

Military Decision-Making in an age of Algorithmic Warfare: Implications for Irish PME

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This paper examines the implications of algorithmic warfare for military decision-making and professional military education (PME), with a particular focus on the Irish Defence Forces (Óglaigh na hÉireann). Emerging technologies such as artificial intelligence (AI) and autonomous systems are transforming the character of war, accelerating decision cycles, and challenging traditional linear planning frameworks such as the Military Decision-Making Process (MDMP) and NATO's Operational Planning Process (OPP). While these processes have historically provided structure and predictability, they prove increasingly inadequate in volatile, uncertain, complex, and ambiguous environments shaped by digital interconnectivity and hybrid threats. Algorithmic warfare introduces both opportunities and risks. AI-enabled systems can automate data collection, analysis, and decision support, but they also amplify challenges related to bias, opacity, and automation dependence.

The paper situates these developments within the broader debate on PME, tracing its evolution from Huntington and Janowitz's sociological foundations through the academisation of military education in Western institutions. It argues that Irish PME, currently oriented toward accreditation and linear problem-solving, must adapt to foster sense-making, adaptability, systems thinking, and digital fluency. Three central implications for PME are highlighted: cultivating trust in AI through ethics and explainability, leveraging diversity of thought across military, academic, and civilian communities, and reorienting pedagogical approaches toward scenario-based learning, wargaming, and interdisciplinary innovation. Ultimately, the paper contends that for Óglaigh na hÉireann to become an agile and fit-for-purpose military force, PME must undergo a cultural and structural evolution. Preparing leaders to critically engage with emerging technologies and embrace complexity is not optional, but a strategic necessity in the age of algorithmic warfare.

Against the backdrop of renewed strategic competition between major powers, technologies such as autonomous systems and artificial intelligence (AI) are changing the character of war, influencing how militaries strive to impose order and predictability on the contemporary operating environment.¹ The accelerated pace of technological change risks exposing the

¹ James Johnson, 'The AI Commander Problem: Ethical, Political, and Psychological Dilemmas of Human-Machine Interactions in AI-Enabled Warfare', *Journal of Military Ethics* 21, nos. 3–4 (2022): 252, <https://doi.org/10.1080/15027570.2023.2175887>.



limitations of traditional decision-making frameworks used by operational and strategic planners. Algorithmic warfare refers to the integration of advanced algorithms – particularly those powered by machine learning and AI – into military operations to automate and enhance analysis, planning and decision-making. The concept, in a similar manner to fourth generation warfare (4GW) and mosaic warfare, marks a paradigm shift from traditional, network centric approaches to warfare since the middle of the last century, to one where intelligent machines not only support but shape military judgement.²

In so doing, this concept reframes warfare as a complex adaptive system in which tactical encounters take place on a strategic scale enabled by the internet. The Clausewitzian concepts of ‘fog’ and ‘friction’ cannot be fully eliminated by new technologies or concepts. Instead, they are intensified by the fragmentation of the engagement space and the velocity of AI-enabled decision loops. In such a fragmented and rapidly shifting environment, the operating environment is no longer static or fully knowable; instead, it is emergent and non-linear.

This paper explores the implications of algorithmic warfare for military decision-making, and more broadly on the professional military education (PME) systems that inculcate our leaders to adhere to such tools and frameworks. Óglaigh na hÉireann’s recently published Joint PME (JPME) Strategy 2025-2028 defines PME as a ‘system of training and education designed to develop the military capabilities of the organisation.’³ The definition highlights the systematic nature of PME which encompasses a range of formal educational activities through the length of a service-persons career to develop their understanding of the art and science of war evolving with experience and rank.

The paper begins by highlighting the limitations of traditional military decision-making frameworks when applied to complex adaptive systems. It argues that traditional decision-making frameworks – based on linear cause-effect reasoning and the prioritisation of process compliance – are increasingly redundant in volatile, uncertain, complex and ambiguous (VUCA) environments. The paper continues by identifying the implications for Irish PME, calling for a shift in culture anchored in digital fluency, diversity of thought and pedagogical approach. It is imperative that PME adapts to this new operating paradigm by moving beyond linear planning doctrine and embracing tools and frameworks that develop leaders’ capacity for sense-making, adaptability and systems thinking. While initiatives have been taken in the US Armed Forces and Australian Defence Forces in particular, Irish PME remains orientated toward accreditation and career progression. Taking steps to enhance sense-making and adaptability means our future leaders will be postured to continue transforming Óglaigh na hÉireann into an agile, fit-for purpose joint force.

² Peter Layton, *Algorithmic Warfare: Applying Artificial Intelligence to Warfighting* (Australian Air Power Development Centre, 2018).

³ Óglaigh na hÉireann, *JPME Strategy 2025-2028* (DFPP, 2025).

What is PME?

Before assessing how military education should evolve in the face of complexity, it is important to first clarify what is meant by Professional Military Education (PME). PME is a deceptively simple term that often masks a deeper debate about the purpose of developing military leaders and the profession of arms. At its core, PME sits at the intersection of training and education, with training emphasising technical proficiency and short-term utility, while education aims more to cultivate critical thinking and professional judgement over a career. While training and education are often used synonymously in strategic documents, they are not one and the same. The purpose of PME is not to provide certainty but to prepare leaders for uncertainty - to expose them to competing perspectives, to teach them how to think rather than what to think.⁴ Whether PME is conceived primarily as training, education, or a hybrid of the two in an Irish context, it has implications for how our military leaders approach uncertainty and complexity.

The theoretical foundations of PME are often traced to the sociological work of Samuel Huntington and Morris Janowitz in the mid-twentieth century. Huntington's *The Soldier and the State* advanced the notion of the officer corps as a professional body, bound by expertise, responsibility and corporateness, emphasising the need for military education to foster a distinct professional identity.⁵ Janowitz, in contrast, saw the officer increasingly engaged in broader social and political responsibilities that blurred the boundaries of the profession.⁶ Regardless, both perspectives situate PME as more than a technical endeavour – it is a cultural process of embedding professional norms and shaping the *habitus* of military officers.⁷ The academies and staff colleges that deliver PME could therefore be considered incubators of the institutional culture and ethos.

PME has evolved considerably in recent decades, influenced by operational imperative and broader societal trends. Following the 1986 Goldwater-Nichols Act and the 1989 Skelton Panel Reports in the United States, western PME has generally emphasised joint and combined operations recognising the value of interoperability among different service branches and nations and necessity to critically analyse complex security environments and effectively contribute to national defence. In western institutions, the same period witnessed what Libel terms the 'academisation' of PME representing an alignment with civilian universities, accreditation bodies, and research-orientated curricula.⁸ This trend has no doubt benefitted the military by enhancing intellectual rigour and professional legitimacy. However, critics argue it

⁴ United States House of Representatives, Subcommittee of the Committee on Armed Services, "Another Crossroads? Professional Military Education Twenty Years After the Goldwater-Nichols Act and the Skelton Panel," H.A.S.C. publication No. 111-67, 20 May 2009.

⁵ Samuel P. Huntington, *The soldier and the state: The theory and politics of civil-military relations* (Harvard University Press, 1957)

⁶ Morris Janowitz, *The professional soldier* (Free Press NY, 1971)

⁷ Pierre Bourdieu, *The Logic of Practice* (Polity, 1999), 53.

⁸ Tamir Libel, 'Professional Military Education as an Institution: A Short (Historical) Institutional Survey', *Scandinavian Journal of Military Studies* 4, no. 1 (2021): 128, <https://doi.org/10.31374/sjms.79>.

has shifted the focus away from strategic judgement and the profession of arms toward securitisation and credentialism.⁹

The Irish context reflects these tensions. Through its vision for the future, Óglaigh na hÉireann considers jointness an integral part of its identity. JPME is the vehicle for achieving this vision acknowledging that PME must continuously evolve in response to continuously shifting security challenges to ‘imbue service members with the intellectual agility to assume expanded roles and to perform new missions’.¹⁰ While contemporary JPME programmes generally emphasise critical thinking, agility and innovative problem-solving skills, experience suggests they continue to prioritise linear problem-solving frameworks and technical mastery over the cognitive agility required for modern warfare. If PME is about preparing leaders for the profession of arms, then it must evolve in line with the environments those leaders will operate in.

Decision-Making

Decision-making is a critical nexus between PME and military operations. As such, the learning, understanding and practicing of military decision-making frameworks form a significant part of Irish PME, in a similar fashion to most western militaries. These activities are normally conducted within the constituent schools of The Military College during longer career development courses. Military decision-making frameworks consist of ‘iterative logical planning methodologies’ used by commanders and staff to overcome the uncertainty and myriad unpredictable challenges that complicate military operations – often referred to in Clausewitzian terms as ‘fog’ and ‘friction’.¹¹ This process represents a perpetual struggle among military commanders to ‘reduce the conduct of war to a set of rules and a system of procedures – and therefore to make orderly and rational what is essentially chaotic and instinctive.’¹²

Contemporary decision-making models such as the Military Decision Making Process (MDMP) or NATO’s Operational Planning Process (OPP) evolved from analytical decision frameworks adopted by the US military in the middle of the twentieth century, which were themselves rooted in the military innovations of the nineteenth century. Theorists such as Antoine-Henry Jomini believed that war could be governed by universal scientific principles, which no doubt appealed to military staff’s search for systematic doctrine in the aftermath of the Napoleonic wars. This mechanistic approach emphasised hierarchical structures and defined processes influencing early 20th century management theories such as Taylorism.¹³ Through the latter half of the century, PME continued to err towards training for predicable responses to predicable situations.¹⁴ Within this paradigm, military commanders and their staff seek to

⁹ Thomas O. Mackubin and Erik C. Wright, “John Lehman: The Secretary of the Navy as Naval Strategist and Force Planner,” *Leadership Concepts Case Study* (National Security Affairs Department, Naval War College, 2013).

¹⁰ US House of Representatives, “Another Crossroads,” vii.

¹¹ Herwin Meerveld et al., “The Irresponsibility of Not Using AI in the Military,” *Ethics and Information Technology* 25, no.1 (2023): 14, <https://doi.org/10.1007/s10676-023-09683-0>.

¹² John Keegan *The Face of Battle*, (Cape, 1976), 20.

¹³ Ben Zweibelson, *Beyond the Pale: Designing Military Decision Making Anew*, (Air University Press, 2023), 154.

¹⁴ Kate Utting, (2009) Beyond Joint – Professional Military Education for the 21st Century: The United Kingdom's Post-defence Training Review Advanced Command and Staff Course. *Defence Studies*, 9(3), 313.

define clear objectives, engineer effects and derive optimal courses of action. Ways, means and risk could thus be balanced against defined ends using reductionist analysis referred to in military parlance as '*factor-deduction-task*'. Contemporary military decision-making frameworks have thus evolved to represent a series of sequential steps, decision points and results.

History has demonstrated that tempo is key when making decisions, underscoring the value of rapidly cycling through the sequential steps of the framework to maintain a physical and cognitive advantage over an adversary – the underlying principle of John Boyd's 'OODA Loop'.¹⁵ The OODA Loop was influenced by Boyd's experience in aerial combat during the Korean War and development of aerial combat capability thereafter. Despite his relative scant canon, his theories have influenced contemporary 'western' military strategy and doctrine since the late twentieth century.¹⁶ Boyd's cycle commences by observing, which involves the gathering of information from one's environment. Orientation takes place through analysis and deduction of selected relevant information. Decide involves the determination and selection of a particular course of action. Finally, Act is the implementation of the decision. Those familiar with Military Doctrine for the Irish Defence Forces (IRLJP-01) will observe this cycle reflected in our own operational design frameworks. Shifting from linearity to something more complex will have direct implications for how leaders think, plan and act.

Understanding the Pieces of the Puzzle

The nature of war has always to some degree involved uncertain and complex situations as pointed out by Clausewitz when observing "War is the realm of uncertainty; three quarters of the factors on which action is based are wrapped in a fog of greater or lesser uncertainty."¹⁷ However, the contemporary multi-domain operating environment encompasses diverse actors and interconnected variables, expanding the traditional battlespace beyond the physical realm and into the information space thanks to the ubiquity of the world wide web. This has compounded the 'fog of war' with something more akin to fragmentation. The military elements that engage in tactical encounters today are connected via a network of systems to multiple sensors and command nodes. In such a scenario, commanders and their staff must deal with incomplete or deceptive information, shifting realities, hybrid threats and rapidly-evolving situations. This brings renewed significance to the term 'strategic corporal'. Contemporary military strategists and operational planners must consider a broad range of informational, diplomatic and social factors when developing any military response option.

In response to social and political conditions, namely the speed and interconnectivity associated with contemporary globalisation and the information revolution, strategists continue to devise warfighting concepts.¹⁸ Algorithmic warfare is one such technology-enabled strategy

¹⁵ Cara Wrigley and Murray Simons, *Creativity in Military Complexity: Design, Disruptors and Defence Forces*, 1st ed. (Routledge, 2024), <https://doi.org/10.4324/9781003502180>.

¹⁶ Ian T. Brown, *A new conception of war: John Boyd, the US Marines, and maneuver warfare*, (Marine Corps University Press, 2018), 100; Grant Hammond, *The Mind of War, John Boyd and American Security*, (Smithsonian, 2001)

¹⁷ Carl von Clausewitz, *On War*, translated and edited by Michael Howard and Peter Paret (Princeton University Press, 1984). 101.

¹⁸ Emile Simpson, *War from the ground up* (Oxford University Press, 2018). 228

consisting of AI¹⁹ enabled analytics and decision support tools that can instantaneously respond to operational needs, creating strategic outcomes through coordinated, networked actions. Advantage is achieved through the combined effect of millions of sensors deployed in all domains processed through bespoke algorithms to filter content for human decision-makers.²⁰ The characteristics of algorithmic warfare are speed beyond human cognition, delegation of agency, opacity of decision processes.²¹ Like other operating concepts - such as mosaic warfare - the goal is 'to create a chain of effects—or, more accurately because these effects are not linear, "effects webs" - to deter and defeat adversaries across multiple scales of conflict intensity.'²² By combining technological innovation with mission command practitioners of algorithmic warfare seek to offset and out-pace adversarial decision-making.²³

Algorithmic warfare has the potential to overcome the inherent shortcomings of traditional military decision-making. Chronicled examples of AI in a military context include the commercial '*Palantir*' system enabling intelligence and logistics continuity by the Ukrainian Armed Forces and the US military's '*Project Maven*' which employs algorithms to detect, classify and present targets to human decision makers before transmitting decisions to a network of automated and human-controlled weapon systems. Closer to home, AI was used to detect Russian 'shadow fleet' vessels operating in Ireland's Exclusive Economic Zone (EEZ) through the cross referencing of satellite imagery with anomalies in shipping data.²⁴ Algorithms have already advanced to a level where they can be used to automate the collection and analysis of data and curate key insights for decision-makers. As outlined, the employment of AI to enable decision-making is 'symptomatic of a cumulative longer-term effort by militaries to use technology to tame chance and eradicate uncertainty.'²⁵ However, the side-effects of this effort are likely to see warfare taking place at a scale and speed beyond the limits of human cognitive capacity. As a consequence, the linear loop of action-reaction-counteraction which has informed traditional decision-making frameworks is becoming increasingly irrelevant.

Re-assessing Traditional Decision-Making

Preparing leaders for complexity requires more than new operational concepts or frameworks; it demands a new way of thinking that PME must deliberately foster. Complexity has become one of the defining features of our era. Kilcullen describes modern conflict as messy and

¹⁹ In this article, the term artificial intelligence (AI) refers to computer systems capable of performing tasks normally requiring human intelligence, such as: human-like perception, cognition, analysis, planning, learning, communication or physical action. (James Johnson [2019], Artificial intelligence & future warfare: implications for international security)

²⁰ Amir Husain, AI is shaping the future of war, *Prism* 9, no. 3 (2021): 53.

²¹ Layton, *Algorithmic Warfare* (2018)

²² DARPA, "Strategic Technology Office Outlines Vision for Mosaic Warfare," 04 August 2017, Available at <https://www.darpa.mil/news-events/2017-08-04>.

²³ Thomas X. Hammes (2005) War evolves into the fourth generation, *Contemporary Security Policy*, 26:2, 189-221, DOI:10.1080/13523260500190500

²⁴ Conor Gallagher, 'Dramatic Increase in Number of Russian "Shadow Ships" in Irish-Controlled Waters', *The Irish Times*, accessed 01 August 2025, <https://www.irishtimes.com/ireland/2025/07/21/number-of-russian-shadow-ships-in-irish-controlled-waters-rises-dramatically/>.

²⁵ James Johnson, 'The AI Commander Problem: Ethical, Political, and Psychological Dilemmas of Human-Machine Interactions in AI-Enabled Warfare', *Journal of Military Ethics* 21, nos. 3-4 (2022): 252, <https://doi.org/10.1080/15027570.2023.2175887>.

ambiguous, 'shaped more by interactions than individual actors.'²⁶ A complex system is any organisation that comprises many dynamically interacting elements. Humans, by nature are complex systems due to the vast network of interactions and causal relationships they embody.²⁷ Individuals continuously adapt their orientation to their environment through interaction, informed by their internal perceptions of incoming information.²⁸

With war increasingly taking place 'among the people,' it in itself begins to resemble a complex adaptive system characterised by self-organisation and adaptation to evolutionary pressures, resembling biological ecosystems.²⁹ When AI-enabled information systems take on a greater role in our daily lives, interpreting the full scale of interacting nodes, relationships and potential risks within a complex adaptive system becomes increasingly challenging. For military decision-makers, the challenge lies in developing an understanding of their evolving situation and articulate their objectives, while simultaneously trying to achieve them.³⁰ This has been likened to 'playing chess on multiple stacked boards where each move influences the moves of all other boards.'³¹ Military decision-making's reliance on predictable cause-effect relationships falls short in dynamic and chaotic contexts. Without a change in how we train our decision-makers, we are likely to continue to plan and engage in tactical activities grounded in outdated mental models. In the midst of a similar paradigm shift a century ago, J.F.C Fuller observed that military resistance to change derived not only from its 'worship of traditions' but its incapacity to 'see world forces in their true relationship'.³²

'Worship of tradition' is often rooted in deeper systemic factors. Over-reliance on historical precedent as the primary lens for anticipating challenges constrains innovation and agility.³³ While staff colleges invest heavily in historical grounding and battlefield studies, they seldom engage in scenario-based planning or wargaming 'beyond the start line'. Leaders are trained to assume a static environment where the sequential logic of planning remains valid from conception through to execution. Adherence to doctrinal processes, reinforced through institutional evaluation systems, fosters compliance and conformity, even as PME espouses critical and creative thinking.³⁴

Gaining advantage in algorithmic warfare requires military decision-makers not merely to cope with complexity but to perceive and act upon systemic interdependencies – what Fuller termed 'seeing the world forces in their true relationship.' Human cognition, however, is bounded. Decision-making blends intuitive impressions with deliberate reasoning, shaped by

²⁶ David Kilcullen, *The accidental guerrilla: Fighting small wars in the midst of a big one*. (Oxford University Press, 2011)

²⁷ Lewis A. Coser, (2004). *Masters of sociological thought: Ideas in historical and social context*. 2nd edn. (Rawat 2004)

²⁸ Tamir Libel, 'Professional Military Education as an Institution: A Short (Historical) Institutional Survey', *Scandinavian Journal of Military Studies* 4, no. 1 (2021): 121–31, <https://doi.org/10.31374/sjms.79>.

²⁹ Rupert Smith, *The utility of force: The art of war in the modern world*. (Penguin, 2012); Ben Johnson, "The Age of Disorder," *Wavell Room*, 09 August 2023, Available at: <https://wavellroom.com/2023/08/09/the-age-of-disorder/>.

³⁰ Stephanie E. Huebner, *Learning to Think for Understanding: Introducing Systems Thinking into Professional Military Education*, School of Advanced Military Studies US Army Command and General Staff College (2020), 18.

³¹ Thom Hawkins and Alexander Kott, "Beyond the Hype: Why We're Closer to AI-Enabled Mission Command than You Think" - Modern War Institute, 04 May 2022, Available at: <https://mwi.westpoint.edu/beyond-the-hype-why-were-closer-to-ai-enabled-mission-command-than-you-think/>

³² Colonel J.F.C. Fuller, *The Foundations of the Science of War*, (Hutchinson & Co., 1926), 31.

³³ Ben Zweibelson, *Beyond the Pale: Designing Military Decision Making Anew*, (Air University Press, 2023), 207.

³⁴ Johnson, "The Age of Disorder," (2023)

the mental models we develop from a young age to make sense of the world.³⁵ These heuristics – mental shortcuts that frame problems in ‘problem-solution’ terms – are influenced by context and social conditioning, often introducing cognitive bias.³⁶ In data-rich environments characteristic of algorithmic warfare, such biases risk flawed assessments and operational failure. For instance, the Israeli intelligence failure preceding the 1973 Yom Kippur War illustrates how doctrinal conformity and lack of institutional challenge can blind organisations to emerging threats.³⁷

AI offers the promise of processing vast volumes of data more efficiently than humans, but it is not immune to bias. Data quality and the human assumptions embedded in training sets shape algorithmic outputs.³⁸ Predictive policing studies in the USA revealed how reliance on biased data amplified errors, causing law enforcement officers to dismiss contradictory situational evidence.³⁹ A new form of bias in military decision-making is becoming apparent – automation bias. As humans increasingly anthropomorphise AI systems and overestimate their reliability, there is a tendency to accept algorithmic outputs uncritically, using them as a ‘heuristic replacement’ for independent verification.⁴⁰ This phenomenon is already playing out on the social media platform ‘X’, where users frequently engage with and defer to the algorithm known as ‘GROK’. Conversely, experienced decision-makers are often more cautious, favouring their own judgement – particularly when the opaque nature of machine-learning processes obscures how conclusions are reached.⁴¹ This opacity generates mistrust, which can slow adoption of otherwise valuable tools for navigating complex adaptive systems. Bridging this trust gap, while acknowledging human and machine limitations, is essential to leveraging AI effectively in future, distributed operational environments.

When we view the environment as a complex system we begin to understand that there are often initial, secondary and tertiary effects of our decision and actions. Systems thinking offers a lens through which decision-makers can interpret their situation, identify root causes of problems, and influence the various interacting nodes.⁴² Evolutions of Boyd’s Cycle have been developed in recent years based on emergent and systems thinking approaches. At their heart is the above premise that one cannot understand a complex adaptive system except by interaction with it. David J. Bryant’s work with the Australian Defence Forces in particular emphasises systematic enquiry and experimentation *from within the system* and prioritises emergent stability rather than rigid outputs. Bryant’s Create, Explore, Compare, Adapt (CECA) and the Australian Defence Force’s Act, Sense, Decide, Adapt (ASDA) models both commence with the

³⁵ Daniel Kahneman, *Thinking, Fast and Slow*, (Penguin, 2011)

³⁶ Russell L. Ackoff, "On the use of models in corporate planning." *Strategic Management Journal* 2, no. 4 (1981): 353-359.

³⁷ Noah B. Cooper, AI and Intelligence Analysis: Panacea or Peril? *War on the Rocks*, 10 October 2024, Available at: <https://warontherocks.com/2024/10/ai-and-intelligence-analysis-panacea-or-peril/>.

³⁸ Peter Layton, "Algorithmic warfare: Applying artificial intelligence to warfighting." (Australian Air Power Development Centre, 2018).

³⁹ Kevin Millar 2014; Albert Meijer and Martijn Wessels 2019 in Johnson, 'The AI Commander Problem: Ethical, Political, and Psychological Dilemmas of Human-Machine Interactions in AI-Enabled Warfare', 214.

⁴⁰ Johnson, 'The AI Commander Problem: Ethical, Political, and Psychological Dilemmas of Human-Machine Interactions in AI-Enabled Warfare', 256.

⁴¹ Anna Nadibaidze, Ingvild Bode, and Qiaochu Zhang. (2024). *AI in Military Decision Support Systems: A Review of Developments and Debates* (Odense: Center for War Studies).

⁴² Huebner, *Learning to Think for Understanding: Introducing Systems Thinking into Professional Military Education*, (2020)

actor interacting with their environment in a shift from Boyd's passive 'observe' stage. The models then progress through an exploratory 'sense-make' stage prioritising plausible understanding over Boyd's definitive 'orientation'.⁴³

Some scholars regard sense-making as an art form through which analysts impose order on complexity to better comprehend it and mitigate uncertainty.⁴⁴ When sense-making, decision-makers will be required to filter information, interpret analytics and derive strategic implications from real time developments. In this context, strategic judgement may be a more apt description of the competence required of commanders than Clausewitz' concept of strategic genius.⁴⁵ Sense-making is developed through discourse and competition with diverging views. It is sustained by intuition and experience enabling decision-makers discern patterns of regularity that can fill the blank spaces of knowledge.⁴⁶ Therefore, a large degree of the competence required for sense-making is tacit, such as communication and interpersonal skills.

Both CECA and ASDA models conclude with the actor adapting to the emerging context in contrast to Boyd's 'Act' stage. Adaption is not a new phenomenon and in many ways represent core Boyd principle. However, adaption in this context concerns the modification or re-organising of the conceptual model to cope with uncertainty.⁴⁷ In 2012, the then Chairman of Joint Chiefs of Staff released a white paper calling for the US armed forces to imbue its leaders with curiosity, an openness to new ideas and mental agility.⁴⁸ In a similar vein, General Stanley McChrystal made adaptability a central tenet of his leadership in an attempt to optimise his staff not for efficiency but to embrace uncertainty.⁴⁹ As evolutions of Boyd's cycle, the adaptive decision-making models discussed here offer utility in considering how decision-making may be postured to deal with complexity in the contemporary operating environment. They do not discount Boyd's fundamental principle of tempo. In a similar vein, the frameworks we use to handrail our decision-making remain valid to a point. The argument here is that we, as military professionals should not become slaves to process when guided by them. Enabling adaptive decision-making requires embracing uncertainty and fostering creativity, intuition, and interdisciplinary collaboration in PME and not simply applying them as visionary buzzwords. These competencies cannot be developed in isolation. They require institutional environments that reward creative problem-solving and unorthodox thinking – something not synonymous with military hierarchies.

⁴³ Bryant 2006. "Rethinking OODA"; Mike Brennan and Justin Kelly. "OODA versus ASDA: metaphors at war.[Paper in special edition: The Adaptive Army.]" *Australian Army Journal* 6, no. 3 (2009): 39-51

⁴⁴ Deborah Ancona, "Sensemaking: Framing and Acting in the Unknown," in Scott Snook, Nitin Nohria, and Rakesh Khurana, eds., *The Handbook for Teaching Leadership: Knowing, Doing, and Being*. (SAGE Publications, 2011). 3.

⁴⁵ Andrea Gilli, Future warfare, future skills, future professional military education, *NATO Defence College Policy Brief* No. 18 November 2021. 2

⁴⁶ Andrew D. James, 'Emerging Technologies and Military Capability', in *Emerging Critical Technologies and Security in the Asia-Pacific*, ed. Richard A. Bitzinger (Palgrave Macmillan, 2016), https://doi.org/10.1057/9781137461285_2. 5

⁴⁷ Bryant 2006, "Rethinking OODA".

⁴⁸ US Joint Chiefs of Staff, "Joint Education White Paper" (16 July 2012)

https://www.ndu.edu/Portals/59/Documents/BOV_Documents/2013/Joint%20Education%20White%20Paper.pdf.

⁴⁹ Gen. Stanley McChrystal, *Team of Teams: New Rules of Engagement for a Complex World*, (Penguin, 2015)

Implications for Irish PME

The generation of a suitably reflexive decision-making ethos in military organisations hinges not solely on the introduction of new methodologies, but on the cultivation of a supporting institutional culture and ethos that promotes its practice. As noted earlier, it is in the PME institutions where genuine culture change will emerge despite superficial efforts to regularly engage broader audiences. Notwithstanding the acknowledgement of the importance of adaptability to the future force, it is not included as one of the six guiding principles outlined in the Ireland's JPME strategy. Even more under-utilised are the words 'innovation' and or 'agility'.⁵⁰ Our current system teaches leaders how to critically think, but rarely trains them how to see the whole picture and 'visualise the environment as a system.'⁵¹ The JPME Strategy's emphasis on accreditation and career development suggests less focus on agility and innovation, which may constrain the development of critical skills for complexity. To resolve this, there is potential to create an environment where digitisation is the norm not the exception, where diversity of thought and challenging the status quo are truly valued and where our institutions seek out solutions to today's problems.

The first implication is trust. As AI tools become integral to sense-making, enhancing data literacy is critical for decision-makers to effectively lead analysts, navigate the limitations of machine interactions, and critically engage with AI-generated outputs generated.⁵² Cultivating trust in AI systems - anchored in robust ethics, governance, and continuous validation - remains a cross-cutting enabler of wider adoption.⁵³ The Government of Ireland has committed to the ethical use of AI and emerging technologies based on the principles of human agency, technical robustness and privacy. While this is unlikely to stymie any early capability development by Óglaigh na hÉireann, there may be issues regarding collaboration and innovation with companies based in countries that have not signed up to similar principles. The Military College continues to be an overwhelmingly paper-based institution. Óglaigh na hÉireann should prioritise 'explainable AI' as a starting point in digital capability generation and personnel development. Dual training of human operators and AI systems (known as Human-Machine Teaming [HMT]) underscores the importance of symbiotic development. A recent RAND study examining AI integration in the US Department of the Air Force highlights the significant challenge in translating the transformative potential of AI for sense-making to tangible capability. Careful dataset curation and simultaneous workforce training are key to sustainable strategic adoption, where AI augments not replaces human judgement in complex military planning.⁵⁴ Explainable AI in decision-making can be something as straightforward as the interaction of students analysing a theatre sustainment problem using large language models to

⁵⁰ The six guiding principles of the JPME Strategy are: Excellence, Integrity, Inclusivity, Mission focused, Learner focused, Collaboration

⁵¹ Huebner, *Learning to Think for Understanding: Introducing Systems Thinking into Professional Military Education*, 42.

⁵² Alexander Treiblmaier, 'Improving Efficiency Through Data-Driven Decision-Making In A Military Environment', TDHJ.Org, 27 October 2022, <https://tdhj.org/blog/post/data-driven-decision-making-military/>; Nadibaidze et al. *AI in Military Decision Support Systems: A Review of Developments and Debates*.

⁵³ Layton, "Algorithmic warfare."

⁵⁴ Kristin Warren et al., *Improving Sense-Making with Artificial Intelligence* (2025), RAND, Date Accessed: 25 August 2025. https://www.rand.org/pubs/research_reports/RRA3152-1.html.

provide data sheets and suggest sequencing. Regardless of the nature of future HMT in an Irish military context, the key is immediate adoption, even if in localised PME settings.

Given AI technologies will likely emerge from civilian sectors, responsiveness in our capability development function are critical for leveraging cutting-edge innovations. In theory, this should be less problematic for a country as advanced as Ireland. To this end, PME must foster an environment where diverse perspectives - spanning military, academic, and civilian stakeholders - collaborate to exploit emerging technologies. This segues into the second implication for PME – Diversity. Leaders in digital innovation have long recognised the value of the flow of ideas from inside and outside the community regarding enhanced decision-making. According to the head of Massachusetts Institute of Technology's (MIT's) Human Dynamics Laboratory "the collective intelligence of a community comes from idea flow; we learn from the ideas that surround us, and others learn from us".⁵⁵ By not engaging in multiple, diverse perspectives, leaders are likely to be deficient in the contextual intelligence required for effective decision-making in complex adaptive systems.⁵⁶ Diversity brings with it new language and perspectives that challenge dominant frames and improve our decision-makers ability to sense-make. A comprehensive approach in PME could inculcate collaboration with both civil servants and industry representatives taking part in various modules of military career courses. We have seen this gradually develop in the Defence Forces' Military College, but more can be done. Ireland's EI/IDA Technology Centre for Applied Data Analytics and Machine Intelligence (CeADAR), has been designated Ireland's National AI Hub and could serve as a strategic partner in the short to medium term. More broadly, the development of a national security and defence university using the blueprint of Sweden or Austria is a solid foundation for a whole of government approach to the new paradigm.

The third implication is education itself. While the underlying goal of PME should always remain the profession of arms, our institutions should remain responsive to evolutions in the character of war. We need our personnel in PME streams to engage in a more diverse range of specialities. Data science, analytics and visualisation should be encouraged at undergraduate level to ensure decision-makers possess the correct language and information when making decisions in a data-rich environment. Innovation and speciality programmes should be explored and encouraged at post-graduate level to mitigate against the development of 'groupthink' among senior leadership. Therefore, flexibility in the curriculum is likely to be a feature of future PME programmes recognising the rapid pace of technological change and dearth of specialist expertise in any particular area. While institutions cannot predict what skills and specialities will be important in the short term, providing selected leaders with greater flexibility in their educational journey may 'prove an effective solution for preparing the

⁵⁵ Alex Pentland, "Why Startups Should Steal Ideas and Hire WeirDOS," *Wired.com*, 07 February 2014, Available at www.wired.com/opinion/2014/02/ideas-flow/.

⁵⁶ Joan Johnson-Freese, Ellen Haring, and Marybeth Ulrich, "The Counterproductive Sea of Sameness" (2014) *Joint Force Quarterly*, 3rd Quarter.

organisation for future strategic challenges.⁵⁷ This should be guided by a future joint concepts branch.

The way we teach should evolve, developing the habits of mind to cope with complex systems. The US Department of Defense has already recognised the need to shift away from front-facing directed lectures using theoretical certainties to guided learning using scenario-planning and analogous case studies so senior leaders can grapple with the ‘messiness’ of real-world decision-making.⁵⁸ Thanks to large-language models (LLM), learners now have an ocean of content from eminent professors and industry experts one-click away. Again, in the US LLM are an effective tool in the faculty’s toolbox facilitating learning in laws of land warfare and military ethics.⁵⁹ Institutions such as the UK’s Defence Academy have begun to realign the purpose of faculty and directing staff from instructing to coaching, guiding learner inquiry of complex problems.⁶⁰ International PME programmes increasingly emphasise visualisation techniques – such as wargaming – to model systemic effects of decisions and foster collaborative, reflective analysis.⁶¹ Professional wargaming supported by AI tools will enable leaders to conceptualise the environment as a dynamic system with cascading effects. For the Irish Military College, wargaming (even in basic manual form) should be implemented in a much more comprehensive manner than it is today. In a similar vein, assessments should consider a pedagogical shift from one based on rote memorisation to one promoting the connection of ideas and creative dialogue.⁶² This holistic approach will not only prepare leaders for complexity but to create the conditions for a suitable learning environment for future generations of digital learners.⁶³ AI fluency should be considered a baseline requirement; resisting it in the learning environment is not only futile but strategically negligent.⁶⁴ These implications highlight both structural gaps and ways forward. To remain relevant in a rapidly evolving complex security environment, Óglaigh na hÉireann must learn from global PME trends and evolve accordingly.

Conclusion

The accelerating diffusion of emerging technologies and the increasingly complex nature of modern operating environments demand a re-assessment of how military leaders are prepared for contemporary decision-making. This paper has argued that traditional linear frameworks, such as MDMP and OPP, while historically effective, are no longer sufficient when confronted with rapidly shifting complex adaptive systems and adversaries that operate within them. To

⁵⁷ Gilli, *Future warfare* (2021). 4.

⁵⁸ Charles A. Goldman et al., *Intellectual Firepower: A Review of Professional Military Education in the U.S. Department of Defense* (2024), RAND, Date Accessed: 21 August 2025. https://www.rand.org/pubs/research_reports/RRA1694-1.html.

⁵⁹ William Barry and Aaron “Blair” Wilcox, ‘Hybrid intelligence: Decision dominance at the strategic level’, War Room - U.S. Army War College, 17 October 2024, <https://warroom.armywarcollege.edu/articles/hybrid-intelligence/>.

⁶⁰ James Black et al., *Strategic Competition in the Age of AI: Emerging Risks and Opportunities from Military Use of Artificial Intelligence* (2024), RAND. Date Accessed: 21 August 2025. https://www.rand.org/pubs/research_reports/RRA3295-1.html.

⁶¹ Huebner, *Learning to Think for Understanding: Introducing Systems Thinking into Professional Military Education*.

⁶² Mark Burnett, Pete Wooding, and Paul Prekop. "Sense Making-Underpinning Concepts and Relation to Military Decision-making." 9th International Command and Control Research and Technology Symposium, Defence Science and Technology Organisation, Command and Control Division (Australia, 2004).

⁶³ Those characterised as Generation Z currently hold junior command responsibilities in Óglaigh na hÉireann

⁶⁴ James Lacey, *Peering into the future of Artificial Intelligence in the Military Classroom*. War on the Rocks. 03 April 2025 Available at: <https://warontherocks.com/2025/04/peering-into-the-future-of-artificial-intelligence-in-the-military-classroom/>

maintain a degree of operational effectiveness, leaders must be educated not merely to follow linear processes, but to embrace complexity through sense-making, adaptability, and systems thinking.

The discussion on algorithmic warfare illustrates both the opportunities and risks inherent in this new paradigm. On one hand, AI promises accelerated analysis, more efficient data fusion and insights delivered at speeds unattainable by human cognition alone. On the other hand, AI introduces vulnerabilities – biases, opaque processes and an over-reliance on machine-generated outputs – that demand further detailed consideration. Emerging from this tension however is a recognition that effective military decision-making in the future will be determined by the symbiotic interaction of human judgement enabled by machine assistance. Leaders that can critically interrogate AI-generated outputs and adapt conceptual models in real time will be better positioned to exploit the advantages of these technologies while mitigating potential risks. Shifting mindsets and developing the competencies of sense-making and adaptability begins with a modern PME system reflexive enough to encourage challenge and innovative thinking.

For a small, non-aligned military such as Óglaigh na hÉireann, the implications for our PME system are particularly acute. While the Defence Forces' JPME Strategy 2025–2028 emphasises the need for greater adaptability, it gives comparatively little direction as to how this may be achieved, let alone other core competencies discussed here. This imbalance risks leaving our future commanders and staff unprepared for the dynamic realities of the next operating environment, where no doubt agility and creativity are as important as technical mastery – Ukraine is a case in point. Irish PME must therefore evolve from a primarily academic orientation toward a reflexive model prioritising the profession of arms while integrating systems thinking, cross-disciplinary collaboration and active experimentation with emerging technologies. As outlined, this will require a step change in culture driven, it is hoped, by an overarching PME structure in any future force design.

Adapting PME to emphasise sense-making, adaptability, and digital fluency is not an optional enhancement; it is a strategic necessity. As General Stanley McChrystal warned, organisations that persist in using twentieth-century tools in today's complex environment do so at their peril.⁶⁵ If Óglaigh na hÉireann is to become a joint, agile, and fit-for-purpose military force, it must begin by reforming how it educates and develops its leaders. The task ahead is not only to keep pace with changing technologies but to posture our leaders to embrace uncertainty and complexity as the character of war continues to evolve.

Please note that the views expressed above are those of the author alone and should not be taken to represent the views of the Irish Defence Forces, the Command and Staff School or any other group or organisation.

⁶⁵ Gen. Stanley McChrystal, *Team of Teams: New Rules of Engagement for a Complex World*. (Penguin, 2015)