23 Aug 2023, How might expectations and execution of AI technology in warfighting drive conceptual thinking about AI-power in warfare?

In 2018, the Department of Defense observed that “AI is poised to transform every industry, and is expected to impact every corner of the Department, spanning operations, training, sustainment, force protection, recruiting, healthcare, and many others”[3]. Nonetheless, at this nascent stage of AI in warfare it is difficult to predict precisely how AI might affect military force structure, organization, defense planning, and overall strategy. Nonetheless, work is intensely underway by countries to assimilate AI applications and capabilities into military organizations, and harvest offset advantages from its' use in warfare. To be sure, critics claim that a vast gulf exists between expectations with AI and the development of operational concepts and tenets (e.g., synergistic effects) to guide effective military execution for advantage. The historical record has shown that in previous military revolutions the ability of militaries to assimilate and adopt new operational concepts and tactics is a vital determinant of the ability of states' to leverage, and successfully synthesize, technologies for warfighting. In the case of AI, its utility in warfare is expected to be not narrowly limited to specific applications, systems, or domains. Thus far, the wide range of emerging AI applications suggest prospects for helping to enable new operational concepts and tactics in warfare at the level of systems-of-systems. When AI is applied as a system-of-systems capability it becomes amplified and offers a rather unique contributor to overall warfare power. Two examples, in relation to airpower, can help to illustrate the

[3] Summary of the 2018 Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance Our Security and Prosperity (Washington, D.C.: U.S. Department of Defense, February 12, 2019), p. 5, https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD- AI-STRATEGY.PDF. On potential military applications, see NSCAI, Final Report; and Daniel S. Hoadley and Kelley M. Sayler, Artificial Intelligence and National Security, CRS Report R45178 (Washington, D.C.: Congressional Research Service, November 21, 2019), https://crsreports.congress.gov/product/pdf/R/R45178/7.

systems-of-systems amplification of AI applications in the near future for warfare: drone swarms and loyal wingmen.

In drone swarms, tiny autonomous systems can operate whereby each individual element is not necessarily highly specialized but, combined into a systems-of-systems, provides a semblance of collective intelligence. As one element offsets the technical limitations of others, working together in synch, these swarms can perform complex functions such as detection, deception, and strike. Drone swarms are seen as the essential means to saturate enemy air defenses in the future (Noël, 2022). This can also be envisioned across multiple warfighting domains involving multiple systems-of-systems. For example, imagine a "swarm-of-swarms" involving swarms of air, land, and sea-based AI-enabled drones.

Regarding the loyal wingman concept, sixth-generation aircraft now under development are envisioned operating with autonomous drones to execute missions collaboratively. These wingmen will improve situational awareness and survivability for their manned counterparts and assist pilots in making better decisions faster. Loyal wingmen will be adaptable for roles that reflect specific mission objectives – such as with electronic warfare or strike functions. Building on the same approach used by the U.S. Air Force to exploit quality to defeat adversaries for the past century, the loyal wingman will redefine the dynamics of human-machine teaming and is expected to lead to radical changes in the future structure of air forces (Ibid, 2022).

Although the above examples of AI applications in warfare are compelling, operational theory and tenets for guiding effective military execution is nascent and experience with its use is very limited. Interestingly, the current zeitgeist being addressed with the nascent rise of AI technology in warfare has parallels to the period of 1914-18 involving the primitive and dangerous introduction of aircraft in warfare. Speaking to the context of making sense of the novelty of air warfare in the period of 1914-18, Colin Gray (2017) offered interesting questions and insights helping to account for the evolving awareness among leaders that there was something 'bigger' happening in the conceptual/operational realm of the 'art-of-the-possible' with warfare than had initially been imagined with the introduction of a novel aircraft technology. The something 'bigger' transformed understanding of aircraft technology beyond its technical terms towards the concept of 'airpower'. Something similar might take place arising from experiences informing expectations and execution of AI technology in warfighting that drives conceptual thinking about 'AI-power' in warfare.

Understanding AI technology beyond its' technical terms might very well transform thinking about AI in warfare to a more encompassing 'AI-power' concept informed by experience and larger warfare principles (e.g., maneuver, surprise, perseverance, unity of effort). As suggested from the history of how experience with the use of aircraft in warfare shaped the evolving concept of airpower, a similar journey might likewise be expected with how AI is understood conceptually as experience grows in its use to meet warfare needs. It is worth quoting Gray's questions and insights at length here as a brief historical backdrop:

"Everything about aircraft was novel. Aerodynamic theory was elementary and distinctly incomplete. An aircraft industry was lacking. Institutions with careers and doctrines were barely nascent, while military organizations devoted to the execution of air warfare did not exist. Everything was in play. But, one could ask, what was the game and what role or roles should air-minded people reasonably aspire to play? Perhaps most important of all, with a view to the longer term, how important would airpower be strategically, relative to land power and sea power? The Great War provided plausible answers to these questions, though not all airmen chose to accept the verdict of experience in that conflict as constituting anything other than a launch pad for the future. Given the extreme youth of the airplane, technically and tactically, it was not unreasonable for people to draw conclusions from the combat experience of 1914-18, extensive though it had been, that were at odds with the record of actual achievement...What needs to be emphasized is how rapidly airpower advanced from all but zero as a military factor to an essential and important element in the combined arms mix and style that was to become the modern way of warfare.

Context always matters. Prior to August 1914, military and naval leaders had seen just enough of the potential value of aircraft in the reconnaissance role to be persuaded that aircraft had some modest utility...Nonetheless, skeptics were abundant, while even those who accepted the desirability of an air instrument for reconnaissance understandably regarded it as a tool entirely auxiliary to ground power. On the evidence available, no other position was reasonable...Airpower developed so rapidly and grew so substantially from 1914 to 1918 because the context was one of general industrialized war between coalitions of states too powerful to be defeated rapidly. This was also the political context of 1939-45. And, it must be reemphasized, military airpower was so rudimentary in 1914 that qualitative and quantitative advance was almost bound to be rapid, indeed radical.

It can be claimed by some historians that American airpower, which arrived late on the scene of the crime in Europe, entered the interwar period bereft of theory and doctrine. This was true in a formal sense, but it is seriously misleading. Prior to 1914 there had been some prescient, if mainly lucky, strategic theorizing about airpower...Indeed, the potent concepts of air superiority and command of the air both appeared prewar. What was lacking in 1914 was a practical concept of air warfare in any useful detail. In fact, the very concept of air war typically invited either contempt or deep skepticism.

It may be true to claim that technology led tactics and strategy in the air war, though I am not convinced of the validity in this suggestion. Whether or not on balance it is true, the fact remains that air forces had the most pressing tactical need of all that science, technology, and engineering could provide: both tactics and strategy were eagerly waiting for technically better military enablers. Without forgetting the play of much technological push and the benefits and harassments of ever-powerful contingency, it is both possible and necessary to identify a great chain of military logic that goes most of the way to explain how airpower evolved from 1914 to 1918. Yes, technical discoveries were made and almost accidental findings were recorded unexpectedly from experience and were applied, but the story of airpower in 1914-18 is not one that should be understood primarily in technical terms. The cumulative technological achievement was impressive indeed, but it was technology applied for particular, most-pressing military needs. This was a case of motive propelling means to meet the demands of circumstance." (pp. 91-94)

So, what were the most-pressing military needs involved with WW I that likely drove early expectations and military execution of nascent aircraft technology? And might there be similar parallels and insights to be harvested from this period involving the introduction of aircraft technology for informing expectations and military execution of nascent AI technology that drives conceptual thinking about AI-power in warfare?

Colin Gray makes the argument that prior to 1918 neither side in WW I had achieved the quality and quantity of combined arms under the direction of what was considered to be 'sound contemporary tactical doctrine' for addressing protracted, attritional, static trench war on land. Trench breakthrough prospects from artillery precision bombardment had not been realized until aircraft provided the platforms at altitude from which the enemy (and friendly forces) could be located (and terrain mapped) with accuracy sufficient for precision artillery bombardment for ever-greater tactical benefits. Naturally, the growing awareness of the tactical benefits from using aircraft for greater precision in observation, reconnaissance, and surveillance motivated each side to deny the enemy the same benefits thus leading to aerial combat. However, as breakouts became possible from trench warfare, it became difficult for ground artillery to stay dynamically connected to the advancements and retreats of forces at the fighting edge so airpower began to be used for 'close artillery support' by means of dropping bombs from aircraft (conceptually thought of at the time as 'flying artillery') that furthered maneuverability of forces.

Out of this rapid emergence of war in the air, practical doctrine for air warfare began to take shape with the understanding that it was now necessary to win the war in the air if one were to exploit the air environment to assist the army and navy. Following WWI, for nearly 21 years, strategic thinking about the 'what-ifs' with future prospects for the potency of airpower languished due largely from the perceived lack of a great power rival. Most airpower thinking in relation to future warfare during this period of time prior to WWII was undertaken as a 'necessary matter of precautionary modernization' (Ibid, 2017, p. 102). But over time thinking about airpower began to include 'strategic' lines of thought that pivoted from 'pursuit aviation" for air supremacy towards 'long-range bombing' as a 'war-winning military tool' (see Faber, 1997).

The pivot can be traced back to 1922 with the formation of the Air Service Tactical School (note: later to become known in 1926 as Air Corps Tactical School when the Air Service became the Air Corps) to serve as a clearinghouse for air tactics and doctrine in the Army. The most influential course taught at the school was the 'Combined Air Force Course '(later referred simply as the Air Force Course). The course was known by airmen as a place where radical ideas about future possibilities of airpower could be introduced and discussed (e.g., bombardment, which was introduced in 1925-26 as 'doctrine' in course material).

Strategic airpower theory emerged largely from growing awareness of impending perils expected ahead with great power confrontation and advantages offered from modernization advancements leading to the introduction in 1935 of the B-17 long-range bomber. Indeed, the technology and capabilities offered by the B-17 became

emblematic of what the Air Corps Tactical School (ACTS) theorists meant by airpower. Colin Gray summarized two key ideas held with the strategic airpower view of long-range bombing as a war-winning tool: 'either (1) uniquely among the forms of military power, it could attack and destroy directly the will of enemy society to resist; or (2) it could function uniquely as the "silver bullet" that literally would disable and disarm the enemy, again by taking direct action that would bypass the enemy's hard military shell of its army and navy' (Ibid, 2017, pp. 104-105).

Since WWII retrospective analysis of the so-called 'strategic bombing theory and doctrine' continues to raise debates about the thinking and approach taken with long-range bombing during the war and its' continued role in shaping current expectations with airpower offering ever greater precision of kinetic delivery from altitude.[4] The debate cannot be fully addressed in this short brief but it is worthwhile to summarize a blunt critique offered by Faber in 1997, regarding thinking about long-range bombing during the 1930s and early 1940s, that might inform early thinking about AI-power in warfare (see pp. 220-221):[5]

> 1. Unescorted high-altitude precision daylight bombing (HAPDB) assumed that one could scientifically manage war... It wrongly assumed that one could impose precise positive controls over complex events.
> 2. [It] saw technology as a panacea.
> 3. The theory failed to acknowledge properly that armed conflict was an interactive process between at least two competing wills--not the imposition of one's will against a passive foe.
> 4. Unescorted HAPDB overemphasized the offensive aspects of air warfare, like all other significant airpower theories, while minimizing the mischievous potential of defensive strategies and technologies.
> 5. It overstressed the psychological impact of physical destruction and merely assumed that the terrors inherent in bombardment would eventually destroy an enemy's will to resist.
> 6. HAPDB repeatedly (and wrongly) used metaphors to imply that modern industrial states, with their "organic essentials," were brittle and closed socioeconomic systems--not the adaptable and open systems that they were in World War II.
> 7. The theory wrongly assumed that opposing states were rational, unitary actors that based their political decisions on lucid cost-benefit analyses and not potentially obscure organizational, bureaucratic, or emotional factors.
> 8. [It] grossly exaggerated the frailty and manipulability of popular morale.
> 9. The strategic economic targeting methods formulated by ACTS ran the risk of "mirror imaging," whereby the key nodes of one's own industrial infrastructure became confused with the critical vulnerabilities of an opponent's system.

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[4] Note: The evolution of airpower has evolved significantly since WWII but its' original formulation stems from the Airman's original vision of combat from a distance, bypassing the force-on-force clash of surface combat. Originally manifested in long-range aircraft delivering kinetic weapons, airpower has evolved to include other global capabilities, notably non-kinetic forces and capabilities that can produce lethal or non-lethal effects. Airpower evolution accelerated as technological advancements allowed Airmen to conduct a greater percentage of operations globally versus regionally(see AFDP-1 (10 Mar 2021). p. 7).

[5] See Watts (1984) regarding an organic view of war for facilitating better understanding of lessons from military history.

What Faber's blunt critique offers is an explanation of the intellectual roots of strategic bombing theory that were most likely to promote expectations that would not be fulfilled in military execution in the early years of WWII and some might argue even today continues to persist in various forms of thinking about airpower (see Gray, 2017, p. 137). Indeed, Faber's critique of hopeful expectations tied to an airpower theory of strategic bombing in relation to the reality of fulfilled military execution in warfare offers a cautionary note for contemporary reflection about any theory proposed for the use of AI-power in warfare going into the future. The approach and consequences of applying AI-power in support of any nascent theory about AI in warfare can persist much longer than anticipated or desired if the gap is too large between hopeful expectations and what is likely to be realized in military execution. That said, it's worthwhile to 'recast' Faber's critique in the form of questions to highlight the importance of discerning underlying assumptions that might lead to potential gaps between expectations held by nascent AI theory and execution of AI-power in warfare:

1. Are there indications of underlying assumptions of machine-algorithmic means to manage and impose precise positive controls of AI technology over complex events in warfare?
2. Are AI technologies over portrayed as a panacea to address a warfare need?
3. Is there accounting that armed conflict involving AI is very likely to be an interactive process among combatants?
4. Is there accounting for mischievous potential of defensive AI strategies and technologies?
5. Are there indications of over-stressing the psychological impact of AI's use for eventually destroying an enemy's will to resist?
6. Are assumptions being made that a potential adversary's systems (e.g., industrial, cyber) are brittle and not likely to adapt from the effects of AI-power?
7. Are assumptions being made that responses to AI-power by opposing states are expected to be rational, involving unitary actors, and that reactions will be based on lucid cost-benefit analyses and not potentially obscure organizational, bureaucratic, or emotional factors?
8. Are there indications of grossly exaggerating the frailty and manipulability of popular morale from the use of AI-power?
9. Are there indications of "mirror imaging," whereby the key nodes of one's own AI infrastructure/systems might be confused with the critical vulnerabilities of an opponent's AI infrastructure/systems?

The above questions, while potentially useful for helping to identify gaps between expectations and effective execution expressed in a theory of AI in warfare, are ultimately not sufficient apart from tenets that can be adapted to reflect unique aspects of AI-power and experience with its use. It is expected that warfighters would benefit considerably by relying on established doctrinal tenets to address unique aspects of applying AI-power to the operational environment that are guided by established doctrinal principles (e.g. the 13 principles for joint operations) as informed by human judgment that grows from acquired experience with AI-power in warfare (see Goldfarb & Lindsay, 2021). Just as the application of airpower evolved through experience and under the doctrinal guidance of principles and tenets necessary for increasingly effective execution there is every reason to expect a similar and necessary journey with the use of AI in warfare. Similar to the introduction of aircraft technology in WWI, '*tactics and strategy were eagerly waiting for technically better military enablers*' that ultimately drove thinking about the application of aircraft technology towards a conceptual understanding as a unique form of warfare power. So it might go with AI

technology in warfighting as it evolves and benefits from greater experience in its application…driving conceptual thinking about AI-power in warfare.

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