culture as 'super, super tactical', with the 'light infantry mindset' practically in the force's DNA.[75] This emphasis is reflected in successive iterations of the Army's formal ethos and doctrine. The 'I'm an Australian Soldier' initiative, for example, described every soldier as 'an expert in close combat' and as 'physically tough'; and these attributes remain in the opening statement of the Army's solemn obligation to the nation. The Army's recent 'cultural optimisation initiative' has likewise been couched around 'good soldiering', while the Forces Command Plan 2020–28 centres on the promotion of 'combat behaviours' including individual marksmanship, unarmed combat, first aid under fire, and physical fitness.[76] Indeed, this image of Australian soldiering is deeply embedded in wider Australian society through the foundational role of the ANZAC legend in national identity, performatively reinforced though the Army's public symbols, traditions and ceremonies, together with the widespread belief in the myth of the 'natural Australian soldier'.[77] As a result, participants emphasised that 'nobody knows better than the soldier' in Army culture. It was suggested therefore that Australian soldiers would be slow to swap their rifles for an autonomous system.[78]

This has significant implications for the potential of HUM-T to generate mass in the Australian Army. In the Army's Semi-Autonomous Combat Team (SACT) concept, for example, a light role infantry company of around 100 soldiers, augmented by various RAS platforms, is envisaged as the equivalent in combat power of a present-day battlegroup. Just as an infantry battalion a century ago might boast 1,000 men at full strength while its contemporary successor is established for half that number (notwithstanding the battlegrouping of combat support assets), so future HUM-T infantry platoons might be expected to undertake battlefield tasks currently assigned to a company group, and a future battlegroup those akin to a brigade—all for the same or less actual headcount.[79] Practically, this might be achieved in a number of ways, depending on the level of autonomy achievable. High levels of autonomy might allow tactical concepts based around self-synchronising swarms of RAS.[80] Swarming RAS would provide high levels of tactical flexibility and redundancy, providing the depth required to present multiple simultaneous challenges to an adversary. Such an ability would also reduce the level of communication required to coordinate tactical activity between autonomous platforms and overseeing soldiers, improving human survivability in heavily contested electromagnetic environments. Many officers remain sceptical as to the technical viability of true swarming; however, one participant offered the sceptical view that 'everybody says that they are swarming but they are not'.[81] Alternatively, manned platforms might serve as control nodes for their own fleets of RAS—as motherships directing uncrewed wingmen or task-specific unmanned platforms. Such a concept would likely require a less sophisticated degree of autonomous operation, but at the expense of flexibility and electronic signatures.[82] In either model, though, autonomous systems would produce mass by relegating human soldiers to direction and oversight functions rather than direct close combat.

The extent to which current Australian combat soldiers are willing to accept their relegation to control and support tasks in favour of remote or autonomous platforms is open to debate. While the SACT dismounted infantry concept, for example, emphases the benefits of autonomous mass in alleviating the Australian Army's current culture of scarcity in favour of an 'abundance mindset', it nonetheless envisages organisational structures broadly similar in overall establishment to those of the present, with infanteers still directly engaging in close combat alongside their machines.[83] Similar dynamics can be seen in discussions of the Army's recent trials with optionally crewed M113 armoured personnel carriers.

Given that the M113 is already obsolete, the 'demonstration wasn't necessarily about the M113 or automation *per se* but rather about "a potential alternative future"'. In the words of Colonel Robin Smith, then Staff Officer Grade One, Autonomous Systems, '[w]e are trying to open people's apertures beyond what they might be working with currently'. Nonetheless, the benefits of autonomy were still described in terms of producing '25% more combat power on the objective' by freeing up two seats in the vehicle to increase the available infantry *dismounts* to assault a position from six to eight.[84] Yet, for autonomous mass to truly enable Australia to compete in a war of attrition, as some have predicted, RAS would have to be cheap and replaceable and do the brunt of the fighting—or at least the dying.[85] This may present a particular challenge for officer identities, given that, in the eyes of at least some serving officers, the Army's existing ethos of social egalitarianism and tactical reverence already somewhat undermines the organisational importance of higher management, with HUM-T potentially eroding the institutional value of 'officership' still further as commanders become even more abstracted from the conduct of combat.[86]

Paradoxically, therefore, the greatest risk to enacting HUM-T is also automation's greatest benefit: 'that AI will take people away from interesting tasks'—which is to say, combat roles.[87] Yet the real question may be whether HUM-T concepts in which RAS supplant troops in traditional soldiering functions will still be palatable even if this does not significantly increase soldiers' chances of survival on the future battlefield. To a significant extent, one of the more appealing aspects of HUM-T for Australian officers is their potential to reduce the direct risk to soldiers, for example by screening for enemy forces ahead of human troops.[88] However, as machines gradually displace people on the future battlefield, so the tactical and political value of the few remaining soldiers will increase dramatically, potentially increasing the risks for humans in unexpected ways.[89] This includes risk of fratricide by RAS systems.[90] Moreover, for automated mass to have deterrence effect in sub-threshold operations, significant human presence will remain essential.[91]

While the tactical emphasis in Army ethos may sit at odds with aspects of HUM-T, other currents in Australian military culture may nonetheless facilitate implementation, helping to smooth over inherent tensions within the concept itself. Although the Australian ideal of soldiering is far less technologically grounded than that of the US Army, the Australian military nonetheless remains heavily committed to a culture of operational excellence.

As Anthony King has argued, functional performance has increasingly come to define officers' professional identities across a number of Western armed forces, as national service has gradually been replaced by functionally specialised all-volunteer forces.[92] This trend is observable in the Australian Army, which has been described as broadly moving from an 'institutional' model of military service as a vocational career towards one of 'occupational professionalisation', reflected in mounting grassroots demand for more flexible and less generalist career streams.[93] Consequently, while the Army is still composed of 'larrikins that want to do their part', today's officers are singularly 'keen to see the job get done'. In the description of one participant, 'we have a culture to remain relevant in an operational environment where we do not hold many of the decisive levers across some domains'.[94] Consequently, while officers may dislike the prospect of their roles moving further away from the idealised image of Australian soldiering, the centrality of battlefield effectiveness to the Australian officer corps' corporate professional identity may yet make HUM-T culturally palatable. One cavalry officer, for example, admitted that he was 'not excited about technology itself, but excited about the capabilities technology can bring', while a logistician likewise argued that to drive change, the Army must be able to demonstrate autonomy's 'value proposition'.[95] As Brigadier Mark Ascough has argued, while the Army's culture may emphasise 'brilliance at the basics', the implications of this ultimately 'comes down to what your understanding of the basics is'—and this idea may yet prove malleable to the needs of future technology, just as it currently is around trade specialisation.[96]

This underlines the importance of structuring organisational change around future concepts of operation, in order to link cultural adaptation to functional performance.[97] One outside expert on Australian Army transformation notes that 'soldiers will embrace new tech if it can be demonstrated that it will enable them to do their job better or more easily'.[98] Ultimately, it remains to be seen whether the strategic promise of military automation will be sufficient to overcome officers' inherent scepticism towards high technology, particularly at the lowest tactical levels. Despite the centrality of functional performance to Australian officers' professional identity, concepts of 'mateship', national service and ANZAC exceptionalism remain prominent features of Australian military motivation.[99] The next chapter explores this interaction specifically in relation to future command and control, examining the compatibility of existing practices and cultures of command with visions of future automation, and what this may mean for the shape and form of HUM-T in tactical headquarters.

The Architecture of Human-Machine Command and Control

As conventionally defined, *command* can be understood as the lawful authority an officer exercises over military forces by virtue of their rank or appointment, while control refers to the ensuing mandate to implement orders or instructions by managing military activity. Taken together, however, the concept of *command and control* (or C2) can simultaneously mean 'a process, a capability, a system or a structure' and is therefore 'an institutional, compound and contested term'.[100] In recent years, a profound shift in the practice and meaning of command and control has begun to emerge, precipitated by the growing profusion of computers, information processing, communication and sensor systems adopted by land forces. Digitisation has connected commanders to subordinates in novel and pervasive ways, facilitating new ways to orchestrate increasingly dispersed forces. Yet, while combat effectiveness has become ever more reliant on the passage and processing of information across electronic networks, traditional models of command and control have struggled to keep pace with the growth in digital technology. The ensuing complexity of modern operations has seen decision-making functions increasingly distributed across networks of subordinate officers and headquarters staff, blurring historic distinctions between command and control.[101]

In the popular imagination, military autonomy is typically understood in terms of unmanned platforms and remotely directed systems. However, the expected advances in machine learning that underpin this vision of military robotics will have an equally transformational impact on the capacity and capability of military command systems, further revolutionising the practice of command and control.[102] By integrating staff officers and autonomous software on equal terms, HUM-T is expected to produce three key effects on C2, collectively amounting to a new source of battlefield advantage.

Firstly, autonomous systems are expected to improve the fidelity of decision-making, by enabling the effective collection, processing, and dissemination of large amounts of tactical information without overloading commanders and their staffs. Digitisation has dramatically improved armies' ability to collect and communicate information, to the point where the sheer volume of data requiring processing can threaten to overwhelm headquarters and debilitate decision-making. Consequently, 'digitisation is a double-edged sword' for many Australian officers, placing a potent cognitive burden on commanders that may actually reduce their situational awareness and increase the fragility of C2.[103] Moreover, as RAS increase the persistence of surveillance and reconnaissance, the volume of information to be processed seems only likely to increase. Here, autonomous systems are widely expected to improve the identification of enemy forces, using pattern recognition and trend analysis to monitor electronic senor feeds, as well as the subsequent presentation and analysis of that information, by fusing and cross-referencing data across multiple human and electronic sources.[104]

By extension, this ability to analyse large amounts of information is expected to improve the robustness of military planning. In particular, participants highlighted the potential benefits intelligent software might bring to Intelligence Preparation of the Battlespace and the development of courses of action where 'military decision-making relies on data processing, which is the dull end of planning'.[105] Machine learning, for example, is likely to be well placed to undertake logistical planning, where data on friendly force requirements is already highly structured, as well as terrain and weather analysis, time-and-space calculations, and even the identification of relative weaknesses in enemy doctrine and force structures.[106] Moreover, because software is expected to be able to compute these problems far more quickly than conventional staffs, HUM-T would enable commanders to plan in greater detail, mapping out a wider range of contingencies to mitigate possible risks. Similarly, synthetic wargaming might improve the impartiality and robustness with which courses of action and rehearsals of concept are tested and evaluated, currently described by one participant as the Army's 'biggest weakness in planning'.[107]

Secondly, and relatedly, autonomous systems are expected to increase the tempo of operations, by enabling more rapid decision-action cycles without compromising the quality of decision-making.[108] In contemporary military thought, tempo is understood as the ability to impose successive tactical

challenges on the enemy more quickly than they can effectively respond, and is determined by the relative pace and quality of decision-action cycles.[109] Controlling tempo is consequently seen as essential to gaining and maintaining the initiative, providing, in the words of one participant, a 'super effective' means to 'disrupt the enemy's decision process'—especially in the absence of significant overmatch in terms of mass.[110] In practice, the development of tempo at lower tactical levels effectively requires brigades and battalions to take and execute decisions more quickly than the enemy, in order to construct favourable tactical situations through which to impose their will on the enemy.[111] Here, some officers have expressed concern at the Australian Army's perceived propensity to over-plan tactical actions, slowing tempo.[112] Moreover, the future battlefield is expected to be significantly less forgiving than recent Australian experiences of asymmetric operations, where forces were largely free to dictate the tactical tempo.[113] Consequently, the prospect of 'helping individuals with their OODA loops' through autonomy is seen as 'the big win' for Australian HUM-T.[114] Indeed, as autonomous systems proliferate more widely, HUM-T may be the only way to generate tempo, as soldiers become progressively distanced from tactical actions conducted at machine pace.[115]

Thirdly, the introduction of autonomy into command and control is expected to increase the survivability of friendly forces, not simply by improving reaction times in force protection systems but also by enabling the distribution of force elements and headquarters functions in a more resilient and networked fashion. Counter-air and indirect fire systems already rely on autonomy to interdict incoming projectiles otherwise travelling too fast for a human operator alone to respond to, while battlespace management systems are improving the ability to pass orders remotely.[116] In the future, however, HUM-T in C2 is expected to enable the development of denser networking, in part because of its potential to process large quantities of data quickly. This will allow headquarters functions to be undertaken in a more disaggregated way, allowing command and control elements to be further dispersed across the battlespace, improving flexibility, redundancy and resilience.[117] By improving subordinate units' ability to process and analyse information and sensor feeds independent of higher headquarters, HUM-T will also facilitate self-sustaining subordinate operations, enabling greater levels of delegated decision-making, reducing signature emissions between levels of command, and increasing the ability to disperse force elements.[118] Indeed, autonomous systems may even

assume primary responsibility for managing the digital networks that sustain physical dispersion in the face of hostile intrusion, jamming and spoofing.[119]

Importantly, the distribution of command functions across more networked forces is also expected to provide a new means of leveraging tactical capabilities in highly contested environments, reinforcing tempo. In the ADF's vision for future C2, increased networking and intelligent software that support information sharing and situational awareness will enable rapid and responsive restructuring of coordination mechanisms at the tactical level, enabling control to fluidly pass between different force elements in contact according to the exigencies of the situation. This 'agile control' is intended to facilitate a more collaborative response to tactical problems, delegating the authority to manage a tactical situation to the best placed unit or system agent, while simultaneously connecting platforms and force elements across multiple domains and mission sets to maximise efficiency. In so doing, the ADF aims to disaggregate command from control, separating the commander's authority to set direction from the coordinating function of control.[120] Such a vision is broadly compatible with emerging allied interpretations of command and control in multi-domain operations.[121] Participants likewise remarked that the ability to 'link multiple sensors to multiple shooters would be a game changer', while the decentralisation of control nodes will simultaneously improve survivability and redundancy.[122]

Ultimately, though, implementing the vision of HUM-T in C2 relies on the integration of a host of new automated systems, with each other and with the behaviours of human operators. Critically, HUM-T will require a shift in the quality of digital networking, from the present use of machines to exchange information between people, to the meaningful exchange of information between people and machines. The structure of C2 processes must also move away from the distribution of information vertically between layers of command, to focus on the distribution of information horizontally.[123] Importantly, C2 architectures are dependent both on 'the restrictions of the technology available to implement them' and on the mental models and cultures of leadership employed by the soldiers who staff them.[124] Successful HUM-T in C2 will therefore depend as much on the extent to which the technical and doctrinal architectures of command and control can be remade as on the individual capabilities of individual autonomous agents that comprise them. While the Australian Army's ethos may already be less hierarchical than those of many other allied armed forces, it too

has recognised that modernising C2 'isn't solely a technology issue', recently emphasising a 'more inclusive approach involving mission command and C3 modernisation' in Australian digitisation efforts.[125] This chapter will address these twin issues in the modernisation of Australian Army C2, revealing the organisational and behavioural roots of ostensibly technological architectures of command and control.

Overlapping Networks: C2 Architectures as Technological, Tactical and Organisational Systems

In recent years, the Australian Army has begun to invest heavily in digital command and control technologies via the Land 200 Program, including new Battlefield Management Systems (BMS) and linked digital radio and satellite communication equipment.[126] Nonetheless, the introduction of autonomous systems is predicted to be a fundamental discontinuity in the practice of Australian C2, at least according to the current vision of HUM-T. As one Army study has argued, the acquisition of digital BMS has effectively 'reinforced a traditional C2 system by providing digital communications linkages aligned to the current tactical command architecture', concluding that the future adoption of HUM-T is consequently 'not a story of "digitisation"'.[127] Much like the current digitisation effort, however, the success of HUM-T will rely on the design of future network architectures that optimally integrate soldiers and digital systems, and the alignment between those architectures and the mechanisms of command and control actually practised by Australian officers. The existing challenges experienced by the Army in creating digital command architectures thus illustrate the profound technical challenges HUM-T will raise for future C2, as well as the potential path dependencies embedded in the systemic nature of network architectures that future autonomy must contend with, at least in the short term.

Although current digitisation efforts are intended to optimise a model of C2 that is fundamentally different from, and more conventional than, that embedded in future visions of HUM-T, the difficulty of integrating multiple systems across the force has still presented a challenge, hampering Army efforts to leverage the potential of digital command systems to their full extent. In part, this challenge reflects the different pace of digitisation across the Army, hindering the integration of new and legacy components. The artillery, for example, was an early adopter of digital command and

control systems, embracing Raytheon's Advanced Field Artillery Tactical Data System (AFATDS) developed for the US Army in the 1990s. AFATDS connects gun lines with command posts and forward observers through a shared fire support command and control application that can automatically calculate firing solutions, and was seen as something of a test case for the wider concept of digital networking.[128] But, while the artillery has long possessed significant experience of digital command systems, other arms of Service remain significantly less digitised. When asked about their experience of digitisation, a number of officers rhetorically questioned whether it had even happened, noting the continued reliance on 'manual input' like email and Microsoft Excel. One intelligence officer, for instance, described digitisation to date as 'haphazard', while an infanteer likewise remarked that in his experience, the Army has not incorporated digital systems so much as been 'weighed down by digital infrastructure', which has ended up slowing down command processes rather than flattening them.[129]

To a significant extent, uneven digitisation has been caused by the disparate nature of the Army's historical procurement processes, which have created particular issues for C2 modernisation given the systemic nature of networked command technologies. Traditionally, procurement projects have been managed in a discrete fashion, creating a series of stovepipes between different capability owners that saw procurement priorities in each managed in isolation, and integration (and even interoperability) largely neglected. The LAND 200 series, for example, effectively represents the third generation of Australian command and control systems in the land domain, and was described by the Chief of Army in 2017 as the 'highest-priority project in the Army' primarily because of its role in tying together individual platforms and capabilities.[130] Yet prior to this date, individual LAND 200 projects were run by separate organisations with little overarching coordination or oversight. The first tranche of LAND 200, focusing on the procurement of digital radio systems, has been described as driven by 'a "quick win" philosophy' from the bottom-up, resulting in a '"project-by-project" approach that limited the Army's ability to determine or coordinate a system-of-systems acquisition plan'.[131] The second tranche was little better, overseen by two different project offices—one responsible for procuring BMS and the other for the associated tactical communications network that would support it, each with its own prime contractor—which could not agree on the technical specifications for the overarching concept, or how to integrate the two main components.[132]

As a result, the effectiveness of digitisation has been hindered by the difficulties of integrating Israeli-made BMS with US-manufactured radio networks, alongside pre-existing specialist networks like AFATDS, each of which was designed by a different company.[133] Moreover, because many of the individual digital components (such as sensor systems) in Australian service are essentially proprietary, even the purchasing of bespoke new systems from different contractors cannot guarantee full interoperability. However, this problem is significantly the result of organisational processes unrelated to technological challenges, including those generated by staff posting cycles and career pressures, which can encourage a '[this is] my project and this is what we're getting' mentality among project managers.[134] Equally, the regulatory mechanisms used to assure value for money in complex taxpayer-funded projects can likewise exacerbate system integration issues, inserting 'contractual handcuffs' early on that make it difficult for suppliers to accommodate unforeseen integration issues—or respond to new technological developments mid-project.[135] As one participant argued, '[t]he technology problem of systems not speaking to each other is actually a human problem of acquisition', caused, in the words of another officer, by a tendency to 'buy a whole lot of stuff and then try to figure out how it can be integrated' afterwards.[136]

These issues are exacerbated by the lengthy nature of military procurement cycles, which can itself create additional complexities for systems integration. In principle, each tranche of the LAND 200 program was not expected to have to be compatible with components of the previous tranche it was intended to replace. However, the length of time required to roll out each tranche and integrate systems into the Army's extensive fleet of vehicles has meant that successive tranches have of necessity been required to operate alongside legacy systems, complicating systems integration issues. Moreover, accelerating the pace of rollout is inherently constrained by the Army's force generation cycle, which means units can only realistically be re-equipped during their reset phase; thus, the thorough refit of a brigade can require several consecutive years. This inevitably creates capability gaps as available units are equipped ahead of priority ones, creating the sense that the Army constantly 'end[s] up with capabilities that are considered interim' among regimental officers.[137] It also produces pernicious trade-offs between 'short-term or long-term functionality', not least because each new component creates additional liabilities in terms of training, sustainment, and maintenance which can themselves complicate integration, potentially even impeding the 'capacity to absorb additional layers of capability over time'.[138]

Importantly, dysfunctional procurement has had a direct impact on the practice of Australian command, owing to the systemic nature of networked C2 systems. This is most apparent at the lower tactical levels, where a continuing digital watershed effectively limits the utility of digital C2 systems—and the modes of command they represent. The value of BMS, for example, lies in the construction of a shared operating picture to support planning and orders dissemination across the chain of command, as well as for timely decision-making during operational execution. At present, however, lower tactical units (like platoons and companies) are not regularly tracked digitally, reducing the utility of BMS at the brigade level, as it cannot automatically display the actual location of friendly forces in real time and must be augmented by manual monitoring by voice.[139] This is partly the result of bandwidth limitations. The principal trunking systems that support high-bandwidth communications generally stop at the brigade level, while digital combat net radios are only realistically able to support around 2 kBps of traffic—10,000 times less bandwidth than 4G—save at very short distances.[140] The latency of the operating picture supported by such limited bandwidth effectively renders digital tracks an irrelevance at some tactical levels. As one participant argued, systems that only update every half an hour are of little use for tactical coordination when an aircraft can cross a unit's area of responsibility in a few minutes.[141] Consequently, a number of participants argued that limitations in bandwidth effectively limited higher headquarters' ability to understand the tactical situation and therefore exercise effective control.[142] While officers may plan and transmit their orders digitally, when it comes to actually executing operations, the limitations of current digital architectures mean that 'fighting by voice is the only way'.[143]

To a certain extent, the Army has begun to address some of these issues, giving some cause for optimism in the future development of HUM-T in C2. Following the First Principles Review in 2015, capability procurement was reclaimed by the Department of Defence, and oversight has since moved within the purview of the Service Chiefs, providing greater accountability of acquisitions to end users. The Army has also invested in rebuilding its scientific and testing capabilities, and has likewise recognised that multiple acquisition streams can no longer be managed separately, moving from a project to a programmatic approach, although it must still contend with significantly more simultaneous lines of development than its sister services.[144] In the LAND 200 program, for example, the merger of both tranche two project offices into a single authority has been credited with

turning ‘“two previously disenfranchised and factionalised units” into a “cohesive and empowered team”’.[145] The ADF has also established a Robotic and Autonomous Systems Implementation Coordination Office (or RICO) to oversee the development and integration of land systems.[146]

Nonetheless, procurement issues still remain. In the field of digital intelligence and C4ISTAR,[147] for example, one participant cited ‘36 projects that inform capability development’—two-thirds grounded in digital information technology—the majority of which are not integrated. This might lead to a future situation in which sensors, processors and force protection systems are all automated or semi-autonomous but cannot communicate directly with each other, save through some yet-to-be-designed overarching C2 system that may or may not be able to link to them all.[148] As one Australian military analyst has concluded, ‘[r]ather than solving contemporary integration challenges, artificially intelligent, autonomous machines are almost certain to create new ones’.[149] One recent study, for example, recommended that the Army explicitly articulate common architecture standards for new digital systems (including, presumably, autonomous ones) as the necessary precondition for considered architecture design and acquisition, a point echoed by serving officers.[150] The Army’s tactical culture may also impede change here. In Gilchrist’s view, for example:

> *The greatest challenge to an integrated joint force is the focus on platforms that deliver effects, rather than the information and communications architecture that links these capabilities in a meaningful way.*[151]

The alternative, however, is continued ad hoc procurement and inevitable systems integration incoherence.

That said, it is important to recognise that the challenges of architectural change in C2 are not simply the result of poor procurement. Indeed, in some respects, digitisation has still had a notable impact even down to the battlegroup level, with many ‘back of house’ functions like administration and logistics now conducted digitally (albeit often in the form of Microsoft Excel attachments to email).[152] Principally, however, the digital watershed in tactical C2 at the brigade level remains because digital alternatives to analogue command by voice over radio are simply not quick or flexible enough to keep pace with the speed of combat. Moreover, verbal communications provide commanders with a range of non-verbal cues

about soldiers' emotions, intentions and environment that other mechanisms of digital communication like text transmissions cannot.[153] Consequently, digital C2 has struggled to displace traditional forms of command and control at the tactical level even though much of the actual equipment has been digitised, as with the use of digital encryption and frequency modulation in VHF radios and the use of laser target designators to help smart munitions acquire targets.[154]

In the case of HUM-T, the development of new command architectures may face additional challenges resulting from the sheer novelty of the constituent technologies, which creates tandem problems both for procurement and for force development. As the Army itself recognises, the maturation of new military technologies substantially relies on product development by industry. These work streams are usually defined using in-use systems or specific tactical applications, but because 'HUM-T is an immature capability, defined more by imagination and concept than a firm grounding of the technical opportunities and constraints of key technologies' it is consequently 'difficult to pull user requirements for systems without precedent'.[155] In the words of one expert:

> *… as with every focused user community, radical development of wholly new tech is not going to come from the war-fighter—what they want is better Gortex ... not a bunch of batteries that they are going to have to cart around.*[156]

Consequently, industry has consistently complained that Defence lacks a clear understanding of what it wants from both modernisation in general and its suppliers in particular.[157]

The Army primarily appears to be addressing this concern by attempting to embed a culture of innovation within organisational behaviour. At the strategic level, the Army's Industry Engagement Statement can be seen as an attempt to facilitate deeper and less risk-averse commercial partnerships. Internally, this drive can be seen in initiatives such as MakerSpaces and Army Innovation Day, and fora like The Forge and the Defence Entrepreneurs' Forum, rightly described by one interviewee as part of 'a rich military education ecosystem'.[158] Yet, despite the need to develop concerted and coherently designed command architectures to make concepts like HUM-T work, innovation is primarily understood as a bottom-up model, mirroring current trends in business and management theory. One officer stated that the most 'innovative part of Army is [its] soldiers', while Major

General Findlay has characterised Australian Diggers as 'innovation carnivores'.[159] By extension, participants widely argued that the Australian Army contains significant pent-up potential for innovation, which is stymied either by unresponsive senior leaders or by inflexible and lengthy acquisitions processes. Paradoxically, though, while soldiers are universally seen as innovators, their collective Army culture is described as conservative and stifling. Indeed, concern for career prospects was described as the cause of risk aversion, leading to a 'grey' culture of blandness and, in the eyes of some, a toxic 'tall poppy syndrome'.[160] At its most extreme, the Army's current innovation drive was characterised by one frustrated officer as 'all words and hot air', with concepts like NCW outwardly pursued but privately dismissed as 'gimmicks' and shallowly adopted.[161]

Admittedly, a number of participants recognised that the primary constraint on commanders' receptiveness to innovation was resource shortages. In the words of one officer, 'everyone talks of the "big I", but it is the poor man's innovation'.[162] Moreover, much of this bottom-up enthusiasm was described by one officer as the metaphorical equivalent of designing 'a better tent peg'.[163] Instead, a number of respondents argued that senior officers' enthusiasm was actually the more pressing problem. Officers worried that senior leaders did not properly understand the limitations of immature technologies and were too quick to jump on expensive 'silver bullets' all too often 'sold as panacea'.[164] In the words of one participant, '[s]enior officers see capability that works at higher levels and want it to work at lower levels.'[165] As one expert noted, however, Army leaders have not been so keen to make the necessary enabling changes to organisational processes.[166] Certainly, senior officers like Major General Ryan have been quick to acknowledge that Army Headquarters 'needs to listen more closely to people below'.[167]

Unpredictable Architectures: The Second and Third Order Effects of Technological Change in C2

While procurement reform is vital to the coherence of future HUM-T architectures, this is unlikely to guarantee the effective application of autonomous C2 on the battlefield. In part, the strategic environment in which the Australian Army operates will inevitably complicate the development of new C2 systems, as Australian approaches must function both in

isolation and within a coalition dominated by larger partners, creating what one participant described as an expensive 'keeping up with the Jones' problem'.[168] However, procurement decisions alone provide little guarantee of future architectural interoperability, which is as dependent on trust, familiarity and sovereign national security priorities as it is on technology.[169] Although the LAND 200 system is designed to facilitate interoperability with the US, for example, experience on Exercise TALISMAN SABRE saw significant additional staff required to support interoperability, at least initially, owing to Australian unfamiliarity with US systems and processes—a phenomenon mirrored by British experience of coalition operations.[170] Moreover, importing foreign systems comes with its own complications. As one participant remarked of the RAAF's purchase of EA-18G Growler electronic attack aircraft, '[w]e thought we were buying the good stuff but we weren't'.[171]

Importantly, if the experience of digitisation is any indicator, automation will undoubtedly produce new and potentially problematic dependencies that may challenge the utility of HUM-T—particularly if autonomous architectures evolve organically rather than by design. In some visions of HUM-T, for example, autonomy is essentially viewed as a panacea for all systems integration and data-processing tasks, eventually enabling armies to 'eliminate technological constraints that confine us to our current monolithic headquarters approaches'.[172] Yet, unlike in industry, where data can often be generated in useful digital formats suitable for automated management, military data will likely continue to persist in a wide range of different and inherently incompatible formats—'from UAS feeds, to Facebook posts, to scraps of paper and everything in between'—making data integration a potent challenge. Indeed, the automated translation of data from one medium for use in another will inevitably require automatic cleaning and sifting, potentially risking the loss of the key contextual information on which analysis relies.[173] Moreover, the coding skills required to navigate these challenges are far from abundant in the Australian military, while US efforts to enlist Silicon Valley expertise have been stymied by civilian concerns over the legitimacy and ethics of Department of Defense aspirations.[174] Even where data can be integrated, automating analysis presents a further set of challenges. Importantly, the 'procedural consistency of algorithms is not equivalent to objectivity'; in other words, AI is only as good as the data used to train it, creating a further set of potential vulnerabilities. In the worst case, military decision support tools may simply end up replicating the organisational biases contained within the data used to train them,

as can be seen with current concerns over the use of predictive algorithms in policing.[175] More broadly, acquiring, cleaning and updating the datasets needed to train AI applications continues to hamper the development of military autonomous systems even in comparatively simple pattern-matching tasks like vehicle recognition.[176]

Perhaps more esoteric, but no less concerning, is the prospect that HUM-T will necessarily produce highly networked but functionally specialised forces attuned to fight other militaries equipped with high-end technological capabilities, at the expense of low-intensity, population-centric tasks where sensors and processors optimised for seeking conventional military emissions struggle. The electronic specialisation embedded in HUM-T networking, intended to enable the future force to compete in a peer-on-peer engagement, may inadvertently degrade combat effectiveness against less technologically sophisticated adversaries, while simultaneously deepening existing electronic vulnerabilities that near-peer competitors will exploit.[177] In common with partner expectations, however, the ADF's vision of future C2 is reliant on sustaining high levels of networked connectivity between platforms and nodes. In the words of one Australian military commentator, 'resilient network architectures are the critical requirement of a digitised, artificial intelligence-enabled future force'.[178]

At present, network connections are widely viewed as a major source of tactical vulnerability, given the comparative difficulty of concealing contemporary headquarters replete with their 'antennae farms' and large electronic signatures. Indeed, the ease with which pro-Russian forces were able to locate and destroy Ukrainian headquarters was cited by participants as the standout lesson of the Donbas War.[179] Whereas field headquarters were once modest affairs, readily reconfigurable and able to pack up and relocate at short notice, digitisation has rendered this a challenge. Instead, increasing numbers of staff are required to manually process and integrate the increasing quantities of information produced by (and necessary to tactically coordinate) subordinate units, leading to geographically fixed and tactically vulnerable headquarters. On Exercise HAMEL, for example, Major General Ryan 'saw a brigade HQ that couldn't move ... because it had become too bloated'.[180] Moreover, this growth has not necessarily relieved cognitive burden, with commanders' capacity for decision-making in constant danger of being overwhelmed by the demands of larger and less flexible staffs. In the words of one participant, 'What did digitisation do to us? It has led to bloating of HQs'.[181]

To a certain extent, doctrinal and organisational reforms are expected to offset these issues. Major General Findlay, for example, has suggested that some of the issues created by digitisation are actually 'because we've not yet evolved our workforce to be data-literate, and we've often applied an analogue approach or process to a digital backbone'.[182] Equally, as Brigadier Ascough has argued, the combination of digitisation and counterinsurgency has seen divisional functions pushed down to brigade headquarters and below, resulting in larger lower headquarters. Consequently, a return to viewing brigades as a purely tactical manoeuvre element, with correspondingly limited planning and execution responsibilities, might reduce the burden.[183] Yet little consensus exists as to the likely second-order effects of future automation on field headquarters. New autonomous systems might conceivably make some existing support staff redundant, but new specialists may be required to maintain them.[184] Moreover, part of the appeal of HUM-T is the perceived ability to expand tactical headquarters' planning horizons by alleviating information processing and systems integration issues, reinforcing the importance of getting the technical architectures right.[185] The requirement to integrate future Army C2 with the joint environment will likely add additional complexity to the development of HUM-T. Although the ADF is investing in joint digitisation, including via Army signals, participants generally viewed joint integration as a significant contemporary challenge. As one officer quipped, 'Army has enough problems communicating with itself digitally, let alone with joint force comms'.[186]

It is possible that HUM-T may exacerbate this issue, as senior officers recognise. Major General Ryan, for example, has described the Army's present understanding of electronic warfare as akin to 'a 1940s view' based around heat, light and radio traffic, when future conflicts will likely be a 'battle of signatures'. Moreover, as AI processing capabilities diffuse, so the useful indicators available to enemy forces are expected to increase—even down to an 'increase in take-away food' betraying a unit's pre-deployment activity.[187] Digitisation has likewise created an insatiable demand for power to run computers and electronic systems, not just in headquarters but also throughout the force, creating its own tactical footprint. Field headquarters can often require three or more field generators, itself a notable combat indicator for enemy reconnaissance, while the additional fuel and battery demands at all levels is a major logistical challenge. New digital systems have even affected the capabilities of tactical vehicles, as incremental demands for additional energy to run new systems and radios drain power and add weight. In Australian service, for example, the Bushmaster

protected mobility vehicle is now fitted with three separate powerpacks.[188] Critically, as automation transforms the network itself into a decisive capability, so the proportion of enemy effort targeting C2 links can be expected to increase, potentially supported by new weapons systems such as radiofrequency attacks specifically designed to collapse communication systems and fry electronic processors.[189]

Even if HUM-T does not immediately reduce the number of staff required to manage and sustain information flows, automation may nonetheless help to reduce the size and scale of future field headquarters by enabling information processing, analysis and support functions to be conducted remotely by digitally connected staff physically located in secure rear areas. It is hoped that so-called 'reach-back' capabilities will 'mitigate the risk of the Army's network vulnerabilities being exploited in theatre', to the point where many headquarters' functions may 'become a largely virtual service, with high levels of resilience, adaptability and lower operational costs'.[190] Indeed, this process is already underway, as digital networks are progressively broadened and lengthened. Since 2014, for example, the size of a forward-deployed brigade headquarters on Exercise HAMEL has reduced from approximately 250 staff to 75, as commanders and staff have learnt to 'leave as much of the headquarters as possible out of the battlefield and in a protected area, and rely on reach-back'. By automating basic monitoring and data integration tasks, HUM-T might see this number reduce still further—especially as overall headcount is in part constrained by the number of individuals required to minimally staff the headquarters round the clock for an enduring period.[191] In a similar fashion, the US 82nd Airborne Division has constructed a permanent Joint Operations Centre at Fort Bragg to act as the divisional main headquarters, enabling the divisional commander to operate with a forward-deployed staff just 50 to 100 strong through satellite linked reach-back.[192]

Nonetheless, while the Australian officers in this study widely recognised the benefits of increased agility in headquarters, the optimum balance of forward to rear functions will need constant adjustment as technology matures.[193] Even if automation does reduce the physical size of field headquarters, in so doing it may concomitantly exacerbate headquarters' vulnerability in the electromagnetic spectrum through increased reliance on digital connectivity, reinforcing the importance of viewing C2 as a systemic socio-technical architecture. Indeed, the linked problems of digital

signature and emission control well illustrate the importance of interweaving tactics and technical development in future C2 architectures. In principle, the emission vulnerabilities produced by more profound networking and reach-back might be managed through deception, keeping C2 nodes below the threshold of targeting (rather than detection) by blending into the electromagnetic noise of a busy digital battlespace. As some participants argued, 'rather than hiding by austerity, we may need to flood digital signature', precisely 'because the EM spectrum is so congested, one of the best ways to respond is to hide in plain sight'.[194] However, as Professor M J Ryan has observed, managing this volume in a modern digitally encrypted environment will be highly challenging, especially as the limited bandwidth available for data transmission means that current systems are effectively always active. Consequently, some officers have questioned the effectiveness of HUM-T concepts if deep connectivity cannot be assured.[195]

'Edge' systems might provide an alternative to reach-back, reducing digital signature. In an 'edge' system, automation would be embedded at the lowest possible tactical level, minimising emissions by analysing data as close as possible to the source. Such systems might be able to operate more independently in heavily contested electromagnetic environments, but at a cost in terms of platform size, weight, portability and power requirements.[196] This might also allow users to control emissions in a similar way to the current pressel discipline. Nonetheless, some transmissions would still be required for tasking and situational awareness, while the overall C2 architecture would remain comparatively austere, offering commanders limited direct control of subordinates.[197]

In either model, moreover, changes to command behaviours would be essential to effectiveness. In an edge model, where 'you have got to assume that once you're seen, you've got 10 minutes to live', commanding officers would no longer have the luxury of being able to hold prolonged daily radio conferences to provide direction and intent.[198] Similarly, US experience of reach-back communications has likewise highlighted the potential for command confusion and 'power struggles galore' as forward officers find themselves caught between conflicting directions from various senior officers, all of whom claim the ability and right to insert themselves into the situation on the ground.[199]

The introduction of BMS can be seen as a microcosm of this phenomenon. Although technologically novel, Blue Force tracking functions have nonetheless tended to reinforce conventional command hierarchies in the Australian experience (notwithstanding the difficulty in reliably tracking lower-level units), by providing a richer picture higher up the chain of command.[200] Indeed, there is a growing recognition that the digital transformation of C2 must go further to update 'industrial age' doctrine for the information era, potentially even calling into question current shibboleths like the structure of staff branches and the linearity of planning and execution cycles.[201] Yet, at the same time, at least one participant described a continuing perception that officers cannot command if they are not physically able to see the situation on the ground, resulting in a degree of 'cultural miasma' rooted in the Australian Army's enduring tactical culture.[202] The next chapter will examine these social dynamics in detail, focusing specifically on the generation of the trust necessary to implement technologically dependent reforms to command architectures and processes.

Trust and Technology in Future Command and Control

The introduction of HUM-T into command and control will change the way soldiers interact with machines, and each other. In current Australian doctrine, the relationship between commanders and subordinates is framed by the philosophy of mission command, which emphasises the importance of shared understanding and mutual trust in facilitating decentralised execution without compromising unity of effort. Consequently, the Australian Army's existing culture of mission command is seen as the gateway to future models of C2, in which deeper networking, autonomous systems and HUM-T will enable greater levels of self-synchronising tactical activity. Indeed, future C2 is expected to demand even greater levels of trust, in both fellow soldiers and their supporting autonomous systems, as technological change enables greater dispersion and decentralisation.[203] To date, however, technological changes in firepower, sensors, and communication systems have tended to result in ever greater levels of centralised control, leading some to question whether mission command actually remains a practical approach to modern warfare.[204] Moreover, recent studies have highlighted the enduring centrality of interpersonal command relationships to modern military practice, despite the increase in physical dispersion and electronic communications, raising further questions about the feasibility of human-machine integration.[205] This chapter examines the social and interpersonal dynamics of digitised C2, and their compatibility with future concepts of HUM-T, focusing in particular on the importance of trust and training in redefining mission command for the information age.

Doctrines of Trust: Future Technology and Mission Command

Mission command is a comparatively recent innovation in most Western armed forces, the Australian Army included. The concept has its origins in the Prussian system of *Auftragstaktik*, or mission tactics, pioneered in the 19th century as the size and speed of industrialised mass armies began to outpace the commanders' ability to direct them using the nascent communications technologies available at the time. It subsequently became associated with the Wehrmacht's Second World War *Blitzkrieg*, where the combination of radio communications and decentralised execution facilitated new levels of agility in tactical manoeuvre.[206] In most NATO and affiliated armies, however, mission command was only adopted in the late Cold War, as the growth in information technology and deep strike capabilities rejuvenated interest in theories of manoeuvre warfare.

Although its precise application varies somewhat according to national practice, mission command is best understood as a philosophy of command in which commanders designate the objectives to be achieved and provide subordinates with a degree of freedom as to how best to attain them (within specified constraints). In this way, subordinates retain the flexibility needed to respond to the unforeseen, while delegated activity remains nonetheless unified around the commander's overarching intent.[207] As a result, mission command has been reaffirmed by various Western armed forces in their future C2 concepts as the doctrinal precedent for greater levels of technologically enabled delegated control and dispersed activity. The ADF's vision of future C2, for example, views mission command as the foundation from which to evolve future command practices, stating the future force 'will continue to embrace Mission Command because it utilises Australian culture to generate an advantage'.[208]

In recent conflicts, however, there has been a contradictory tendency towards the centralised control necessary to coordinate multiple arms, services, and domains—enabled by the concomitant centralisation of digital information. In the eyes of many Australian officers, therefore, military modernisation has generated tension between the espoused doctrines of mission command and the reality of contemporary operations.[209] Current command structures are optimised for coordinating targeting effects rather than facilitating tactical collaboration, leading to rumbling concerns that the drive for efficiency has substituted thinking and ingenuity for process and routine in Australian command cultures.[210] This centralising imperative can

also come at the expense of rapidity in decision-making. As one participant put it, 'We have invested decision-making authority to people with the least situational awareness', such that any deviation from the prearranged plan—especially changes in tempo—'discombobulates C2'.[211]

In the experience of some participants, this tension can undermine the practical application of mission command, leading a number of Australian officers to question the utility of existing doctrine altogether. In the words of one interviewee, 'Doctrine is a good read but it does not reflect mission command in practice ... mission command and micromanagement tend to go hand-in-hand'.[212] In the experience of another Australian officer, digitisation has created a dissonance between theory and reality as a result of commanders' 'reluctance to decentralise and reticence to employ mission command', concluding that the Army has 'good doctrine but it is the rare officer who practices it'.[213] That said, a number of participants noted that existing doctrine does not preclude commanders from closely directing subordinate activity. Instead, mission command can be understood as a spectrum, in which the degree of supervision commanders choose to exercise is defined by the level of trust they have in the competence and understanding of their subordinates.[214] Consequently, while some officers were highly sceptical about the practice and prospects of mission command, others felt it remained alive and well in the Australian Army.

Nonetheless, the ability to intervene directly in subordinate's activity does already appear to have affected superior commanders' propensity to delegate. If the limitations of communications technology once meant that higher commanders had little choice but to trust to the discretion of their subordinates once battle was joined, this is clearly no longer the case. Instead digitisation has provided senior officers with ever more reach downwards into their own organisations, facilitating the proverbial long-handled screwdriver.[215] This phenomenon is by no means confined to the Australian Army. The British military, for example, explicitly hopes that HUM-T will reverse the existing 'tendency for senior decision-makers to monitor and intercede in low-level tactical action in real time', while one US commentator has described digital communications as 'like crack [cocaine] for generals'.[216] To a certain extent, this imperative can be ascribed to the compression of traditional levels of war during highly politicised campaigns in Iraq and Afghanistan, which may also have contributed to senior officers' widely noted 'obsession' with monitoring tactical operations via real-time

full-motion video feeds.[217] Equally, though, a number of participants felt that the tactical emphasis in Australian Army culture also encouraged officers to disregard mission command to reach down to lower tactical levels where Australian officers are often the most culturally comfortable.[218]

Successful HUM-T will require soldiers at all levels to demonstrate far greater levels of trust—in each other and in machines—than digitisation has so far elicited. In principle, autonomous systems may improve the practice of mission command by facilitating the shared situational awareness necessary for mutual understanding, assuming this does not concomitantly provide commanders with further opportunities for centralised intervention.[219] Yet it is far from clear that HUM-T will improve trust in future C2, not least because the development of trust involves highly emotive and social processes.

In human factors research, trust is understood to comprise both affective and performative elements: it 'requires feeling that an object is trustworthy and acting as though that object is trustworthy, even when there is risk involved in doing so'.[220] Indeed, almost by definition, trust serves 'as a substitute for total reliability' and therefore depends on perceptions of distinctly human and emotive qualities such as reliability, competence, honesty, mutual respect and shared understanding.[221] Typically these qualities are established through close interpersonal interactions, and physical dispersion has been shown to impede the formation of trust in new teams despite pervasive electronic communications.[222] In the Australian Army, for example, integrity is seen as every bit as important as competence to the formation of trust, while exercises in collective planning like rehearsal of concept (ROC) drills and wargaming are explicitly valued for their ability to instil a sense of common purpose and obligation.[223] Moreover, reciprocity appears to play an important role in these interpersonal interactions. Loyalty, for instance, has been described as a 'moral emotion' rooted in understandings of 'mateship' as a professional obligation to fellow Australian soldiers.[224]

This does not mean that trust in machines is impossible or even unusual. Service members already place their trust in some automated systems as a matter of course; aircrew, for example, routinely delegate aspects of navigation to systems like GPS and autopilot, which can be said to constitute part of a human-machine team.[225] However, as machine systems have no capacity for emotional reciprocity, the basis for human assessments of their trustworthiness is primarily task orientated: it depends on perceptions of machine reliability, predictability and utility. Consequently,

people tend to have a much lower tolerance for machine or system failure than for human error, and sustained trust in machine systems typically requires high levels of knowledge about how the system works and its limitations, in order to ensure a firm match between user expectations and its performance in context.[226] In the context of military technology, for example, officers argued that trust required a degree of familiarity born of extensive experience in training, and demonstrable examples of effectiveness and utility. As one officer remarked, 'creating a level of trust within HUM-T needs to come from practice and lived experience'.[227]

The centrality of perceived utility and reliability to the creation of user trust can already be seen in commanders' reactions to digital systems like BMS. On one British Army exercise with a new BMS suite, for example, bandwidth limitations resulted in the presentation of erroneous, out-of-date information about some friendly forces locations, causing confusion among the staff. This immediately compromised officers' trust in BMS, resulting in frantic and repeated efforts to verify all unit locations manually via VHF radio. Eventually BMS was abandoned altogether in favour of reversionary tried-and-trusted paper mapping and manual plotting.[228] Australian officers have described similar experiences with BMS, noting how officers turn off or ignore digital systems when they do not provide the benefits expected.[229] Here, the high expectations associated with digitisation may themselves undermine trust as partially implemented architectures fail to live up to the hype.

To a certain extent, a degree of hype is necessary for organisational change. As Ash Rossiter notes, it creates the institutional momentum required to finance new technologies and implement reform.[230] That said, the exceptionally high expectations placed on AI may result in significant disappointment, with attendant implications for wider military acceptance of HUM-T and automation in general. One participant observed that 'AI is the latest thing people jump on because it will solve all their problems. They don't understand the limitations', while another felt that the Army did not actually need AI to solve half the problems it was being pitched to.[231] Moreover, as one Royal Air Force officer has noted, high expectations can be attributed to 'quite flimsy ... material from the commercial and private sector', and Australian officers described over-promising about technological potential as 'rife'.[232] Analogously, concepts like Revolution in Military Affairs and NCW lack legitimacy among many Australian officers—the latter being described by one participant as 'fool's gold'—owing to perceptions that they failed to live up to expectations, despite the partial realisation of many core elements.[233]

This concern is compounded by perceptions of current engagement with ongoing digitisation as skin-deep, in part because of limited understanding and familiarity with the technologies themselves. In the words of one artillery officer, 'right now, no officer above captain will touch BMS' owing to lack of training.[234] Moreover, participants felt that many commanders were insufficiently invested in the necessary institutional and procedural changes to make digital architectures work, instead focusing simply on the physical artefacts in a superficial way. One officer complained that the Army was not undertaking robust network security testing for fear that revealed vulnerabilities might undermine user confidence. Another recalled personal experience on Exercise TALISMAN SABRE in 2017, when HQ processes continued to be run in traditional fashion despite the brigade commander's personal commitment to BMS, resulting in a situation where the commander failed to recognise that his own staff had effectively turned new digital systems into a glorified PowerPoint presentation solely for his benefit.[235]

To a significant extent, the design of future AI systems will determine the possibilities for user understanding and, by extension, trust. Systems constructed on formal rules-based 'if-then-else' models can be highly deterministic in their operation, for instance, and are generally considered to be 'automated' rather than 'autonomous'. In contrast, systems employing machine learning generate an algorithmically defined 'world model' to simulate reality, from which they draw probabilistic rather than deterministic conclusions. As the system interacts with its external environment, this world model is dynamically sensed and updated, with system effectiveness determined by the accuracy of the world model to reality. These world models are created through training on curated datasets, or through the systems' own iterative experience. In either case, the probabilistic nature of machine reasoning means that 'autonomous systems will not necessarily produce the exact same behaviour every time; rather, such systems will produce a range of behaviours'—even when given the same inputs. Moreover, emerging approaches to AI like deep learning or neural networks make use of multiple layers of machine learning in order to abstract complicated problems, each providing an output for the next, making detailed human oversight of the decision-making process even harder.[236] Consequently, the inherent 'black box' nature of some forms of AI may make reliable predictability and human comprehension of AI decision-making virtually impossible, posing a real challenge for operator trust in military contexts. As one participant argued, 'How do we trust when we don't understand the AI algorithms?'[237]

The detailed management of current digital systems already extends beyond the technical capacity of most officers, especially while attempting to carry out tactical decision-making or staff processes. This has necessitated dedicated military specialists within headquarters, and in some cases contracted civilian support.[238] It also creates potential for enemy infiltration and subversion of autonomous systems, given that most officers will lack the ability to detect breaches and assure systems themselves.[239] The nature of AI may also necessitate changes to officers' own decision-making processes, in order to accommodate autonomous teammates. As Keith Dear has argued:

> *Before one can have explainable AI, one needs explainable humans, and that means being explicit about the premises on which decisions are based, being careful and precise in ascribing weight to these premises and to describing the resultant probabilities and confidence in one's deductions, forecasts and decisions.*[240]

This idea itself runs contrary to some understandings of military command, particularly for the Australian Army, where military culture has traditionally privileged the role of intuition in making sense of complexity and uncertainty.[241]

Conversely the difficulty in fully comprehending autonomous processes and decision-making may lead to unwarranted trust. At present, at least, digital systems tend to be optimised to perform specific tasks within a particular range of operation and so have a tendency to 'fail catastrophically' rather than degrade gracefully once their operating limits are reached. However, it is not always readily apparent when systems are approaching their limit, in part because monitoring tasks tend to be very poor at holding human attention, but also because of operators' limited awareness of machine processing, leading systems to unexpectedly hand control of approaching disaster to human operators without apparent warning.[242] Yet when machines appear reliable, operators often display a tendency to become over-reliant on them. When trusted systems provide recommended courses of action, for example, failures in decision-making tend to mirror the error rate of the machine advisor, suggesting that operators subconsciously begin to defer to the system.[243] Some participants also pointed to risks of conscious deference—that increasing automation in C2 could provide carte blanche for 'weak-minded officers' to absent command processes to machines, or that the perceived rationality of automated computation would make it difficult for officers to override autonomous recommendations,

for fear of being subsequently unable to justify why their decision-making was better than the computer in a court of law.[244] While command responsibility might legally reside in human commanders, perceptions of automated capabilities may nonetheless serve to erode their de facto command authority, with potential legal repercussions.

To a certain extent, these issues can be overcome through careful design of human-machine interfaces. Decision support systems, for example, might be designed to provide information rather than options, negating the dangers of human suggestibility and precluding situations in which machine recommendations amount to a fait accompli.[245] HUM-T might also be constructed around a principle of adaptable autonomy, in which users set the parameters within which autonomous systems operate and the conditions under which control reverts to humans, potentially reducing the scope for operator surprise.[246] Nonetheless, successful HUM-T will still require soldiers to adjust the level of trust they place in a system based on observable indicators of its functional performance in context, especially given the potential risks of compromise by enemy forces.[247] If present digitisation is a guide, however, this too may prove a challenge. Inquiries into the downing of an RAF Tornado by friendly fire from a US patriot missile battery in the opening stages of the invasion of Iraq in 2003 highlighted that, alongside technical failures with Identification Friend or Foe (IFF) systems, the incident was partly caused by the socio-technical design of digital architectures (and associated doctrine) that emphasised autonomous processes over operator decision-making.[248] Indeed, the vision of HUM-T in C2 contains an inherent paradox, inasmuch as autonomous systems are expected to help officers wrong-foot the enemy while simultaneously being highly trustworthy—and therefore comprehensible, predictable and reliable—to their operators.[249]

In summary, HUM-T might reshape the practice of mission command in radically different ways, depending on the degree of trust officers are prepared to place in autonomous capabilities. On the one hand, if HUM-T is perceived to improve the independent capabilities of subordinate commanders relative to higher HQs, autonomy might improve commanders' willingness to delegate. Equally, increased situational awareness might reinforce commanders' confidence in subordinates' understanding, while the growing threat posed by digital emissions might concomitantly curb the penchant for constant downward intervention. Certainly where machines have proven themselves to be reliable and capable, their perceived

predictability already makes them the preferred option over people in routine cases. On the other hand, and absent these levels of trust, autonomy may actually exacerbate some of the existing pathologies of digitisation. A number of participants, for example, felt that Australian officers are culturally underprepared for the prospect of HUM-T. As one officer remarked, '[c]ommanders are not comfortable if the decision-making process is not theirs—even less comfortable if decisions are vested in machines'.[250]

Building Trust: Training, Technology, and Institutional Change

The Army hopes to prepare officers for a more data- and information-centric future through appropriate training.[251] Indeed, studies on military innovation identify training as a key component of the organisational change required to deliver innovation.[252] Given that trust in new systems and approaches in part stems from familiarity and experience, training offers a route to cultural acclimatisation as well as a means to 'upskill' Australian soldiers in particular areas.

Participant opinions on training institutions' receptivity to change varied. However, officers generally doubted the degree of influence minor training reform would have on Australian command culture. While the All Corps Officer Training Continuum (ACOTC)—which governs most Australian Army officers' professional development—was seen as highly influential on junior officers, it was considered to exercise very limited impact at higher levels of command. Consequently, ACOTC was not considered to greatly influence Australian military command practices, which instead perpetuate through lived experience, with career courses seen as exercises in personal broadening and network-building.[253]

The crowded schedule of existing career courses and unit exercise rotations was also identified as a major hurdle to new training for HUM-T. One participant argued that under the 'current training system we don't get enough time to work with other force elements and machines', while another highlighted the difficulty in finding a single clear week to train staff in the use of BMS.[254] More broadly the pressure on training time was perceived as a manifestation of the tension between 'professional mastery' and 'constant change' inherent in the Army's 'Ready Now, Future Ready' strategy, making it difficult to maintain both generalist and specialist skill sets.[255] Anecdotally this contrast has also led to concern over the priorities

in existing Army training mechanisms for (non-technological) specialists such as medical officers.[256] In the case of HUM-T, at least one participant questioned whether the additional technical skills could ever be reconciled with the existing training timelines, mirroring existing concern that digitisation is causing elementary military competencies to atrophy as they become less frequently practised.[257]

Consequently, current training processes will themselves require extensive reform in order for officers to develop the depth of knowledge, familiarity and trust in autonomous systems required for acceptance of HUM-T. The experience of digitisation has highlighted the need to link training systems with doctrinal and technological change in a more concerted way. As a recent Australian Strategic Policy Institute report highlighted, initial provision of 'just-in-time' training to field units as they were refitted with new equipment did little to build confidence in digital systems across the force, amplifying issues of user acceptance and systems integration. Moreover, the use of different systems in tactical contexts and in barracks has created a physical and psychological distinction between routine technical skills and operational technologies, while exacerbating skill fade in the latter.[258] Thus, participants argued that the scale of change represented by HUM-T would require a comprehensive overhaul of Army training to ensure that new practices were embedded consistently across the organisation.[259] Because of the systemic nature of C2 architectures, which to be fully effective must align with both professional development and tactical doctrine, this task represents no small feat. Such a prospect would effectively require the re-engineering of ACOTC syllabuses (and likely accompanying non-commissioned officer development) throughout the training continuum, together with the gradual retraining of field army units in toto, alongside comparable changes to special-to-arm and trade training at successive levels.

The Army is clearly alive to the need to continuously reform training in light of new technological innovations, but it must balance pressure on existing training pipelines and unit rotations with retention priorities. Investment in simulation platforms, for example, is expected to provide an opportunity to exercise new concepts and capabilities with reduced levels of cost and disruption, potentially even ahead of some components' full acceptance into service. Defence is also establishing a joint forces 'battle laboratory' to pioneer integrated warfighting concepts, and presumably also the systems integration that will underpin them.[260] Moreover, the integration of synthetic

environments and live training is seen as a cost-effective means to facilitate experimentation and innovation without compromising on the realism of training. Often armed forces have used dedicated trials formations to pilot new concepts and develop wider organisational confidence in change. Whether such a commitment would be sustainable for the Australian Army at sufficient scale to test formation C2 remains uncertain, but synthetic training environments offer one potential substitute for a dedicated trials brigade, having been extensively developed by the Israel Defense Forces and increasingly employed by partners like the UK.[261]

Even so, effective training for HUM-T would rely on concomitant shifts in both doctrine and education, where a number of participants felt the Army had so far been slow to adjust to emerging technological potential. Although careful design of doctrine, processes and human-machine interfaces is expected to limit the requirement for officers to develop deep specialist knowledge, effective HUM-T is nonetheless expected to necessitate a somewhat greater level of technical understanding among generalist officers, if only to enable them to properly appreciate the strengths and limitations of autonomous systems in context.[262] Accordingly, the Army is seeking to attract more officers with pre-existing STEM backgrounds, and to develop its educational provision in tandem with training. However, the Army's established organisational culture inherently privileges practical or applied knowledge, even in the officer corps, and in the view of some officers actively borders on anti-intellectual.[263] Army leadership recognises the scale of the cultural challenge. As one senior Army officer noted, while the 'Army is on a glide-path to be a data-driven land force', future data competencies represent 'a sea-change for our organisation, and we've been digitising for a decade'.[264]

Potential contradictions remain between the development of the educational capital required to manage automation and the training reforms needed to implement HUM-T. The 2016 Ryan Review, for example, emphasised the importance of fostering competitive dynamics in officer career courses, countering perceived tendencies towards average output standards. Greater intra-officer competition may advance collective mastery of the profession of arms, but may also sit ill at ease with the parallel need to create space for intellectual broadening—and the fostering of more profound teaming behaviours at the heart of future C2 concepts.[265] Equally, changes to education and training are seen as a necessary prerequisite for the widespread acceptance of new tactical and organisational approaches, but may be difficult to enact without a clear doctrinal concept around which to structure reform.

Yet, absent the conceptual shift in officer attitudes educational reforms are intended to facilitate, doctrine has itself been described as unresponsive to change.[266] As Brigadier Ascough has argued, the extent of the professional and technical educational demands of future HUM-T architectures remains somewhat elusive: 'We don't know the scale of the problem yet because we have not yet fully trained our force to be a digitally and data-literate force'.[267]

Embedding these new competencies will necessitate changes to the way the Army manages its people and their careers. At present, growing the Army's technical competencies is complicated by difficulties in both recruitment and retention. Perhaps as many as 40 per cent of junior soldiers leave the Army at or before completion of four years of service, causing one participant to quip that '"Army in Motion" is not a catchphrase but a reality ... We're a youthful army and an army experiencing high personnel turnover'.[268] Concerningly, the ADF members most likely to leave before completion of their first term of enlistment are those serving in the combat arms or in communications and intelligence branches—the areas likely to be most immediately affected by the introduction of HUM-T in C2. In the latter case, the elevated dropout rate appears to be the product of competition for young talent between the military and the civilian labour markets. Moreover, in contrast to the US experience, minority groups are also less likely to remain in Australian service, despite increasing institutional recognition of the value of diversity for innovation and cognitive originality in planning and execution.[269] Ongoing initiatives are attempting to address these issues, such as the Pathway to Change—Evolving Defence Culture program to address problematic behaviours. The 2016 ADF Total Workforce System seeks to provide the military with access to niche expertise through a more flexible employment system, allowing the Army to draw on specialist capabilities from the Reserve and via contractors more easily.[270] In an effort to provide greater continuity and predictability for Service members and their families, Forces Command has prioritised 'time with teams' in its recent command plan, while simulation may also help to balance busy training commitments and the need to develop hands-on experience with the continuity required for steady retention rates.[271]

Even so, the Army itself recognises that designing new career pathways alone will not be enough to embed the skills and behaviours required for HUM-T. In-demand data specialists, for example, will likely require new pay, promotion and benefit structures to align service remuneration with

the civilian value of their expertise as opposed to their military rank.[272] While additional pay for specialist qualifications is not itself revolutionary, the wider implications of new technically orientated career reforms may nonetheless subvert traditional hierarchies embedded in military culture. Major General Toohey has been quick to argue that although an 'expert operator' will require 'specialist pay [that] reflects their ability to effectively employ or sustain an autonomous system', nonetheless, 'a highly-paid Corporal ... will remain different to, and differently compensated from, a commander whose military judgement and leadership skills are trained over years and instilled through lessons on operations'.[273]

Echoing the challenges automation presents for labour relations in the civilian economy, officer views of HUM-T are coloured by perceived impacts on military employment. The prospect of using automation to generate efficiencies in the Army's 'back-end' business has generated a degree of scepticism about the motives behind HUM-T. A number of officers serving at regimental level were quick to point out potential economies flowing from HUM-T, from the optimisation of procurement to the redeployment of intelligence analysts.[274] Staff officers likewise felt that in Army Headquarters, personnel savings were seen as closely entwined with autonomous systems, though as much as an enabler for adoption as an incentive for change.[275] Indeed, senior officers have themselves articulated the potential to generate efficiencies from automation by 'balancing operational and enterprise effectiveness, affordability, and institutional values'. Moreover, the Army's RAS Strategy identified the realisation of post-Fordist just-in-time principles in logistics and business processes as one of the main advantages of automation.[276]

For some officers, the Army's cultural heritage also acts as an anchor on organisational change, tying Australian military identity to the idealised myths of soldiering prevalent in wider society.[277] Digitisation has largely been driven top down by reformist senior leaders, even in the face of significant scepticism from below. As one participant remarked:

> *This is our third go at digital C2. A couple of senior leaders have forced this on the organisation ... Even advocates acknowledged shortcomings but said it was necessary to get on.*[278]

Senior Australian officers are nonetheless sanguine about the potential malleability of Australia's martial heritage to future warfare. In the view of Brigadier Ascough, the Army must always hold its ANZAC heritage dear,

but it should not let this unduly shape soldiers' (and civilians') view of how the Army should develop. Australia's martial history may in fact be actively harnessed in the service of change, as illustrated by Major General Toohey's attempts to cast HUM-T as the intellectual successor of Sir John Monash's innovative practice during the First World War.[279] Consequently, future C2 will also need to accommodate the Army's evolving organisational identity.

Nonetheless, civilian expectations of military conduct are likely to remain influential, given growing public interest in the ethics and accountability of autonomous systems. Humanitarian organisations and civil society groups are particularly concerned about the automation of lethal force. The International Committee of the Red Cross (ICRC), for example, has argued that the lack of predictability inherent in some forms of AI, together with the potential of autonomous systems to diffuse (and, by extension, partially abrogate) responsibility for errors among a very broad range of individuals (from those who supervise, operate or maintain the system on the battlefield to those who designed its functionality or approved its doctrinal method of employment) may reduce de facto legal control and accountability over the applications of human-machine violence. The ICRC has equally objected to the vagaries of various Western armed forces' policy commitments to 'meaningful' human control.[280] Indeed, ethical distinctions between the acceptable and unacceptable applications of autonomy in the public consciousness are not necessarily mirrored by clear technological or tactical cleavages, complicating the extent to which systems design alone can mitigate public concerns.[281]

Many Australian officers appear to share wider societal concerns about the ethical acceptability of military automation. A number of participants expressed ethical concerns about greater use of autonomy in targeting, citing a lack of trust in the reliability of systems and the complicated social and political contexts that the laws of war must invariably be applied in. One described these concerns as part of the 'cultural baggage' associated with HUM-T, while another worried that further autonomy might be the start of a descent into 'immoral warfare'. The prospect of greater autonomy is also seen as potentially lowering the political entry costs for violent conflict and, by extension, undermining traditional concepts of strategic deterrence.[282] In fact, some surveys of US military personnel suggest that Service persons are actually more strongly opposed to the use of lethal autonomous weapons systems than the general public.[283]

Joint Terminal Attack Controllers, for instance, have exhibited consistently high preferences for manned rather than unmanned aircraft in close air support, demonstrating a profound lack of trust in the reliability of robotic systems that lack 'skin in the game' and the reciprocal emotional obligations to ground troops that comes with it.[284]

Consequently, HUM-T may be required to maintain public and professional trust even where autonomy alone is technically capable, providing a bridge between societal expectations and the machines that actually do the fighting. Some participants even suggested that future autonomy might necessitate increased human involvement in targeting, with the inclusion of ethical advisors alongside political and legal advisors in some oversight functions.[285] Thus, when it comes to the design of HUM-T in C2 architectures, the ability to generate trust in future systems will encompass everything from tactical context to Australian civil-military relations.

Conclusions

Military organisational culture has important implications for technological innovation. As Michael Horowitz has argued, the institutional capacity to absorb new military technology can be understood as the product of a cost-benefit analysis in which the expected advantages of adoption are weighed against the potential costs of and impediments to change. Importantly, both halves of this equation are shaped by officers' beliefs and collective preconceptions, affecting the perceived value of new innovations and, by extension, the officer corps' receptivity to change.[287] Military culture is rarely static or uniformly held throughout the officer corps, complicating straightforward generalisations about an army's propensity to innovate technologically. Younger officers are often assumed to be more receptive to technological change, but this is not always the case. Historically, top-down military reforms have sometimes foundered in the face of bottom-up resistance; conversely, grassroots adaptation typically requires senior champions in order to successfully persist.[288] Discerning Australian officers' attitudes to, and expectations of, military automation is therefore vital to understanding the prospects for implementing HUM-T in the Australian Army. Consequently, this paper has sought to address three key questions: What do Australian officers believe about the potential for military automation? How might these attitudes affect the use of automation in future command and control? And, finally, what implications might HUM-T have for the Army's existing organisational preferences? Key findings across each of these themes are summarised below, in turn.

First and foremost, Australian military perspectives on automation must be understood in the light of ongoing changes in Australia's geo-strategic environment. ADF policy and concept documents reflect a growing concern at the rise of Chinese military power and the heightened strategic, political,

and economic competition this has brought to Australia's near abroad and the wider Asia-Pacific region.[289] As a result, there is a growing recognition among Australian officers that the Army must do more to support its sister Services in other domains, and the associated drive to acquire more potent cross-domain capabilities (such as long-range fires and surveillance suites) provides an important mobilising rationale for HUM-T in the land domain. Even so, the further technologisation of land warfare evidently runs counter to some deeply ingrained Australian military preferences. Traditionally Australian military identity has privileged the dismounted close combat soldiering skills considered to epitomise the Army's idealised organisational and conceptual heritage, and a tension between these values and the ongoing drive towards a heavier-weight, digitised force structure can already be evinced. In the words of one interviewee, the 'Australian Army is a light infantry army ... It sees technology as something you've got to carry on your back'.[290] The adoption of future autonomous systems may further exacerbate this contradiction, undermining grassroots support for HUM-T. Equally, though, Australian military culture places a high premium on tactical effectiveness, and the ability to undertake expeditionary operations is highly prized by Army officers. Consequently, the prospective battlefield advantages offered by HUM-T may yet counteract cultural resistance to the idea of future automation in the Australian officer corps.

In particular, the potential to generate cost-effective mass through the use of autonomous systems has significant appeal, allowing the Army to punch above its size. Equally, the prospects of increased operational tempo, greater flexibility in the concentration and dispersion of forces, and reduced cognitive burdens on commanders and staff are seen as especially desirable. Participants likewise recognised the expected benefits of HUM-T in information processing and decision-making, and viewed the prospect of greater agility in command and control as a distinct positive. Nonetheless, many Australian officers remain deeply sceptical about the maturity of autonomous technologies, and ultimately doubt the ability to make good on these visions. For example, as one participant remarked with respect to autonomous weapons systems, 'everybody says that they are swarming but they are not'.[291] In time, continuing allied commitment to HUM-T may help to encourage acceptance among Australian officers, given the widely recognised importance of tactical interoperability and strategic burden-sharing to Australian defence policy. As one officer concluded, 'we have a culture to remain relevant'.[292] That said, novel HUM-T concepts will

need to demonstrate their expeditionary credentials and, above all, clear utility in high-intensity warfighting, to win over Army sceptics. While most participants recognised autonomy's potential in this regard, many doubted the robustness of autonomous capabilities in highly contested military environments, creating a perception that novel systems may be better suited to so-called grey-zone or sub-threshold contexts that may ultimately serve to limit genuine acceptance of HUM-T. Here the public articulation of autonomous benefits *primarily* in terms of reducing risk to human life may prove somewhat unhelpful, in part because HUM-T may yet create unexpected second-order risks to soldiers, and also because this narrative may inadvertently downplay the tactical possibilities such systems could bring—which are equally important for user acceptance.

Leveraging automation in the field of command and control will require more than a simple extension of current digitisation programs, and instead necessitate significant changes to current Australian C2 practices alongside the acquisition of new electronic architectures. Nonetheless, the Army views mission command as a bridge between current doctrine and future concepts of agile control, which rely on officers placing increasing levels of trust in the analytical and tactical decision-making abilities of machines. Yet, in the experience of many participants, digitisation has so far tended to reinforce traditional centralised command hierarchies and often undermined the exercise of mission command. Thus, while significant support for more agile and delegated modes of C2 exists, a number of participants questioned the ability of mission command doctrine to enable greater levels of trust and delegation in the future. Moreover, trust in autonomous systems (and the HUM-T concepts dependent on them) may be inherently difficult to develop. Absent the reciprocal emotive connections that typically underpin trust between people, operator faith in autonomous machines will rely heavily on soldiers' understandings of how autonomous systems function, as a necessary prerequisite for developing confidence in autonomy's reliability, predictability and utility in operational contexts. Quite apart from the potential contradiction between machine decision-making being comprehensible and predictable to users but unpredictable and incomprehensible to enemy forces, the limited technical knowledge of many generalist officers—combined with the 'black box' tendencies of some AI software—may inherently limit Australian receptivity to HUM-T. One officer neatly encapsulated this widely held concern: 'How do we trust when we don't understand the AI algorithms?'[293]

Given the socio-technical and systemic nature of C2 architectures, however, the benefits of novel HUM-T approaches are unlikely to be fully apparent until significant change has already been accomplished. Perceptions of current digital command tools such as BMS, for example, have been undermined by persistent systems integration issues resulting from prolonged rollout times, uneven procurement, and ad hoc training. In the words of one participant, 'We're in this weird transition phase; we are seeking to delegate to the lowest level but constrained by existing processes and capabilities'. Another argued that digitisation 'hasn't changed processes to date, just how processes are conducted ... it's a chicken and egg thing'.[294] While many of the underlying drivers of such issues are organisational and procedural in origin, technical limitations have also played a role—as with the continuing supremacy of voice over VHF to data for C2 in contact—fuelling some participants' scepticism about future autonomy in C2 as technological hype. Moreover, HUM-T will undoubtedly produce new tactical and organisational dependencies, creating an ongoing need for technical and conceptual adjustment. Digitisation, for example, has precipitated a meteoric expansion in the size and footprint of headquarter staffs, as well as the electronic signatures of deployed formations. While automation might offset some of these issues through 'edge' processing capabilities and 'reach-back' services, it may simultaneously exacerbate emissions vulnerabilities and reliance on key enablers. Such trade-offs are unlikely to be avoided altogether, and participants were generally weary of technological 'silver bullets' purporting to provide all things to all soldiers. Consequently, future policy and doctrine should be explicit about the relative merits and trade-offs inherent in the developmental pathways selected, in order to help build organisational consensus prior to program implementation.

Finally, embedding HUM-T in Australian Army C2 practices will likely require significant organisational and institutional reforms to develop and maintain the proficiencies officers will need in order to operate effectively alongside autonomous systems. The Army has already begun to restructure procurement processes, and reforms of military education and career models are underway. Nonetheless, HUM-T will challenge traditional military preferences well beyond its battlefield praxis, and has the potential to subvert conventional military hierarchies and orthodox boundaries between military and civilian roles. The centrality of data science to military autonomy may prove particularly contentious, both because of the high commercial demand for programmers and because the future need to amend or assure

autonomous decision-making on the battlefield will likely blur traditional distinctions between the civilian contractors who manufacture military systems and the soldiers who operate them. The Army's strong training focus and the possibilities offered by new synthetic training environments provide an opportunity to harness existing tactical cultures in the service of digital change while simultaneously contributing to the stability needed for retention. Even so, changing military career pathways will be a particularly sensitive area for the implementation of HUM-T to navigate. A degree of cynicism is already discernible among some Australian officers—especially those outside of staff posts in Army Headquarters—who can see how automation will enable the Army to achieve personnel savings. Although senior officers expect HUM-T to create different rather than reduced roles for soldiers, such role displacement undoubtedly has the potential to distance officers from high-status combat functions currently at the heart of Australian military identities. Managing the reorientation of cultural expectations about functional roles without perceived loss of agency or status will be critical to grassroots reactions to the institutional incorporation of military automation.

There is good reason to believe that Australian military identities can and will adjust to HUM-T. Opposition to digitisation has been far from uncommon across a number of other Western armed forces, and future advances in autonomous practice in one national context will likely encourage cultural acceptance among allies and partners as best practices diffuse. Despite areas of cultural incompatibility, future concepts of HUM-T are still broadly consistent with Australian officers' established commitment to tactical excellence and professional mastery, as well as the Army's espoused belief in the importance of empowering junior commanders. That said, Australian officers do share wider societal concerns about the ethical acceptability of autonomous systems. Participants expressed particular concerns about the detrimental effect autonomous systems might have on officers' own command autonomy, and the implications for legal and moral accountability—even voicing concern about a slippery slope to 'immoral warfare'.[295] Some reformists expect these issues to become less salient as systems become more reliable and society becomes more comfortable with prolific autonomy in everyday life. At the same time, the far-reaching consequences for civilian life and work that automation is expected to produce may actually increase domestic opposition, and the challenge to traditional command roles and responsibilities HUM-T may pose should

not be underestimated. Thus, the implementation of autonomous concepts will need to consciously balance battlefield utility with societal perception by placing human agency at the heart of HUM-T. Ultimately, the successful adoption of autonomous systems in Australian military command and control will be as much a story of officers' changing attitudes and behaviours as of technological innovation.

Endnotes

1. Theo Farrell, Sten Rynning and Terry Terriff, *Transforming Military Power Since the End of the Cold War: Britain, France and the United States, 1991–2012* (Cambridge: Cambridge University Press, 2013).
2. T. X. Hammes, 'Technological Change and the Fourth Industrial Revolution', in George P. Shultz, Jim Hoagland and James Timble (eds), *Beyond Disruption: Technology's Challenge to Governance* (Stanford: Hoover Institution, 2008), pp. 37–74.
3. Australian Army, *Robotic and Autonomous Systems Strategy* (Canberra: Future Land Warfare Branch, 2018); US Army, *The U.S. Army Robotic and Autonomous Systems Strategy* (Fort Eustis: Training and Doctrine Command, 2017); UK Ministry of Defence, *Joint Concept Note 1/18: Human-Machine Teaming* (Shrivenham: Development, Concepts and Doctrine Centre, 2018).
4. Australian Defence Force, *Concept for Robotic and Autonomous Systems* (Canberra: Commonwealth of Australia, 2020); Department of Defence, *2020 Defence Strategic Update* (Canberra: Commonwealth of Australia, 2020), pp. 39, 53–54; Department of Defence, *2020 Force Structure Plan* (Canberra: Commonwealth of Australia, 2020), pp. 72–73.
5. Army, *Robotic and Autonomous Systems Strategy*, pp. 20–22, 27; Major General Mick Ryan, *Human-Machine Teaming for Future Ground Forces* (Washington, DC: Center for Strategic and Budgetary Assessments, 2018), pp. 18–22.
6. UK MoD, *Joint Concept Note 1/18*, p. 51.
7. Thomas Mahnken, *Uncovering Ways of War: U.S. Intelligence and Foreign Military Innovation, 1918–1941* (Ithaca, NY: Cornell University Press, 2002).
8. Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Ithaca, NY: Cornell University Press, 1984).
9. Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010).
10. Theo Farrell, *The Norms of War: Cultural Beliefs and Modern Conflict* (Boulder, CO: Lynne Rienner, 2005).
11. Elizabeth Kier, *Imagining War: French and British Military Doctrine between the Wars* (Princeton, NJ: Princeton University Press, 1997).
12. Theo Farrell, Frans Osinga and James Russell (eds), *Military Adaptation in the Afghanistan War* (Stanford, CA: Stanford University Press, 2013); Sergio Catignani, 'Coping with Knowledge: Organizational Learning in the British Army?', *Journal of Strategic Studies, 37:1* (2014), pp. 30–64; *Torunn Laugen Haaland*, 'The Limits to Learning in Military Operations: Bottom-up Adaptation in the Norwegian Army in Northern Afghanistan, 2007–2012', *Journal of Strategic Studies*, 39:7 (2016), pp. 999–1022.

13. Theo Farrell, 'World Culture and the Irish Army, 1922–1942', in Theo Farrell and Terry Terriff (eds), *The Sources of Military Change: Norms, Politics, Technology* (Boulder, CO: Lynne Rienner, 2002), pp. 69–90.
14. Chris Demchack, 'Creating the Enemy: Global Diffusion of the Information Technology-Based Military Model', in Emily O. Goldman and Leslie C. Eliason, *The Diffusion of Military Technology and Ideas* (Stanford, CA: Stanford University Press, 2003), pp. 307–347. See also Martin Zapfe, 'Strategic Culture Shaping Allied Integration: The Bundeswehr and Joint Operational Doctrine', *Journal of Strategic Studies*, 39:2 (2016), pp. 246–260; Terry Terriff, Frans Osinga and Theo Farrell (eds), *A Transformation Gap? American Innovations and European Military Change* (Stanford, CA: Stanford University Press, 2010); David J. Galbreath, 'Western European Armed Forces and the Modernisation Agenda: Following or Falling Behind?', *Defence Studies*, 14:4 (2014), pp. 394–413.
15. Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca, NY: Cornell University Press, 1991).
16. Eliot A. Cohen, 'Change and Transformation in Military Affairs', *Journal of strategic Studies, 27:3* (2004), pp. 395–407.
17. Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the US and Israel* (Stanford, CA: Stanford University Press, 2010).
18. Carl Bilder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: Johns Hopkins University Press, 1989); Thomas G. Mahnken and James R FitzSimonds, *The Limits of Transformation: Officer Attitudes toward the Revolution in Military Affairs* (Newport, RI: Center for Naval Warfare Studies, 2003); Theo Farrell, 'The Dynamics of British Military Transformation', *International Affairs*, 84:4 (2008), pp. 777–807.
19. Chris C. Demchak, *Military Organizations, Complex Machines: Modernization in the U.S. Armed Forces* (Ithaca, NY: Cornell University Press, 1991).
20. Adam M. Jungdahl and Julia M. Macdonald, 'Innovation Inhibitors in War: Overcoming Obstacles in the Pursuit of Military Effectiveness', *Journal of Strategic Studies*, 38:4 (2015), pp. 467–499.
21. Mahnken and FitzSimonds, *Limits of Transformation; Benjamin M. Jensen, Forging the Sword: Doctrinal Change in the U.S. Army* (Stanford, CA: Stanford University Press, 2016).
22. The project was funded under contract no. AARC 13/19 and received ethical approval from the Defence People Research—Low Risk Ethics Committee under protocol number 010-20.
23. Richard Hughes, 'On the Culture of the Australian Army', *Australian Army Journal*, 10:3 (2013), p. 227.
24. NATO Supreme Allied Commander Transformation definition of automation, as adopted by the Australian Army RAS Strategy. See Army, *Robotic and Autonomous Systems Strategy,* p. 5.
25. Forrest E. Morgan, Benjamin Boudreaux, Andrew J. Lohn, Mark Ashby, Christian Curriden, Kelly Klima and Derek Grossman, *Military Applications of Artificial Intelligence: Ethical Concerns in an Uncertain World* (Santa Monica: RAND, 2020), pp. 9–11.
26. Jack Watling, 'The Key to Armenia's Tank Losses: The Sensors, Not the Shooters', *RUSI Defence Systems*, 6 October 2020, https://rusi.org/publication/rusi-defence-systems/key-armenia-tank-losses-sensors-not-shooters [link no longer active]; Jack Watling and Sidharth Kaushal, 'The Democratisation of Precision Strike in the Nagorno-Karabakh Conflict', *RUSI Commentary*, 22 October 2020, https://rusi.org/commentary/democratisation-precision-strike-nagorno-karabakh-conflict [link no longer active].
27. See Major General Kathryn Toohey, 'Challenge and Opportunity: Robotics and Autonomy as Part of Future Land Warfare', *United Service*, 69:4 (2018), p. 9.

28. Elinor Sloan, 'Robotics at War', *Survival*, 57:5 (2015), pp. 110–111.
29. Jai Galliott, 'The Limits of Robotic Solutions to Human Challenges in the Land Domain', *Defence Studies*, 17:4 (2017), pp. 330–331.
30. See Dennis E. Showalter, 'Infantry Weapons, Infantry Tactics, and the Armies of Germany, 1849–64', *European History Quarterly*, 4:2 (1974), pp. 119–140.
31. Department of Defence, *2020 Defence Strategic Update*, p. 3; Michael Beckley, 'The Emerging Military Balance in East Asia: How China's Neighbors Can Check Chinese Naval Expansion', *International Security*, 42:2 (2017), pp. 78–119; Jonathan D. Caverley and Peter Dombrowski, 'Cruising for a Bruising: Maritime Competition in an Anti-Access Age', *Security Studies*, 29:4 (2020), pp. 671–700.
32. Department of Defence, *2020 Defence Strategic Update*, p. 14; Brigadier Ian Langford, 'Tactical and Strategic "Readiness" for the Australian Army', *Land Power Forum*, 15 May 2020, https://researchcentre.army.gov.au/library/land-power-forum/tactical-and-strategic-readiness-australian-army.
33. Interview with Participant 6, Australian Army Lieutenant Colonel, Cavalry, conducted on 18 August 2020; Correspondence with Participant 10, Australian Army Lieutenant Colonel, Cavalry, received on 22 September 2020; Interview with Participant 11, Australian Army Lieutenant Colonel, Intelligence, conducted on 5 November 2020.
34. Barry R. Posen, 'Command of the Commons: The Military Foundation of U.S. Hegemony', *International Security*, 28:1 (2003), pp. 5–46.
35. Stephen Biddle and Ivan Oelrich, 'Future Warfare in the Western Pacific: Chinese Antiaccess/Area Denial, U.S. AirSea Battle, and Command of the Commons in East Asia', *International Security*, 41:1 (2016), pp. 7–48.
36. Department of Defence, *2020 Defence Strategic Update*, p. 13.
37. Lieutenant General Rick Burr, 'Army in Motion: Accelerated Warfare Statement', Australian Army, 22 October 2020, https://www.army.gov.au/sites/default/files/2020-11/2020%20-%20Accelerated%20Warfare_0.pdf.
38. Interview with Participant 2, Australian Army Lieutenant Colonel, Army HQ, conducted on 7 August 2020; Interview with Participant 5, Australian Army Lieutenant Colonel, Army HQ, conducted on 14 August 2020; Interview with Participant 7, Australian Army Lieutenant Colonel, Engineering, conducted on 19 August 2020; Interview with Participant 9, Australian Army Lieutenant Colonel, Army HQ, conducted on 10 September 2020; Interview with Participant 13, Australian Army Lieutenant Colonel, Aviation, conducted on 13 November 2020.
39. Department of Defence, *2020 Defence Strategic Update*, pp. 4, 27.
40. Army, *Robotic and Autonomous Systems Strategy,* passim. See also Toohey, 'Challenge and Opportunity', pp. 9–12; Ryan, *Human-Machine Teaming*, pp. 7–30; Australian Army Headquarters, 'Human-Machine Teams: Discussion Paper', Soldier Combat System Program, 29 March 2019, pp. 1–28.
41. UK MoD, J*oint Concept Note 1/18*, p. 2; UK Ministry of Defence, *Joint Concept Note 2/17*: *Future of Command and Control* (Shrivenham: Development, Concepts and Doctrine Centre, 2017), p. iii.
42. US Army, *Robotic and Autonomous Systems Strategy*, p. i, p. 10.
43. US Army, *Robotic and Autonomous Systems Strategy*, p. 1; UK MoD, *Joint Concept Note 1/18*, p. iii.
44. Interview with Participant 2; Interview with Participant 8, Australian Army Lieutenant Colonel, Artillery, conducted on 20 August 2020; Interview with Participant 12, Australian Army Lieutenant Colonel, Signals, conducted on 3 November 2020; Interview with Participant 3, Australian Army Major, Army HQ, conducted on 10 August 2020.

45. Interview with Participant 14, Australian Army Lieutenant Colonel, Army HQ, conducted on 26 November 2020.
46. Interview with Participant 13.
47. Interview with Participant 6; Interview with Participant 8; Interview with Participant 2; Interview with Participant 5; Interview with Participant 11; Interview with Participant 13; Interview with Participant 14.
48. Interview with Participant 8; Interview with Participant 5; Interview with Participant 11.
49. Interview with Participant 11; also Interview with Participant 13.
50. Interview with Major General Mick Ryan, Commander Australian Defence College, Australian Army, conducted on 29 September 2020.
51. Interview with Participant 8; Correspondence with Participant 10; Interview with Participant 12; Interview with Participant 13; Interview with Participant 2.
52. Interview with Participant 13.
53. See Jerome Aliotta, 'Using Long-Distance Control, Army Tests Robotic Vehicle Along Challenging Australian Terrain', U.S. Army Tank Automotive Research, Development and Engineering Center Public Affairs, 7 October 2016, https://www.army.mil/article/176368/using_long_distance_control_army_tests_robotic_vehicle_along_challenging_australian_terrain; Department of Defence, *Giving Army the Capability Edge: Science and Technology Highlights from the Land Domain* (Canberra: Defence Science and Technology Group, 2017).
54. Interview with Participant 6; Interview with Participant 11.
55. Interview with Participant 3; Interview with Participant 6.
56. Toohey, 'Challenge and Opportunity', p. 10. See also Matthew Sawers and Kim Tang, *Semi-Autonomous Combat Team: Dismounted Infantry 2030 Concept* (Canberra: Defence Science and Technology Group, 2020), p. iv.
57. UK MoD, *Joint Concept Note 1/18*, p. 1; Ryan, *Human-Machine Teaming*, pp. 11–14.
58. ADF, *Concept for Robotic and Autonomous Systems*, p. 9.
59. Interview with Participant 6.
60. Army, *Robotic and Autonomous Systems Strategy*, p. 9.
61. Interview with Participant 3.
62. Ryan, *Human-Machine Teaming*, pp. 11–12.
63. For a recent discussion on the difficulty of defining such terms in doctrine, see ADF, *Concept for Robotic and Autonomous Systems*, pp. 16–19, 29–31, 71–73.
64. Interview with Participant 3.
65. Toohey, 'Challenge and Opportunity', p. 10; see, for example, US Army, *Robotic and Autonomous Systems Strategy,* p. 3. See also Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York: W.W. Norton, 2018), pp. 321–330.
66. UK MoD, *Joint Concept Note 1/18*, p. iii.
67. Interview with Participant 11.
68. Interview with Major General Ryan; Interview with Participant 9.
69. Interview with Participant 6; Interview with Participant 7; Interview with Participant 14.
70. Hammes, 'Technological Change and the Fourth Industrial Revolution'.
71. Correspondence with Participant 10; Interview with Participant 14.
72. Interview with Participant 3; Interview with Participant 8; Interview with Participant 5.
73. UK MoD, *Joint Concept Note 1/18*, p. 41.
74. Interview with Participant 5; Interview with Participant 6.
75. Interview with Participant 11.

76. See Warrant Officer David Ashley, 'Army's Spirit', *Australian Army Journal*, 10:3 (2013), p. 210; Australian Army, *Good Soldiering* (Canberra: Australian Army, 2020), https://www.army.gov.au/sites/default/files/2020-11/Good%20Soldiering%20-%20Values%20and%20Army%20teaming.pdf; Forces Command, *Forces Command 2020 to 2028* (Sydney: Headquarters Forces Command, 2019). See also Australian Army, *Land Warfare Doctrine 1: The Fundamentals of Land Power* (Canberra: Australian Army, 2014), pp. 27–46.
77. Anthony John, 'From Institution to Occupation: Australian Army Culture in Transition', *Australian Army Journal*, 10:3 (2013), p. 197; Captain James Brown, 'Fifty Shades of Grey: Officer Culture in the Australian Army', *Australian Army Journal,* 10:3 (2013), p. 249.
78. Interview with Participant 2.
79. Interview with Participant 3; Samuel Cox and Lieutenant Colonel Scott Holmes, 'An Interview with Scott Holmes: Human-Machine Teaming', *Grounded Curiosity*, 1 March 2020, https://groundedcuriosity.com/wp-content/uploads/2020/02/LTCOL-Scott-Holmes-Interview-APPROVED.pdf; Sawers and Tang, *Semi-Autonomous Combat Team*, p. iv.
80. For a discussion of swarming as a concept and as a military tactic, see Sean J. A. Edwards, *Swarming on the Battlefield: Past, Present, and Future* (Santa Monica, CA: RAND, 2000); Paul Scharre, 'How Swarming Will Change Warfare', *Bulletin of the Atomic Scientists*, 74:6 (2018), pp. 385–389; ADF, *Concept for Robotic and Autonomous Systems*, pp. 38–39.
81. Interview with Participant 5.
82. Sloan, 'Robotics at War', p. 112; Interview with Participant 5; UK Ministry of Defence, *Joint Concept Note 1/18*, pp. 21–23, 34–5.
83. Sawers and Tang, *Semi-Autonomous Combat Team*, p. iv.
84. Samuel Cox and Lieutenant Colonel Robin Smith, 'An Interview with Robin Smith: Robotic and Autonomous Systems in the Australian Army', *Grounded Curiosity*, 2 March 2020, https://groundedcuriosity.com/wp-content/uploads/2020/02/LTCOL-Robin-Smith-Interview-APPROVED.pdf. Colonel Smith has since been promoted to Director Robotic and Autonomous Systems Implementation Coordination Office.
85. Cox and Holmes, 'Interview with Scott Holmes'; Interview with Participant 3.
86. Brown, 'Fifty Shades of Grey'; Interview with Participant 1, Australian Army Lieutenant Colonel, Artillery, conducted on 5 August 2020.
87. Interview with Participant 2.
88. Cox and Smith, 'An Interview with Robin Smith'.
89. See Erik Gartzke, 'Blood and Robots: How Remotely Piloted Vehicles and Related Technologies Affect the Politics of Violence', *Journal of Strategic Studies,* Online First (2019), pp. 15–19.
90. Scharre, *Army of None*, pp. 137–160.
91. Interview with Participant 4, Australian Army Lieutenant Colonel, Cavalry, conducted on 12 August 2020.
92. Anthony King, *The Combat Soldier: Infantry Tactics and Cohesion in the Twentieth and Twenty-First Centuries* (Oxford: Oxford University Press, 2013). See also Theo Farrell, 'Transnational Norms and Military Development: Constructing Ireland's Professional Army', *European Journal of international Relations*, 7:1 (2001), pp. 309–326.
93. John, 'From Institution to Occupation'; Army, *Army's Contribution to Defence Strategy*, pp. 42–43; Nick Jans and Judy Frazer-Jans, 'Still the "Pragmatic Professional"? Pre- and Post-9/11 Professional Orientation in the Australian Military', *Armed Forces & Society*, 35:2 (2009), pp. 241–265; Interview with Brigadier Mark Ascough, Commander 6 Brigade, Australian Army, conducted on 21 October 2020; Interview with Major General Adam Findlay, Special Operations Commander Australia, Australian Army, conducted on 23 October 2020; Interview with Participant 13.

94. Interview with Participant 7; Interview with Participant 3; Correspondence with Participant 10.
95. Interview with Participant 4; Interview with Participant 5.
96. Interview with Brigadier Ascough.
97. Ryan, *Human-Machine Teaming*, pp. 37–88.
98. Interview with Professor M. J. Ryan, Director of the Capability Systems Centre, University of New South Wales Canberra at the Australian Defence Force Academy, conducted on 6 November 2020.
99. Garth Pratten, 'New Model Diggers: Australian Identity, Motivation, and Cohesion in Afghanistan', in Anthony King, *Frontline: Combat and Cohesion in the Twenty-First Century* (Oxford: Oxford University Press, 2015), pp. 167–199.
100. Australian Defence Force, *Australian Defence Doctrine Publication 00.1: Command and Control* (Canberra: Australian Defence Force Warfare Centre, 2009); Australian Army, *Land Warfare Doctrine* 3-0: Operations (Canberra: Australian Army, 2018), p. 26; UK MoD, Joint Concept Note 2/17, p. 9.
101. Anthony King, *Command: The Twenty-First-Century General* (Cambridge: Cambridge University Press, 2019).
102. UK MoD, *Joint Concept Note 1/18, p. vi; Army, Robotic and Autonomous Systems Strategy*, pp. 8–9.
103. Interview with Participant 12; Interview with Participant 4; Interview with Participant 13.
104. US Army, *Robotic and Autonomous Systems Strategy*, p. 16; Army, *Robotic and Autonomous Systems Strategy*, p. 7. See also UK MoD, *Joint Concept Note 1/18*, p. 15.
105. Interview with Participant 4.
106. Interview with Participant 8; Interview with Participant 11; Interview with Major General Ryan; Interview with Participant 6; Interview with Participant 7.
107. Army, *Robotic and Autonomous Systems Strategy*, pp. 15–16; Interview with Participant 13; Interview with Participant 9; Interview with Participant 1; Interview with Participant 2; Interview with Participant 6.
108. Army, *Robotic and Autonomous Systems Strategy*, p. 2; US Army, Robotic and Autonomous Systems Strategy, p. 3.
109. Army, *Land Warfare Doctrine 3-0*, p. 45; Interview with Participant 6; Correspondence with Participant 10. On the conceptualisation of tempo in manoeuvre thinking more generally, see Brigadier Richard Simpkin, *Race to the Swift: Thoughts on Twenty-First Century Warfare* (London: Brassey's Defence, 1985); Robert R. Leonhard, *Fighting by Minutes: Time and the Art of War* (Westport, CT: Praeger, 1994).
110. Interview with Participant 4; Interview with Participant 3; UK MoD, Joint Concept Note 1/18, p. 34.
111. Interview with Participant 11; Army, Land Warfare Doctrine 3-0, p. 28.
112. Interview with Participant 13.
113. Interview with Participant 9; Interview with Brigadier Ascough.
114. Interview with Participant 2; Interview with Participant 7
115. Ryan, *Human-Machine Teaming*, p. 25; Army, *Robotic and Autonomous Systems Strategy*, p. 21; Interview with Participant 1; UK MoD, *Joint Concept Note 1/18*, p. 34; Keith Dear, 'Artificial Intelligence and Decision-Making', *RUSI Journal*, 164:5–6 (2019), pp. 18–25.
116. P. W. Singer, 'Tactical Generals: Leaders, Technology, and the Perils of Battlefield Micromanagement', *Australian Army Journal*, 6:3 (2009), p. 157; Interview with Participant 9.
117. Toohey, 'Challenge and Opportunity', p. 10.

118. Interview with Participant 9; UK MoD, *Joint Concept Note 2/17*, p. 19.
119. Ryan, *Human-Machine Teaming*, pp. 23–24; US Army, *Robotic and Autonomous Systems Strategy*, p. 5.
120. Australian Defence Force, *ADF Concept for Command and Control of the Future Force* (Canberra: Department of Defence, 2018), p. 19 and passim.
121. See UK MoD, *Joint Concept Note 2/17*; Lieutenant General David Deptula, Heather Penney, Major General Lawrence Stutzriem and Mark Gunzinger, *Restoring America's Military Competitiveness: Mosaic Warfare* (Arlington, VA: Mitchell Institute, 2019). See also John R. Hoehn, 'Joint All-Domain Command and Control (JADC2)', Congressional Research Service briefing, 16 November 2020, https://fas.org/sgp/crs/natsec/IF11493.pdf.
122. Interview with Participant 12.
123. Army, 'Human-Machine Teams: Discussion Paper', pp. 2–6.
124. UK MoD, *Joint Concept Note 2/17*, p. 5; ADF, Command and Control of the Future Force, p. 19.
125. ADF, *Command and Control of the Future Force*, p. 32; Michael Clifford, Michael Ryan and Zoe Hawkins, *Special Report: Mission Command and C3 Modernisation in the Australian Army—Digitisation a Critical Enabler* (Canberra: Australian Strategic Policy Institute, 2015), p. 5. Here, C3 means 'Command, Control, Communications', ibid., p. 5.
126. Ibid.; Colonel Joanne Whittaker and Colonel Michael Toohey, 'Land 200 Battlefield Command System: The Core of Land Combat System', Army Land C3 Presentation, n.d.
127. Army, 'Human-Machine Teams: Discussion Paper', pp. 2, 16.
128. Interview with Participant 9. See also Raytheon Technologies, 'Advanced Field Artillery Tactical Data System (AFATDS)', https://www.raytheon.com/capabilities/products/afatds; Steven W. Boutelle and Ronald Filak, 'AFATDS: The Fire Support Window to the 21st Century', *Joint Force Quarterly,* 10 (1996), pp. 16–21.
129. Interview with Participant 7; Interview with Participant 11; Interview with Participant 2.
130. Australian National Audit Office, *Auditor-General Report No. 40 2018–19: Modernising Army Command and Control—the Land 200 Program* (Barton: Commonwealth of Australia, 2019), p. 14.
131. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 6.
132. National Audit Office, *Modernising Army Command and Control*, pp. 24–33.
133. Interview with Participant 8.
134. Interview with Participant 7.
135. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 8.
136. Interview with Participant 7; Interview with Participant 3; Interview with Participant 11; Mark Gilchrist, 'You Can't Write an Algorithm for Uncertainty: Why Advanced Analytics May Not Be the Solution to the Military "Big Data" Challenge', *The Strategist*, 23 August 2017, https://www.aspistrategist.org.au/cant-write-algorithm-uncertainty-advanced-analytics-may-not-solution-military-big-data-challenge/.
137. Interview with Professor Ryan; Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 12; Interview with Participant 8; Interview with Participant 12.
138. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 12; Cox and Holmes, 'Interview with Scott Holmes'.
139. Interview with Participant 4; Interview with Participant 2.
140. Interview with Professor Ryan.
141. Interview with Major General Findlay. Successive tranches of LAND 200 are expected to address this issue, though it has been a particular problem with older AUSTACCS and BCCS applications. See National Audit Office, *Modernising Army Command and Control,* p. 14.

142. Interview with Participant 8; Interview with Participant 4.
143. Interview with Participant 4.
144. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 6; Interview with Professor Ryan; Army, *Army's Contribution to Defence Strategy*, p. 48.
145. National Audit Office, *Modernising Army Command and Control*, p. 34.
146. Army, *Army's Contribution to Defence Strategy*, p. 40.
147. Command, control, communications, computers, intelligence, surveillance, targeting acquisition and reconnaissance..
148. Interview with Participant 12.
149. Mark Gilchrist, 'Emergent Technology, Military Advantage, and the Character of Future War', *Strategy Bridge*, 26 July 2018, https://thestrategybridge.org/the-bridge/2018/7/26/emergent-technology-military-advantage-and-the-character-of-future-war.
150. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, pp. 9–10; Interview with Participant 3.
151. Gilchrist, 'Emergent Technology'.
152. Interview with Participant 5; Interview with Major General Findlay.
153. Interview with Major General Findlay; Interview with Professor Ryan; Interview with Participant 4; Interview with Participant 6; Interview with Participant 7; Interview with Participant 8; Interview with Participant 2.
154. Interview with Professor Ryan; Interview with Major General Findlay.
155. Army, 'Human-Machine Teams: Discussion Paper', p. 13.
156. Interview with Professor Ryan.
157. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 8.
158. Army, *Army's Contribution to Defence Strategy*, pp. 40–47; Interview with Participant 5.
159. Interview with Major General Findlay; Interview with Participant 13.
160. Interview with Participant 7; Interview with Participant 12; Interview with Participant 3; Interview with Participant 2; Brown, 'Fifty Shades of Grey', p. 250; Interview with Participant 1.
161. Interview with Participant 13.
162. Interview with Participant 1.
163. Interview with Participant 2.
164. Interview with Participant 11; Interview with Professor Ryan.
165. Interview with Participant 8.
166. Interview with Professor Ryan.
167. Interview with Major General Ryan.
168. Interview with Participant 8.
169. Interview with Participant 13.
170. Interview with Participant 12; Whittaker and Toohey, 'Land 200 Battlefield Command System'; UK MoD, *Joint Concept Note 2/17*, p. 12.
171. Interview with Participant 8.
172. UK MoD, *Joint Concept Note 1/18*, p. 16.
173. Interview with Professor Ryan; Gilchrist, 'You Can't Write an Algorithm for Uncertainty'.
174. Interview with Participant 11; UK MoD, *Joint Concept Note 1/18*, pp. 4–5; UK MoD, *Joint Concept Note 2/17*, p. 41.

175. UK MoD, *Joint Concept Note 1/18*, p. 30; Will Douglas Heaven, 'Predictive Policing Algorithms are Racist. They Need to be Dismantled', *MIT Technology Review*, 17 July 2020, https://www.technologyreview.com/2020/07/17/1005396/predictive-policing-algorithms-racist-dismantled-machine-learning-bias-criminal-justice/; Stephen Buranyi, 'Rise of the Racist Robots: How AI is Learning all our Worst Impulses', *The Guardian*, 8 August 2017, https://www.theguardian.com/inequality/2017/aug/08/rise-of-the-racist-robots-how-ai-is-learning-all-our-worst-impulses.
176. Sydney J. Freedberg, Jr, 'Pentagon's AI Problem is "Dirty Data": Lt Gen. Shanahan', *Breaking Defence*, 13 November 2019, https://breakingdefense.com/2019/11/exclusive-pentagons-ai-problem-is-dirty-data-lt-gen-shanahan/; US Department of Defense, 'Lt. Gen. Jack Shanahan Media Briefing on A.I.-related Initiatives within the Department of Defense', 30 August 2019, https://www.defense.gov/Newsroom/Transcripts/Transcript/Article/1949362/lt-gen-jack-shanahan-media-briefing-on-ai-related-initiatives-within-the-depart/.
177. Galliott, 'Limits of Robotic Solutions', p. 336.
178. ADF, *Command and Control of the Future Force*; UK MoD, Joint Concept Note 2/17; Hoehn, 'Joint All-Domain Command and Control'; Gilchrist, 'Emergent technology'.
179. Interview with Participant 8; Interview with Participant 5; Interview with Participant 4; Interview with Major General Findlay.
180. Interview with Major General Ryan; King, *Command*, pp. 301–305.
181. Interview with Participant 14; Interview with Participant 13.
182. Interview with Major General Findlay.
183. Interview with Brigadier Ascough.
184. Interview with Participant 7; Interview with Participant 9.
185. Interview with Participant 6.
186. Interview with Participant 7; Interview with Participant 11; Interview with Participant 13; Department of Defence, *2020 Force Structure Plan*, p. 28.
187. Interview with Major General Ryan.
188. Interview with Participant 9; Interview with Professor Ryan; Interview with Participant 14.
189. Sawers and Tang, *Semi-Autonomous Combat Team*, p. v. This capability is different to jamming, in that it can cause physical damage to electronic components, permanently disabling systems, as opposed to temporary disruption. See Jean-Jacques Quisquater and Samyde David, 'Radio Frequency Attacks', in Henk C. A. van Tilborg (ed.), *Encyclopedia of Cryptography and Security* (New York: Springer, 2005), pp. 503–509.
190. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 11; UK MoD, *Joint Concept Note 1/18*, p. 17; Interview with Participant 7; Interview with Participant 9; Interview with Participant 12.
191. Interview with Participant 1; Interview with Major General Findlay.
192. King, *Command*, pp. 315–321.
193. Interview with Participant 11.
194. Interview with Brigadier Ascough; Interview with Major General Findlay; Interview with Participant 4; Sawers and Tang, *Semi-Autonomous Combat Team*, p. iv.
195. Interview with Professor Ryan; Interview with Participant 11; Interview with Participant 13.
196. Interview with Participant 5.
197. Ibid.; Interview with Professor Ryan; Interview with Participant 3.
198. Interview with Major General Ryan.
199. Singer, 'Tactical Generals', pp. 153–154.
200. Interview with Participant 5.

201. Interview with Participant 3. See also UK MoD, *Joint Concept Note 2/17*, pp. 18–19, 45.
202. Interview with Participant 14.
203. ADF, *Command and Control of the Future Force*, p. 32.
204. Paul Cornish, 'Cry, "Havoc!" and Let Slip the Managers of War: The Strategic, Military and Moral Hazards of Micro-Managed Warfare', Strategic and Combat Studies Institute Occasional Paper, 51 (2006).
205. King, *Command*, pp. 327–357; Anthony King, 'The Deputy: Enhancing Command in the Twenty-First Century', *RUSI Journal*, 162:2 (2017), pp. 44–51.
206. Dennis E. Showalter, 'Prussian-German Operational Art, 1740–1943', in John Andreas Olsen and Martin van Creveld (eds), *The Evolution of Operational Art: From Napoleon to the Present* (Oxford: Oxford University Press, 2010), pp. 40–44; Geoffrey L. Herrera, 'Inventing the Railroad and Rifle Revolution: Information, Military Innovation and the Rise of Germany', *Journal of Strategic Studies*, 27:2 (2004), pp. 243–271; Dennis E. Showalter, 'Soldiers into Postmasters? The Electric Telegraph as an Instrument of Command in the Prussian Army', *Military Affairs*, 37:2 (1973), pp. 48–52; Robert Citino, 'Beyond Fire and Movement: Command, Control and Information in the German Blitzkrieg', *Journal of Strategic Studies*, 27:2 (2004), pp. 324–344.
207. For an exploration of the development of Mission Command in the Australian military context, see Russell W. Glenn (ed.), *Trust and Leadership: The Australian Army Approach to Mission Command* (Dahlonega, GA: University of North Georgia Press, 2020).
208. ADF, *Command and Control of the Future Force*, p. 32 and passim. See also UK MoD, Joint Concept Note 2/17; US Army, *Robotic and Autonomous Systems Strategy*.
209. Interview with Brigadier Ascough; Interview with Participant 6.
210. Cox and Holmes, 'Interview with Scott Holmes'; Lieutenant Colonel Richard King, 'How the Army Learned to Plan but Forgot How to Think', *Australian Army Journal*, 5:3 (2008), pp. 141–152.
211. Interview with Participant 7; Interview with Major General Findlay; Interview with Participant 3; Interview with Participant 13.
212. Interview with Participant 1.
213. Interview with Participant 3.
214. Interview with Participant 4; Interview with Participant 1; Interview with Participant 5; Interview with Participant 8; Interview with Participant 14; Interview with Major General Ryan; Interview with Brigadier Ascough; Interview with Major General Findlay.
215. Interview with Participant 5; Interview with Participant 13.
216. UK MoD, *Joint Concept Note 1/18*, p. 33; Singer, 'Tactical Generals', p. 150.
217. Interview with Participant 5; Interview with Participant 14; Interview with Major General Ryan; Interview with Brigadier Ascough.
218. Interview with Participant 1; Correspondence with Participant 10; Interview with Participant 12; Interview with Participant 13.
219. Interview with Participant 6; Ryan, *Human-Machine Teaming*, p. 41.
220. Anna T. Cianciolo, Karen M. Evans, Arwen H. DeCostanza and Linda G. Pierce, 'Trust in Distributed Operations', in Neville A. Stanton (ed.), *Trust in Military Teams* (Farnham: Ashgate, 2011), p. 90, emphasis added.
221. Aiden Warren and Alek Hillas, 'Friend or Frenemy? The Role of Trust in Human-Machine Teaming and Lethal Autonomous Weapons Systems', *Small Wars & Insurgencies*, 31:2 (2020), pp. 824–825.
222. Cianciolo et al., 'Trust in Distributed Operations', p. 91.
223. Correspondence with Participant 10; Interview with Participant 2.

224. James Connor, Dia Jade Andrews, Kyja Noack-Lundberg and Ben Wadham, 'Military Loyalty as a Moral Emotion', *Armed Forces & Society*, Online First (2019), pp. 1–21.
225. A. J. Masys, 'Teamwork and Trust: A Socio-Technical Perspective', in Stanton (ed.), *Trust in Military Teams*, p. 237.
226. Justin G. Hollands and Heather Neyedli, 'A Reliance Model for Automated Combat Systems: Implications for Trust in Automation', in Stanton (ed.), *Trust in Military Teams*, pp. 153, 175–6. See also UK MoD, *Joint Concept Note 1/18*, p. 48; Professor Ryan.
227. Interview with Participant 3; Interview with Participant 11; Interview with Participant 1; Interview with Participant 7.
228. Paul M. Salmon, Neville A. Stanton, Guy Walker, Daniel Jenkins, Laura Rafferty and Kirsten Revell, 'User Trust in New Battle Management Technology: The Effect of Mistrust on Situational Awareness', in Stanton (ed.), *Trust in Military Teams*, pp. 183–195.
229. Interview with Participant 6; Interview with Participant 1; Interview with Participant 12; Interview with Participant 13.
230. Ash Rossiter, 'High-Energy Laser Weapons: Overpromising Readiness', *Parameters*, 48:4 (2018–19), pp. 33–44; Ash Rossiter, 'Bots on the Ground: An Impending UGV Revolution in Military Affairs?', *Small Wars & Insurgencies*, 31:4 (2020), p. 854.
231. Interview with Participant 11; Interview with Participant 13.
232. Dear, 'Artificial Intelligence and Decision-Making', p. 21; Interview with Participant 5.
233. Interview with Participant 5; Interview with Brigadier Ascough; Interview with Major General Ryan; Gilchrist, 'Emergent Technology'; Gilchrist, 'You Can't Write an Algorithm for Uncertainty'; Interview with Major General Findlay; Interview with Participant 2.
234. Interview with Participant 1.
235. Interview with Participant 12; Interview with Participant 11; Interview with Participant 12.
236. M. L. Cummings, 'Artificial Intelligence and the Future of Warfare', Chatham House Research Paper, January 2017; Martin Hagström, 'Military Applications of Machine Learning and Autonomous Systems', in Vincent Boulanin (ed.), *The Impact of Artificial Intelligence on Strategic Stability and Nuclear Risk: Volume I, Euro-Atlantic Perspectives* (Stockholm: SIPRI, 2019), pp. 32–38.
237. Interview with Participant 3; Interview with Participant 2.
238. Interview with Professor Ryan.
239. Interview with Participant 13; Interview with Major General Findlay.
240. Dear, 'Artificial Intelligence and Decision-Making', p. 25.
241. Interview with Participant 6. On intuition, see also Gilchrist, 'You Can't Write an Algorithm for Uncertainty'; Taryn Elliott, *An Exploration of Unit Commander Decision-Making in the Australian Army* (University of Adelaide: PhD Diss., 2006), pp. 224–225.
242. For a discussion in a military context, see UK MoD, Joint Concept Note 1/18, pp. 31–32.
243. Raja Parasuraman, Michael Barnes, Keryl Cosenzo and Sandeep Mulgund, *Adaptive Automation for Human-Robot Teaming in Future Command and Control Systems* (Aberdeen Proving Ground: Army Research Lab, 2007).
244. Interview with Participant 6.
245. Parasuraman et al., *Adaptive Automation for Human-Robot Teaming*; UK MoD, *Joint Concept Note 1/18*, p. 42.
246. Parasuraman et al., *Adaptive Automation for Human-Robot Teaming*.
247. Elisabeth W. Fitzhugh, Robert R. Hoffman and Janet E. Miller, 'Active Trust Management', in Stanton (ed.), *Trust in Military Teams*, pp. 209–210.
248. Masys, 'Teamwork and Trust', pp. 227–240.
249. Interview with Participant 5.

250. Interview with Participant 1.
251. Department of Defence, 2020 Force Structure Plan, p. 83; Army, *Army's Contribution to Defence Strategy*, p. 40; Interview with Participant 6; Interview with Participant 11.
252. See Terry Terriff, 'Warriors and Innovators: Military Change and Organizational Culture in the US Marine Corps', *Defence Studies*, 6:2, (2006), pp. 215–247; Rosen, *Winning the Next War*; Cohen, 'Change and Transformation in Military Affairs'.
253. Interview with Participant 4; Interview with Participant 7; Interview with Participant 1; Interview with Participant 2.
254. Interview with Participant 11; Interview with Participant 1.
255. Interview with Participant 2; Interview with Participant 8.
256. R. Worswick, 'Medical Officer Training—An Infantryman's Perspective', *Journal of Military and Veterans' Health*, 27:3 (2019), pp. 6–10.
257. Interview with Participant 3; Galliott, 'Limits of Robotic Solutions', pp. 336–338; UK MoD, *Joint Concept Note 1/18*, p. 32.
258. Clifford, Ryan and Hawkins, *Mission Command and C3 Modernisation*, p. 7; Interview with Participant 1.
259. Ibid.; Interview with Participant 5; Interview with Participant 9; Interview with Participant 11; Interview with Participant 12.
260. Department of Defence, 2020 Force Structure Plan, p. 83; Army, *Army's Contribution to Defence Strategy*, p. 43. See also Department of Defence, 'Vice Chief of the Defence Force Executive', https://www1.defence.gov.au/about/vice-chief-defence-force; Department of Defence, 'Shaping the Future Force', https://defence.gov.au/VCDF/Forceexploration/; Defence Science and Technology Group, 'Joint Warfare and Operations', https://www.dst.defence.gov.au/capability/joint-warfare-and-operations.
261. Interview with Major General Ryan; Interview with Participant 2; Interview with Participant 13.
262. Interview with Major General Ryan; Interview with Brigadier Ascough.
263. Army, *Robotic and Autonomous Systems Strategy*, p. 16; Participant 6; Brown, 'Fifty Shades of Grey'.
264. Interview with Brigadier Ascough.
265. Brigadier Mick Ryan, *The Ryan Review: A Study of Army's Education, Training and Doctrine Needs for the Future* (Canberra: Australian Army, 2016), p. 33.
266. Interview with Participant 2; Interview with Participant 7; Galliott, 'Limits of Robotic Solutions', p. 334.
267. Interview with Brigadier Ascough.
268. Interview with Participant 3; Interview with Participant 9.
269. Phillip J. Hoglin and Nicole Barton, 'First-term Attrition of Military Personnel in the Australian Defence Force', *Armed Forces & Society*, 41:1 (2015), pp. 61–62; Interview with Brigadier Ascough.
270. Interview with Major General Findlay; Department of Defence, *2020 Defence Strategic Update*, pp. 59–61.
271. Forces Command, *Forces Command 2020 to 2028*, p. 8–13.
272. Army, *Army's Contribution to Defence Strategy*, pp. 42–43; Ryan, *Human-Machine Teaming*, p. 37; Interview with Major General Findlay.
273. Toohey, 'Challenge and Opportunity', pp. 11–12.
274. Interview with Participant 4; Interview with Participant 7; Interview with Participant 12.
275. Interview with Participant 11.

276. Ryan, *Human-Machine Teaming*, pp. 11–14, p. 44; Army, *Robotic and Autonomous Systems Strategy*, pp. 12–14.
277. Brown, 'Fifty Shades of Grey'; Interview with Participant 8.
278. Lieutenant Colonel Scott Winter, '"Fixed, Determined, Inviolable": Military Organisational Culture and Adaptation', *Australian Army Journal*, 6:3 (2009), pp. 53–67; Interview with Participant 4.
279. Toohey, 'Challenge and Opportunity', p. 11; Interview with Brigadier Ascough.
280. International Committee of the Red Cross, 'Ethics and Autonomous Weapon Systems: An Ethical Basis for Human Control?', ICRC report/position statement, 3 April 2018, https://www.icrc.org/en/document/ethics-and-autonomous-weapon-systems-ethical-basis-human-control.
281. Morgan et al., *Military Applications of Artificial Intelligence*, pp. 11–13, pp. 100–110; Warren and Hillas, 'Friend or Frenemy', pp. 829–830.
282. Interview with Participant 13; Interview with Participant 9; Correspondence with Participant 10; Interview with Participant 4. See also Ryan, *Human-Machine Teaming*, pp. 32–36. For potential implications of RAS on deterrence, see Amy Zegart, 'Cheap Fights, Credible Threats: The Future of Armed Drones and Coercion', *Journal of Strategic Studies*, 43:1 (2020), pp. 6–46.
283. See Morgan et al., *Military Applications of Artificial Intelligence*, p. 101.
284. Julia Macdonald and Jacquelyn Schneider, 'Battlefield Responses to New Technologies: Views from the Ground on Unmanned Aircraft', *Security Studies*, 28:2 (2019), pp. 216–249.
285. Interview with Participant 2; Interview with Participant 8; Interview with Participant 9; Interview with Participant 11; Interview with Brigadier Ascough.
286. Horowitz, *Diffusion of Military Power*.
287. Kier, *Imagining War; Farrell, Norms of War*.
288. Mahnken and FitzSimonds, *Limits of Transformation*; Rosen, Winning the Next War; Farrell, Osinga and Russell (eds), *Military Adaptation*.
289. See Department of Defence, *2020 Defence Strategic Update*.
290. Interview with Participant 14.
291. Interview with Participant 5.
292. Correspondence with Participant 10.
293. Interview with Participant 3.
294. Interview with Participant 12; Interview with Participant 4.
295. Interview with Participant 13.

About the Authors

David J Galbreath is Professor of International Security and Dean of the Faculty of Humanities and Social Sciences at the University of Bath. His expertise covers defence and war studies with a particular focus on how science and technology influences doctrine, concepts and tactics, alongside broader applications such as defence engagement and defence procurement. In addition, Professor Galbreath has long worked on the former Soviet Union, the Baltic States and, more recently, the war in Ukraine. He has been the editor of *European Security* (2008–2015) and *Defence Studies* (2014–2016), and Associate Editor of the *European Journal of International Security* (2016–2020).

Dr Alex Neads is a Research Associate at the University of Bath, specialising in international security and the diffusion of military power. His research on security assistance and civil-military relations has been published in the *Journal of Strategic Studies, Security Studies, the European Journal of International Security and Democratization*. Prior to joining the University of Bath, Dr Neads taught at the Defence Academy of the UK as part of Cranfield University, and internationally in support of UK Defence Engagement programs.

Professor Theo Farrell is Deputy Vice-Chancellor (Education) at the University of Wollongong, Australia. He was previously Professor and Head of the Department of War Studies at King's College London. Professor Farrell's research focuses on transformative change in the character of armed conflict. During the war in Afghanistan, he acted as strategic advisor to the UK government and US-led command in Kabul, and participated in track II talks with the Taliban. His latest monograph, *Unwinnable: Britain's War in Afghanistan*, 2001–2014 (Penguin Random House, 2017) was shortlisted for three national book awards and selected as book of the year by *The Sunday Times*.

Acknowledgements

The authors would like to thank Glenn Kolomeitz for his research assistance, as well as all those in the Australian Army and beyond whose generous participation contributed to the project.