Journal of Military and Strategic Studies

VOLUME 20, ISSUE 1

Annual Award of Excellence 2019
Honourable Mention

The Role Of Artificial Intelligence In Facilitating Military Innovation

Colin Ijebor

Most scholarly research into the concept of military innovation tend to focus on the nature of military innovation and how it comes about, but rarely investigate the reasons why these innovations come about in the first place. Rosen suggests that the reasons for military innovation could potentially include intelligence, analysis of previous wars/future wars (simulation) or technological advances. [1] Artificial Intelligence (AI), which forms the basis for many new technological advancements today, can compel military innovation. AI does not constitute military innovation, but the technological advancements produced based on AI can inspire senior officers to innovate in their military establishment. This paper seeks to conceptualize military innovation by considering various definitions and schools of thought on the subject and

[1] S. P. Rosen, "New Ways of War: Understanding Military Innovation," *International Security* 13, no. 1 (1988): pp. 134-168.

©Centre of Military and Strategic Studies, 2019

ISSN : 1488-559X

to examine the potential reasons for innovation as identified by Rosen, highlighting the role of AI within each of them.[2]

Conceptualizing Military Innovation

Rosen's explanation of military innovation primarily centres on the social aspect, viewing an innovation as a fundamental change in the military organization that affects the way service personnel behave.[3] Military innovation goes beyond something that reinforces the current pattern of the organization's operations. It is something strategically different, which fundamentally impacts the core of the military organization. In this way, an innovation forces a change in the way a service conducts its mission and essentially involves "a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in the critical military tasks, the tasks around which war plans revolve."[4] This perspective of military innovation has been described by Grissom as the **intra-service model of military innovation**, in which the military organization is seen as full of rivalry, and the competition between the various branches in each service gives rise to innovation when it is mediated by senior level officers who create promotion paths for established mid-level officers, in order to convert them to the new theory of war.[5] Rosen's book, *Winning the Next War*, is considered the seminal text amongst those who subscribe to the intra service model of military innovation.[6]

However, there are other perspectives on how military innovation arises, such as the civil-military model, the inter-service model and the cultural model of military innovation.[7] In the civil-military model, as developed by Posen in *The Sources of Military Doctrine*, interactions between civilians, in the person of statesmen, and maverick

[2] Rosen, "Military Innovation," pp. 134-168.
[3] S. P. Rosen, *Winning the Next War: Innovation and The Modern Military* (New York: Cornell University Press, 1994)
[4] Rosen, "Military Innovation," p. 134.
[5] A. Grissom, "The Future of Military Innovation Studies," *Journal of Strategic Studies* 29, no. 5 (2006): 9pp. 05-934.
[6] Rosen, *The Modern Military*.
[7] Grissom, "Innovation Studies."

military officers who refuse to adhere to the drudgery and bureaucracy of military organizations is what produces military innovation. Absent civilians and maverick officers with foresight, Posen believes that the military organizations will stagnate.[8] This conception of how military innovation occurs is directly antagonistic to Rosen's view, because Rosen believes that not only is civilian intervention and collusion with mavericks not necessary to produce military innovation, any such attempt to create innovation that bypasses senior officers cannot succeed.[9]

Based on his analysis of the examples of innovation in the British Royal Air Force and the US Navy in the first half of the twentieth century, Rosen believes that the role of senior military officers in successful military innovation cannot be overemphasized because it is they, who as bona fide members of the military organization, have the capacity to translate new capabilities "into new critical military tasks and missions for the entire service" and create new and stable career paths for younger officers willing to be involved and engage in the new way of war.[10] Therefore, the only role for civilians that Rosen sees in this process of military innovation is that they can support senior officers (not mavericks) in their task of creating a favorable environment for innovation.

The third major conception of military innovation is the **inter-service model** of military innovation, which as its name suggests, considers resource scarcity and the resultant competition between military services as the primary factor that gives rise to innovation.[11] Finally, the *cultural model* of military innovation argues that culture, or actors' beliefs about the world that defines the world around them and how they act within it, plays a significant role in allowing and more often, preventing military innovation, and it is either senior service officers or external shocks that reshape this culture in such a way that it allows for innovation.[12]

It becomes appropriate to explore the meaning of military innovation. Like many popular concepts, there are many varied and contradictory definitions of military

[8] B. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Ithaca: Cornell University Press, 1984).
[9] Rosen, "Military Innovation,"; Rosen, *The Modern Military*.
[10] Rosen, "Military Innovation," p. 134.
[11] Grissom, "Innovation Studies."
[12] A. Hill, "Military innovation and military culture," *Parameters* 45, no. 1 (2015): p. 85; Grissom, "Innovation Studies."

innovation. However, Grissom, believes that many of the examples of military innovation provided by scholars in the field share three common attributes: an innovation that changes the manner in which a military formation functions in the field, an innovation significant in scope and impact, and an innovation that makes the military organization more effective.[13] These attributes can be considered a tacit consensus definition of military innovation. Yet, the existing literature on military innovation suggests a tendency for analysis of what constitutes military innovation to focus on one of these three attributes – the battlefield results produced by the innovation.[14]

Features of military innovation

This subsection considers four important issues that appear in scholarly discourse on military innovation, namely: mavericks, bottom-up military innovation, military organizational culture, and disruptive innovations. First, is the issue of mavericks, and what roles, if any, they play in military innovation. Mavericks, in the conventional sense, are those who by virtue of the fact that they work outside the system and do not conform to it are typically considered and treated as outcasts. Rosen is adamant that mavericks do not bring about military innovation because, by virtue of who they are and where they exist (on the fringes of the organization), they do not possess the capacity to bring about the fundamental change in the core of the military organization that military innovation entails.[15] He believes it is senior officers who can and should facilitate the acceptance of a new "theory of victory" i.e. innovation, that is expressed in specific tasks, because it is these officers who have political power within the service.[16]

Mavericks are typically positioned as facilitating military innovation because it is believed that their brand-new ideas of how a technology is to be used or a strategy is to be carried out is what moves the military organization bogged down by bureaucracy to

[13] Grissom, "Innovation Studies."
[14] R. D. Marcus, "Military Innovation and Tactical Adaptation in the Israel–Hizballah Conflict: The Institutionalization of Lesson-Learning in the IDF." *Journal of Strategic Studies* 38, no. 4 (2015): pp. 500-528.
[15] Rosen, *Modern Military*.
[16] Rosen, "Military Innovation," p. 142.

change.[17] However, Galbraith's analysis suggests that ideas alone do not have the capacity to create change within an organization, but how they are used to create events also have a significant role to play.[18] Hence, mavericks may have "new" ideas, but their inability to implement them prevents the creating of any real innovation. Furthermore, the newness of this idea itself is questionable, and Williams argues that "people who appear as great innovative thinkers are often only pointing out what has become true but is not yet commonly known and accepted."[19] Accordingly, Rosen's study of three mavericks within the French, British and American militaries found that despite the strong external support they had, their innate hostility towards their military organizations made them ineffective in promoting innovation.[20] Others perceive mavericks as not just ineffective in bringing about innovation, but as dangerous individuals whose propensity to work outside the system in the name of creating change causes them to circumvent the checks and balances that exist within the organization, potentially leading to innovation that is destructive.[21]

An example of innovations gone awry due to the actions of so-called mavericks is the abuses at Abu Ghraib which show the outcome of uncontrolled innovation and which may be considered by a maverick as an efficient way of bypassing the logjams of ineffective bureaucracy. Soldiers stationed there believed that *breaking the will* of detainees through unscrupulous acts was the most efficient path to gaining required results. Eventually, however, this proved to be futile due to the public outcry over the atrocities perpetuated. In this light, Williams believes that while the military must be open to new ideas, important boundaries must be maintained to prevent harmful effects of such attempts to innovate.[22] Despite this dim view of mavericks, there are those who consider them indispensable in the process of creating military innovation. According to Hill and Gerras, there are certain individuals who are more courageous and open to identifying new ideas that can lead to innovation, even though these individuals are likely to be not very acceptable within the military organization because they lack "the social intelligence and savoir faire required to persuade audiences of the importance of

[17] Posen, *World Wars.*
[18] J. Galbraith, *The Affluent Society (*New York: Houghton Mifflin Company, 1998)
[19] T. Williams, "Understanding Innovation," *Military Review 89,* no. 4 (2009): p. 61.
[20] Rosen, "Military Innovation."
[21] Williams, "Understanding Innovation," pp. 59-67.
[22] Ibid., pp. 59-67.

their insights."[23] The description of these individuals draws a striking semblance to the mavericks considered above, and instead of seeing them as destructive, these scholars recognize that their foresight can spur innovation.

However, this positive view of mavericks is not too different from the views of those who seem more antagonistic to mavericks, because even though they identify their capacity to come up with new ideas, these scholars also recognize that mavericks' new ideas alone cannot bring about military innovation. It is implied that since they do not have any political capacity (or even social capacity) to effect these ideas, such mavericks must take them to senior officers able to make changes that can significantly transform the core of the military organization. This scenario suggests a situation in which there must be cooperation between officers at both senior levels, and middle and/or bottom level officers in order to bring about innovation. According to Marcus (although the maverick is creative and bold, they require the support of mid and top-level officers for their ideas to lead to any significant change in the organization's core.[24] Despite the emphasis of most studies on military innovation in considering military organizations as inflexible and only capable of being transformed from the top-down, lower level officers can also contribute to innovation.

A second feature in the discourse on military innovation is the existence of bottom-up military innovation. According to Grissom, there have been several cases of bottom-up innovation in the military which meet the field's consensus definition of a 'military innovation', so there is a need for them to be considered more often within the field.[25] An example of bottom-up innovation which exists both within and outside of the military is when consumers use technology in a way that is different from what they were designed for by the developers because this new way suits their specific needs.[26] This form of bottom-up innovation was present in the US Army's Force XXI initiative announced in 1994, designed to "exploit new information technologies to create

[23] A. Hill and S. Gerras, "Systems of Denial: Strategic Resistance to Military Innovation," *Naval War College Review* 69, no. 1 (2016): p. 125.
[24] R. D. Marcus, "Military Innovation and Tactical Adaptation in the Israel–Hizballah Conflict: The Institutionalization of Lesson-Learning in the IDF," *Journal of Strategic Studies* 38, no.4 (2015): pp. 500-528.
[25] Grissom, "Innovation Studies."
[26] N. Oudshoorn and T. Pinch, *How Users Matter: The Co- Construction of Users and Technology* (Cambridge: MIT Press, 2003).

innovative new tactical capabilities."[27] Some soldiers in Iraq, from 1994 onwards, acquired digital devices under this initiative and ultimately decided how best they could use these devices. They carried out different field experiments and each team ultimately ended up with a different mix of devices that were used differently depending on the situation.[28] Some teams used communication systems originally intended for administrative communication in the battle field, in a way that was not predicted by the leaders, as "[m]any tactical commanders relied heavily on an 'email' system embedded in the FBCB2 system, though this was against doctrine and procedures because the system was intended for routine administrative use in garrison, not as a primary means of battlefield communications."[29]

This example shows the combination of bottom-up and top-down approaches to innovation because how the new technology, that was made available due to initiatives from leaders at the top, was actually used in a way determined by mid and bottom level officers in the field and changed the way the military functioned in the field. This example also displays the aforementioned tendency of descriptions of military innovation to focus more on how the innovation transformed the organizations' battlefield processes and made them more effective. There is no consideration of whether these "bottom-up innovations" in the form of using technologies in ways other than that for which they were provided made any fundamental change in the organization's core. In the absence of this effect, scholars like Rosen may not consider this a genuine military innovation.[30]

A different example of a combination of the bottom and top-level efforts to produce military innovation can be seen in the actions of the Israeli Defense Forces (IDF) in the course of the Lebanon war of 2006. According to Marcus, "in the IDF, the interactive and dynamic role of mid-level, visionary military officers who convince the top brass to delegate authority to maverick unit commanders at the bottom illustrates a successful, culturally-compatible Israeli pattern of adaptation".[31] In this view, which accommodates the foresight so-called mavericks may possess, both mid and senior level

[27] Grissom, "Innovation Studies," p. 927
[28] Ibid., p. 927.
[29] Ibid., p. 929.
[30] Rosen, *Modern Military.*
[31] Marcus, "Lesson-Learning in the IDF," p. 503.

officers create the favorable environment for the maverick's ideas to turn to innovation. However, the IDF is especially conducive to bottom-up innovation not just because of the favorable environment for this created by mid and senior level officers, it is also because the organization virtually lacks a central doctrine, thereby creating a greater opportunity for unit commanders and fighters in the field to determine exactly how to respond to situations that arise on the battlefield.[32]

Another important feature of the discourse on military innovation is the role of military culture. The organization's culture can limit the extent to which it is receptive to a change that would transform the organization's core. Innovations that are incompatible with the organization's concept of war and its notion of the ideal combatant will be resisted, whereas those that are compatible can be implemented within the organization.[33] Furthermore, there are those who believe that military institutions are inherently rigid and resistant to change, and this coupled with their hierarchical and disciplined nature make them fundamentally resistant to change.[34]

In this vein, Hill identifies three aspects of the military organization that can influence its receptiveness to new innovation.[35] The first *is the conduct of honorable warfare*, which according to Hill is when the military organization's perception of what physical courage and just war entails can influence its response to the use of a new technology or tactic of warfare; the delegation of decision-making authority: the extent to which the organization delegates authority when making important decisions is also important. Given the hierarchical nature of military organizations, innovations that allow for more direct control of subordinate members of the force by senior officers will be more favorably received than those that shift greater responsibility to subordinates. As Horowitz notes, the more the bureaucratic disruptiveness potential of a technology, the more obstacles there will be to its implementation within established military organizations; and, the degree of regularity in military assets, and the tolerance for

[32] N. Petrelli, "Deterring Insurgents: Culture, Adaptation and the Evolution of Israeli Counterinsurgency, 1987–2005," *Journal of Strategic Studies* 36, no. 5 (2013): 666-691; Marcus, "Lesson-Learning in the IDF," pp. 500-524.
[33] Hill, "Military Innovation and Military Culture," p. 85.
[34] W. Murray, "Innovation: Past and Future," in *Military Innovation in the Interwar Period*, ed. W. Murray and A. Millett (Cambridge: Cambridge University Press, 1996), pp. 306-310.
[35] Hill, "Military Innovation and Military Culture," p. 85.

differences among those assets: the degree of an organization's tolerance for predictability in terms of its strategy, training, equipment, and general way of war will determine how open it is to a new theory of war that can distort these familiar patterns.[36]

This analysis of military organizational culture suggests that in situations where the innovation and culture are at variance with each other – which, going by Rosen's conceptualization of innovation as a transformation of the organization's core, is bound to be the case more often than not – it is necessary for senior officers to seek to first change this culture, before trying to implement the new way of war. Hill believes this can be done by creating exercises in which the gaps or problems with the current culture become evident, and then solutions to these problems in the form of the innovation trying to be implemented is then introduced.[37] In sum, the role of visionary leadership in creating a conducive environment for innovation is once again evident in the task of addressing aspects of a military organization's culture that may hinder innovation.

Additionally, an important feature of the discourse on military innovation are the concepts of sustaining and disruptive innovations. Sustaining innovations involve changes that reinforce the existing technology in order to make them more efficient, while disruptive innovations slowly but surely destroy the existing technological base until it is finally rendered obsolete.[38] Innovations are disruptive when they are used to their best capacities, and typically involve not just the use of one new and radical technology, but a combination of different ones.[39] While these descriptions of disruptive and sustaining innovations suggest that they are limited to technological innovations, this is not necessarily so. Like Christensen, generally considered the seminal authority on disruptive innovation, notes, disruptive innovations are not necessarily technological, and when they do involve technology, it is how such technology is used

[36] M. C. Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power," *Artificial Intelligence* 1, no. 3 (2018): pp. 37-57.
[37] Hill, "Military Innovation and Military Culture," p. 85.
[38] R. Smith, "Technology Disruption in the Simulation Industry," *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology* 3, no. 1 (2006): pp. 3–10.
[39] R. E. Franck and T. C. Pierce, "Disruptive Military Innovation and the War on Terror: Some Thoughts for Perfect Opponents," *Defense & Security Analysis* 22, no. 2 (2006): pp. 23-140.

that determines whether innovation is truly disruptive or simply sustaining.[40] If the technology is used to implement such a prominent change that transforms the core of the military organization, it can be considered disruptive, but if the change is minimal, it is typically considered more of a sustaining innovation.[41] Furthermore, Dombrowski and Gholz believe disruptive innovations transform not just how the organization performs, but how this performance is measured, whereas sustaining innovations may only improve performance in the way it was being measured prior to the introduction of the so-called innovative technology or strategy.[42]

Given the inherently destructive nature of disruptive innovations, there is a need for effective senior military officers, who understand how the organization works and possess the capacity to convince the necessary parties, to agree with the innovation whilst preventing hostile actors from hindering its progress to intervene.[43] Dombrowski and Gholz argue that sustaining and not disruptive innovation was necessary for the US military's transformation project after 9/11 because the changes required to improve the military did not require a shift from some existing practices like the current equipment suppliers.[44] This suggests that technology that transforms the core of a military organization does not have to be disruptive. While the form of AI as it currently exists is more a sustaining than disruptive innovation, it still possesses the capacity to substantially transform military organizations, even though this may not be to the extent predicted by Rosen.

Creating an environment favorable for military innovation

The foregoing discussion has emphasized the need for senior military officers to create environments favorable for military innovation to overcome stumbling blocks like rigid organizational cultures, which may seek to prevent innovation. This sub-

[40] C. Christensen, *The Innovator's* Dilemma. (New York: Harper Business Essentials, 2003).
[41] G. Mukunda, "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy," *Security Studies 19* no. 1 (2010): pp. 124–159.
[42] P. Dombrowski and E. Gholz, "Identifying Disruptive Innovation: Innovation Theory and The Defense Industry," *Innovations: Technology, Governance, Globalization* 4, no. 2, (2009): pp. 101-117.
[43] Williams, "Understanding Innovation," pp. 59-67.
[44] Dombrowski and Gholz, "The Defense Industry," pp. 101-117.

section, however, explores various ways by which senior officers can overcome a military system resistant to innovation, using the framework provided by Hill & Gerras.[45] They include:

- **Identify anomalies in the external environment**: leaders of military organizations must create mechanisms such as simulations or war games which will allow them to identify situations outside the organization that require it to update or change its current theories of "the security environment and the uses of military force".[46]

- **Conduct formal thought experiments**: regular thought experiments involving various members of the organization are equally necessary to identify the ways in which its current practice needs to be improved. While the previous point focuses on identifying external situations that may require innovation, the point here is to take an inward look to see where innovation is necessary.

- **Do not succumb to the tyranny of expertise**: experts should not be considered as the only ones capable of determining when current theory of war is inadequate or when a new way of war is necessary. This is especially so since they have typically emerged as experts under the current way of war and are therefore likely averse to change or unable to recognize when there is a need for change. Opportunities should be made for those with the tendency to identify anomalies (like the so-called mavericks identified above) who are typically considered to be non-experts, to bring forward their new theories of war.

- **Deliberately seek and explore anomalies**: the two steps above – conducting thought experiments and creating opportunities for 'mavericks' to share new ideas – are ways by which senior officers in military organizations can deliberately seek out anomalies that necessitate innovation.

- **Create conditions that inspire surprising experiment results**: the simulations, war games and thought experiments should be specifically engineered to, upon

[45] Hill, and Gerras, "Military Innovation," p. 111.
[46] Ibid., p. 111.

identifying the problem areas with the currently dominant theories, give rise to surprising new ideas.

- **Necessary leadership qualities**: evidently, this process of identifying the problems with current theories and experimenting with new ones requires "intelligent, open-minded leaders—men and women who understand the fundamental principles of logic and evidence, are nimble enough to recognize the significance of strategic anomalies, and have the mental tools to think of what to do next".[47] Senior military officers seeking to create an environment favorable to innovation should themselves be open to new ideas as they arise.

Catalysts for Innovation

Upon the conclusion of his analysis on how military innovation comes about as a result of the actions of senior military officers, Rosen in his 1988 article *New Ways of War* identifies a gap in the literature that his study did not address; the factors that led these senior military men to decide that an innovation was necessary in the first place.[48] The discussion in the previous section suggests that the foresight of these senior officers in creating an environment that is favorable to the emergence of innovations that can transform the military organizations core is an important first step that impels innovation. Rosen identifies three concrete factors which could potentially convince military leaders of the need to innovate, namely: intelligence, analysis of previous/future wars (simulation), and technological advances.[49] The link between these three catalysts for innovation is evident in Rosen's analysis.[50] He believes that the process of gathering intelligence about the enemy's plans or capabilities is surrounded by uncertainty. This uncertainty can, however, be mitigated using simulations of different scenarios that can occur in the course of warfare.[51] Simulations help leaders of military organizations to determine exactly where innovation is necessary and the extent to which new technology factors into accomplishing this innovation.

[47] Hill, and Gerras, "Military Innovation," p. 130.
[48] Rosen, "Military Innovation," pp. 134-168.
[49] Rosen, "Military Innovation," pp. 134-168.
[50] Rosen, Modern *Military.*
[51] Ibid.

Artificial Intelligence (AI) is linked to each of these catalysts - intelligence, simulation and technological advances - in various ways. AI-based technology can be used to gather intelligence and create simulations, but they are arguably most important in the creation of new technological advancements.

Conceptualizing AI

Although there is no generally accepted definition of AI, it is important to consider some of the ways it has been described. AI has been described as "the use of computers to simulate the behavior of humans that requires intelligence".[52] A broader definition of AI considers it to include a "variety of technologies and approaches to computing focused on the ability of computers to make flexible rational decisions in response to often unpredictable environmental conditions".[53] These definitions focus on the capacity of AI-based technologies to carry out action that is to various extents, independent of human intervention. This suggests that if new technologies with such abilities are introduced into military organizations in certain ways, they can potentially lead to sustaining or disruptive innovations. AI itself is not a military innovation but it has the potential to be an enabler of military innovations in both the technological and social sense.[54] The role of AI as an enabler means that, like electricity or the internal combustion engine, it is a general-purpose technology that can be used to develop technology in different sectors ranging from economics, agriculture, manufacturing, military services to health care.[55]

AI is usually considered to be of two types: general and modular. General AI is designed to address a broad, nearly boundless range of problems while modular/narrow AI focus on a specific field and improves performance by operating

[52] Horowitz, "Balance of Power," p. 40.
[53] L. Tredinnick, "Artificial Intelligence and Professional Roles," *Business Information Review 34*, no. 1 (2017): p. 37
[54] Horowitz, "Balance of Power," p. 40.
[55] W. Frick, "Why AI Can't Write This Article (Yet)," *Harvard Business Review* (2017, July), accessed January 24, 2019, https://hbr.org/2017/07/why-ai-cant-write-this-article-yet.

within this field.[56] In other words, AI can be considered as existing on a continuum, in which one end consists of narrow AI applications designed to carry out a specific task and that task alone, and at the other end is a general AI that does much more than a specific task and can "functionally think for itself and design solutions to a broader class of problems".[57] Autonomous systems, important aspects of AI, are essentially artificially intelligent robots because of the way they "can independently compose and select among alternative courses of action to accomplish goals based on its knowledge and understanding of the world, of itself, and of the local, dynamic context".[58]

Most analysis of the role of AI in military innovation focus on the effect of narrow/modular AI-based technology which operate in specific sectors, and experts believe there is still a long way to go before general AI that surpasses human capabilities can be developed .[59] Even though general AI is the most commonly portrayed form of AI in popular culture, the focus of most current practice is in designing AI-based technology for specific contexts and situations.[60] This suggests that militaries that seek to capitalize on AI technologies as a way to improve their way of war should focus on identifying specific domains where modular/narrow AI is needed to make the organization more effective. Modular AI has been used in different military sectors to various degrees, as the following discussion will show. Horowitz identifies some of the potential effects of AI on a military organization, namely that they can increase the speed of war, allow for a more accurate assessment of specific locations, increase the speed of data analysis and manage complex operations.[61] This suggests that they have the potential to transform the very core of military organizations, affecting the way they operate, their structure and their effectiveness.

---

[56] K. Ayoub and K. Payne, "Strategy in the Age of Artificial Intelligence," *Journal of Strategic Studies* 39, *no.* 5-6 (2016): pp. 793-819.

[57] Horowitz, "Balance of Power," p. 41.

[58] A. Ilachinski, *Artificial Intelligence and Autonomy: Opportunities and Challenges*. Center for Naval Analyses Arlington United States. (2017).

[59] K. Grace, et al., "When will AI Exceed Human Performance? Evidence from AI Experts." *Journal of Artificial Intelligence Research 62*, (2018): pp. 729-754.

[60] L. Tredinnick, "Artificial Intelligence and Professional Roles," *Business Information Review* 34, no. 1 (2017): pp. 37-41.

[61] Horowitz, "Balance of Power," pp. 37-57.

Intelligence and innovation

Based on the example of the American military, Rosen believes that intelligence about the behavior and capabilities of the enemy has a limited role in stimulating innovation.[62] There is a scarcity of scholarly sources that consider the link between intelligence and military innovation. Yet, the creation of Arpanet, the forerunner of the modern-day internet, through the efforts of the Department of Defense during the Cold War is arguably one instance in which intelligence has contributed to some level of transformation in the American military organization. During the Cold War, Mutually Assured Destruction (MAD) meant that either the US or the Soviet Union could respond in equal force if it experienced a nuclear attack from the other side. This concept, however, provided considerable advantage to the aggressor, whose initial attack could be devastating enough to significantly destroy the enemy's capacities and prevent it from retaliating.[63] There was a need to develop "a communications system capable of surviving a devastating thermonuclear attack [and] this challenge was taken up by a researcher in the RAND Corporation."[64]

This need for a new communications' system, coupled with a demand for the computers in the Department of Defense's newly formed Advanced Research Projects Agency (ARPA) to share information with each other despite their incompatibility led to the development of Arpanet, a precursor of the modern internet. Intelligence arguably contributed to the development of Arpanet in that it was information on the assumed nuclear capability of the Soviet Union that drove the US' desire to get ahead in the nuclear arms race in a bid to achieve perceived superior capabilities. This inspired the US to seek to dominate in any way possible, including the formation of a link of networks such as Arpanet. According to Lukasik, Arpanet was built "to exploit new computer technologies to meet the needs of military command and control against nuclear threats, achieve survivable control of US nuclear forces, and improve military tactical and management decision-making".[65] This suggests that the intent of

[62] Rosen, *Modern Military.*
[63] K. Lieber and D. Press, "The End of MAD? The Nuclear Dimension of US. Primacy," *International Security* 30, no. 4 (2006): pp. 7-44
[64] J. Naughton, "The Evolution of the Internet: from Military Experiment to General Purpose Technology," *Journal of Cyber Policy* 1, no. 1 (2016): p. 7.
[65] S. Lukasik, "Why the Arpanet Was Built," *Annals of the History of Computing, IEEE* 33, no. 3 (2011): p. 4.

developing this technology (which was not necessarily accomplished) can be conceived as an innovation, although the extent to which this innovation can be considered sustaining or disruptive remains up for question.

Preliminary or explorative work has been done to identify the role AI can play in intelligence gathering. Some of the roles of AI in military intelligence are:

The rise of AI-Enabled data fusion, information processing, and intelligence analysis, which include the use of techniques such as machine learning for data fusion, information processing, and intelligence analysis could yield potentially impactful short-term military applications.[66] In other words, AI can, through "intelligent sensing" and automation, enhance situational awareness on the battlefield.[67] For instance, in satellite imagery processing, the application of big data algorithms can be used to facilitate a "prediction revolution" to potentially introduce and support early warning capabilities on and off the field.[68]

Also, extreme involvement in defense, offense, and command in information warfare, when relying on the definition of Information warfare (IW) as the gaining of information and intelligence dominance over an enemy.[69] IW integrated with big data analytics, machine learning, and automation could enable precision psychological warfare which can be useful in profiling targets and customizing attacks to shape individuals' emotions and behavior.[70]

Finally, AI could be extremely relevant for usage in cyber defense and cyber warfare. AI leverages on enhancing the defense of critical military networks and information systems by using big data analytics to enable massive information retrieval

[66] E. B. Kania, "Battlefield Singularity," Artificial Intelligence, *Military Revolution, and China's Future Military Power* (2017 Nov.), accessed 28 January 2019, https://www.cnas.org/publications/reports/battlefield-singularity-artificial-intelligence-military-revolution-and-chinas-future-military-power

[67] D. K. Gupta, Military Applications of Artificial Intelligence (2018). accessed 28 December 2018, http://www.claws.in/1878/military-applications-of-artificial-intelligence-deepak-kumar-gupta.html

[68] Kania, "Battlefield Singularity."

[69] M. Endsley and W. M. Jones, *Situation Awareness Information Dominance & Information Warfare* (Dayton: Logicon Technical Services Inc, 1997).

[70] Kania, "Battlefield Singularity."

and inform command decision-making in cyber warfare.[71] AI applications in cyber domain can be also be used as a powerful cyber defense tool by non-state actors.[72]

There have been predictions that AI will improve military organizations' capacity to collect and analyze data from intelligence operations.[73] The American military's interest in using AI for intelligence operation led to its development of Project Maven, which was designed to simplify intelligence work for analysts by gathering information, tagging objects in video footage from drones and other platforms and narrowing focus on potential targets.[74] In summary, intelligence is a relevant concern for military organizations and feeds largely into tactics they employ. Left in its natural state, intelligence might not directly induce innovation, but is a major component in the creating of simulations.

Simulation and innovation

Rosen considers simulation to be a more useful stimulant of military innovation than intelligence because it helps "military leaders envision the shape the next war might take and how military innovations could affect it."[75] Simulations could also facilitate the development of new capabilities that may function more effectively within this vision. Hence, the objective of simulation within military organizations is to recreate the behavior of a given system or organization in order to: train individuals or groups of different sizes; research into complex military problems; plan and rehearse military operations; and train operators in the use of given weapon systems.[76] AI can be useful in carrying out simulations that involve modelling human decision and their potential outcomes, to assess risk and to explore available data in ways that can lead to

[71] Ibid.
[72] Gupta, *Military Applications of Artificial Intelligence*.
[73] G. Allen and T. Chan, *Artificial Intelligence and National Security*. (Cambridge, MA: Belfer Center for Science and International Affairs, 2017).
[74] E. Lacey, "Inside the Pentagon's plan to win over Silicon Valley's AI experts." *Wired*. Retrieved from https://www.wired.com/story/inside-the-pentagons-plan-to-win-over-silicon-valleys-ai-experts (21 December 2018).
[75] Rosen.
[76] I. Oswalt, "Current Applications, Trends, and Organizations in US. Military Simulation and Gaming," *Simulation & Gaming* 24, no. 2 (1993): pp. 153–189.

the challenging of accepted assumptions.[77] This means that such simulations using AI-based technology can be especially useful in identifying areas where more research is required and where disruptive military innovations should be focused on.

Several military simulations use AI-based technology, particularly *intelligent agents*, which are autonomous entities/machines designed to carry out rational actions (whether simple or complex) within a given environment to accomplish a specific goal. Intelligent agents can be used to simulate potential human actions particularly when a military service has obtained "a major new capability, such as an aircraft or a significant upgrade to a sensor or weapon system" which requires specific procedures to be used.[78] While these procedures are typically developed by officers, based on their experience with similar capabilities, simulations are typically used to fill in the gaps in operational knowledge that may arise.[79] Simulations are also used to determine the efficacy of defense systems which play a large role in the success of military operations, and AI through intelligent agents is typically used to model the human operators of these defense systems, who are critical to the effectiveness of such systems. Simulations provide cost effective ways of improving on specific military tactics, and it is important for operational crews to be involved in the development of simulation because this helps to improve the development of the intelligent agents created to model their actions.[80]

The American military is an example of an organization that has been considerably altered due to its use of simulations. According to Macedonia, simulation technology that draws upon advances in AI have become increasingly realistic since the 1970s, and have significantly transformed the nature of the US military training to be much more effective, such that troops are not just taught how to effectively use their equipment, "but also how to work in teams, move efficiently through a battle space, and negotiate a wide range of conflicts which may or may not involve military

[77] K. Ayoub and K. Payne, "Strategy in the Age of Artificial Intelligence."
[78] C. Heinze et al., "Interchanging Agents and Humans in Military Simulation," *AI Magazine* 23, no. 2 (2002): p. 37
[79] C. Heinze, et al., "Military Simulation."
[80] J. Fletcher, "Education and Training Technology in the Military," *Science* 323, no. 5910 (2009): pp. 72–75; C. Heinze, et al., "Interchanging Agents," p. 37.

force".[81] He further notes that simulations have so significantly changed the culture of the American military that the army now considers simulations and computer games as an important aspect of military education, training and socialization. [82] The popularization of the use of simulation in the American military is evident in the fact that as far back as the 1990s, the military's flight simulation market was quadruple that of the civilian market. [83]

Furthermore, there were several practical reasons for the American military's shift towards the use of simulation such as: a desire to cut budget costs, train servicemen to perform combat in climates that are inaccessible and unfamiliar, avoid safety concerns that could arise during physical training exercises and reduce the environmental damage that may result from training activities.[84] Despite the progress that is being made, it is important to note that the process of simulating human intelligence using AI-based technology has been a challenging task and there is still significant work to be done in the area.[85]

Technological advancement (through artificial intelligence) and innovation

Rosen simply describes technology as the development of machines. Even though technological changes are often linked to military innovations, most scholars agree that new technologies do not automatically result in military innovations. [86] Military innovations result in a significant change in the organization's core, which does not always occur when new technology is introduced. It is how the technology is used that may lead to innovation, not the inherent nature of the technology itself.[87] The example typically used to show the difference between technological and military innovation is the situation of the British Navy at the end of the First World War.

[81] M. Macedonia, "Games Soldiers Play," *Ieee Spectrum* 39, no. 3, (2002a): p. 32.
[82] M. Macedonia, "Games, Simulation, and the Military Education Dilemma," In *Internet and the University: 2001 Forum* Louisville, (2002b): pp. 157-16.
[83] R. Miller, et al., "Innovation in Complex Systems Industries: The Case of Flight Simulation," *Industrial and Corporate Change* 4, no. 2 (1995): pp. 363-400.
[84] Oswalt, "Simulation and Gaming,".
[85] Tredinnick, "Artificial Intelligence and Professional Roles."
[86] Rosen, *Modern Military.*
[87] Allen and Chan, *Artificial Intelligence and National Security*.

Although they were the first to develop and use aircraft carriers, they only saw them as means of "providing airplanes to serve as spotters for the battleship," and it was American and Japanese militaries who "innovated by using the aircraft carrier as a mobile airfield, fundamentally transforming naval warfare in the 20th century".[88]

The United States military has been accused of making the same mistake as the British Navy did in this example. According to Franck and Pierce, the US military in carrying out its war against terror has not used the new technologies available to it in the novel ways that terrorists are using theirs, particularly in the virtual domain where the terrorists use information technologies like the internet to command, control and organize their global organization.[89] In this vein, they suggest that there is a need for the US to develop a counterterrorism strategy that specifically addresses these concerns by undercutting terrorists' support by disrupting their communication with their global audience.[90] Similarly, Horowitz argues that if the US continues to take its military superiority and relents on developing its technological capabilities, it is at risk of being overtaken by competing states like Russia and China who are already investing significantly in new AI-based technology.[91]

Despite this criticism of the American approach to the use of AI-based technology, the increasing importance of AI is evident in the US military's current offset strategy introduced in 2014. Offset strategies are the approaches favoured by the US for dealing with the perceived gaps or weaknesses in the country's military strategy relative to that of other countries. The First Offset strategy was introduced in the 1950s to limit the Soviet Union's numerical and geographical advantages in Western Europe, while the Second Offset was introduced in the 1970s and 1980s, designed to minimize the impact Soviet Union's nuclear technology.[92] The Third Offset which was announced in November 2014 centres on promoting the development of AI-based technology that allows "the military services to more clearly identify the threats they face and the capabilities they need to maintain military and technological superiority over potential

[88] Horowitz, "Balance of Power," p. 38.
[89] Franck and Pierce, "Perfect Opponents."
[90] Ibid., pp. 123-140.
[91] Horowitz, "Balance of Power," pp. 37-57.
[92] Ilachinski, *"Opportunities and Challenge."*

near-peer competitors."[93] This description of American offset strategy not only shows the potential of AI as a catalyst for military innovation when it promotes technological advancements, it also shows that AI-based technology can impel military innovation by helping to develop simulations of future war scenarios.

The foregoing discussion has suggested that a new technology's effect on the military organization depends on not just the content of this technology, but how it is used. Yet, most writings on AI in the popular press typically focus on the development of new AI technology and their revolutionary potentials, without considering the fact that that the impact of these new AI technology depends to a large extent on if and how they are used by each organization.[94] Furthermore, military leaders' decision to include a given technology in their way of war depends to a considerable extent on how complex this technology is and how predictable and effective its outcome.[95]

An event that has been hailed as a significant development in the field of AI in general, is when in March 2016: AlphaGo, a Go-playing AI developed by Google's DeepMind, defeated an 18-time world champion (Lee Sedol) in the game of Go.[96] Then came AlphaGo Zero, an updated version of the AlphaGo, released on October 2017. AlphaGo Zero was different from and more powerful than the original program in that it required no human training as opposed to the AlphaGo that needed to battle with humans.[97] This development, although not military inclined in its original purpose, further identifies the abilities of AI to simulate and anticipate actions. It also shows the learning capabilities of AI that transcends basic human input and dependence.

The commercial sector has a significant role to play in the development of new AI-based technologies which have the capacity to compel military innovation. Unlike military technology of the Cold War era like GPS and even the Arpanet example provided above, it appears that AI-based technology is being primarily driven by the

[93] K. H. Hicks et al., "Assessing the third offset strategy," *Center for Strategic & International Studies*. (2017): p. 7.
[94] Horowitz, "Balance of Power."
[95] A. Gilli, and M. Gilli, "Military-Technological Superiority, Systems Integration and the Challenges of Imitation, Reverse Engineering, and Cyber-Espionage," International Security (2018).
[96] Ilachinski, *Opportunities and Challenge.*
[97] D. Silver et al., "Mastering the Game of Go Without Human Knowledge," *Nature* 550, no. 7676 (2017): p. 354.

commercial world and in academia.[98] This is significant, because Horowitz argues that "technologies that have only military purposes tend to spread more slowly than technologies where commercial incentives drive their development."[99] This suggests that the control of AI by the commercial industry means they can spread more rapidly and are more accessible to weaker military organizations and even non-state actors.

The accessibility of new AI-based technology can be measured in terms of the cost and organizational capacity needed to operate them. As Ayoub and Payne note, AI research seems to be easy to copy once the codes and algorithms underlying them, most of which can be downloaded from the internet, can be acquired.[100] This considerable ease of access means that both states and their enemies – whether state or non-state actors – have considerable opportunities to develop their military capabilities using AI, and the onus is on states that wish to rise to the top or remain at the top, to constantly work at keeping up with relevant and recent AI developments by inculcating them into their tactics, and even their overarching strategy. In this light, leading states have been described as being involved in an arms race to develop their AI capabilities, with the United States and China being at the forefront while other countries like Russia are also competing for AI leadership.[101] Even non-state actors have capitalized on the accessible nature of AI based technologies, and they are now able to deploy drones with improved situational awareness.[102] However, it is important to note that the seeming ease of access to AI development is limited by factors such as the need for a substantial amount of hardware to develop such technologies and the technical capacity needed to develop and operate them.[103]

Scholars are optimistic about the role AI based technologies are poised to play in military organizations. They note that given the fact that increasingly autonomous weapon systems are being developed for use in various sectors of military operations, it

[98] Allen and Chan, *Artificial Intelligence and National Security*; Ilachinski, *"Opportunities and Challenge."*
[99] Horowitz, "Balance of Power," p. 45.
[100] Ayoub and Payne, "Strategy in the Age of Artificial Intelligence."
[101] M. Hughes, "Do or Die: Why Industry Must Embrace AI," Forbes, (2018, November 28), accessed 24 January 2019, https://www.forbes.com/sites/mikehughes1/2018/11/28/do-or-die-why-industry-must-embrace-ai/#ef81f7b7cf66; M. C. Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power," *Artificial Intelligence* 1, no. 3 (2018): pp. 37-57.
[102] Ilachinski, *"Opportunities and Challenge."*
[103] Ayoub and Payne, "Strategy in the Age of Artificial Intelligence."

is evident that the question is not whether future warfare will involve AI technology, it is the extent to which it will do so.[104] According to Allen & Chan, these advancements in AI-based technology will like the prior transformative military technologies in nuclear, aerospace, cyber, and biotech sectors, lead to the development of radical and revolutionary government policy ideas, not merely different ones. This implies the ability of AI to have substantial transformative effect on military organizations that employ them in unconventional ways.[105]

There are a number of ethical questions facing AI-based technology that currently exists and may be developed in the future, surrounding such technology's ability to distinguish between military and civilian targets, recognize signs of enemy surrender, how they choose those who deserve to be killed, and so on.[106] Some also argue that the ability of autonomous technologies to reduce casualties on the deploying side may make them resort to war more quickly than they otherwise would.[107] These questions are important issues for militaries that seek to use AI-based technologies to improve or revamp their current way of war to consider.

Furthermore, based on Rosen's idea that innovation requires the creation of new promotion paths for those who are skilled in the new area, operating new AI-based military technologies with various levels of autonomy evidently requires the need to recruit individuals who are trained in such areas and also create opportunities for already existing service men and women to be trained in such paths.[108] This could lead to disruptive shifts that affect the core of the military organization but this is inherently what military innovation is all about, and once the leaders advancing the innovation are able to influence the organizational culture to see why there is a need for change, negative fallout from such innovation can be diminished. [109]

---

[104] J. R. McGrath, "Twenty-first century information warfare and the third offset strategy," *Joint Force Quarterly 82*, (2016): pp. 6-23; Ayoub and Payne, "Strategy in the Age of Artificial Intelligence,"; Ilachinski, *"Opportunities and Challenge."*

[105] Allen and Chan, *Artificial Intelligence and National Security*.

[106] Ilachinski, *"Opportunities and Challenge."*

[107] P. Lin, "Ethical Blowback from Emerging Technologies," *Journal of Military Ethics 9,* no. 4 (2010): pp. 313–331.

[108] S. P. Rosen, "Military Innovation," pp. 134-168.

[109] M. C. Horowitz, "Balance of Power," pp. 37-57.

Conclusion

Ultimately, it appears that as the field of AI and technologies based on AI continue to develop with each passing day, new AI technology has the ability to propel military leaders into seeing the need for a change in their current way of war. Yet, like many scholars have noted, it is not the technology that is military innovation, it is the way it is used by the military organization. Hence, it behooves insightful military leaders to create environments where novel ways of using these technologies in a way that can bring about meaningful transformation of the organization can be developed. While it is safe to say that AI has a substantial role in compelling the leadership of military organizations of the need to innovate, it is important to mitigate predictions of the effect AI can have in producing innovation that transforms the core of the military organization.

Bibliography

Allen, G., and T. Chan. *Artificial Intelligence and National Security*. Cambridge, MA: Belfer Center for Science and International Affairs, 2017.

Ayoub, K., and K. Payne. "Strategy in the Age of Artificial Intelligence." *Journal of Strategic Studies* 39 (2016): pp. 793-819.

Christensen, C. *The Innovator's* Dilemma. New York: Harper Business Essentials, 2003.

Dombrowski, P., and E. Gholz. "Identifying Disruptive Innovation: Innovation Theory and the Defense Industry." *Innovations: Technology, Governance, Globalization* 4, no. 2 (2009): pp. 101-117.

Endsley, M., and W. M. Jones. *Situation Awareness Information Dominance & Information Warfare*. Dayton: Logicon Technical Services Inc, 1997.

Fletcher, J. "Education and Training Technology in the Military." *Science* 323, no. 5910 (2009): pp. 72–75.

Franck, R. E., and T. C. Pierce. "Disruptive military innovation and the War on Terror: Some Thoughts for Perfect Opponents." *Defense and Security Analysis* 22, no. 2 (2006): pp. 123-140.

Frick, W. "Why AI Can't Write This Article (Yet)." *Harvard Business Review*. (2017) Accessed, July 24 https://hbr.org/2017/07/why-ai-cant-write-this-article-yet.

Galbraith, J. *The Affluent Society.* New York: Houghton Mifflin Company, 1998.

Gilli, A., and M. Gilli. "Military-Technological Superiority, Systems Integration and the Challenges of Imitation, Reverse Engineering, and Cyber-Espionage." *International Security.* (2018).

Grace, K., J. Salvatier, A. Dafoe, B. Zhang, and O. Evans. "When will AI Exceed Human Performance? Evidence from AI Experts." *Journal of Artificial Intelligence Research 62*, (2018): pp. 729-754.

Grissom, A. "The Future of Military Innovation Studies." *Journal of Strategic Studies* 29, no. 5 (2006): pp. 905–934.

Gupta, D. K. "Military Applications of Artificial Intelligence." (2018). Accessed 28 December 2018. http://www.claws.in/1878/military-applications-of-artificial-intelligence-deepak-kumar-gupta.html.

Heinze, C. S. Goss, T. Josefsson, K. Bennett, S. Waugh, I. Lloyd, G. Murray and J. Oldfield. Interchanging agents and humans in military simulation. AI Magazine 23, no. 2 (2002): pp. 37.

Hicks, K. H., A. Hunter, L. S. Samp, and G. Coll. "Assessing the Third Offset Strategy." *Center for Strategic & International Studies*. (2017).

Hill, A. "Military Innovation and Military Culture." *Parameters* 45, no. 1 (2015): p. 85.

Hill, A. and S. Gerras. "Systems of Denial: Strategic Resistance to Military Innovation." *Naval War College Review* 69, no. 1 (2016): p. 7.

Horowitz, M. C. "Artificial Intelligence, International Competition, and the Balance of Power." *Artificial Intelligence* 1, no. 3 (2018): pp. 37-57.

Hughes, M. "Do or Die: Why Industry must embrace AI." Forbes. (2018). Accessed 24 January 2019. https://www.forbes.com/sites/mikehughes1/2018/11/28/do-or-die-why-industry-must-embrace-ai/#ef81f7b7cf66

Ilachinski, A. "Artificial Intelligence and Autonomy: Opportunities and Challenges." *Center for Naval Analyses.* Arlington: United States, 2017.

Kania, E. B. "Battlefield Singularity." (2017). Accessed 28 January 2019. https://www.cnas.org/publications/reports/battlefield-singularity-artificial-intelligence-military-revolution-and-chinas-future-military-power

Lacey, E. "Inside the Pentagon's plan to win over Silicon Valley's AI experts." *Wired*. (2018) Accessed 21 December 2018. https://www.wired.com/story/inside-the-pentagons-plan-to-win-over-silicon-valleys-ai-experts/

Lieber, K. and D. Press. "The End of MAD? The Nuclear Dimension of U.S. Primacy." *International Security* 30, (2006): pp. 7-44.

Lin, P. "Ethical Blowback from Emerging Technologies." *Journal of Military Ethics* 9, no. 4 (2010): pp. 313-331.

Lukasik, S. "Why the Arpanet Was Built." *Annals of the History of Computing, IEEE* 33, no. 3 (2011): pp. 4-21.

Macedonia, M. "Games Soldiers Play." *Ieee Spectrum* 39, no. 3 (2002a): pp. 32-37.

Macedonia, M. (2002b). "Games, Simulation, and the Military Education Dilemma. In Internet and the University, Forum (2001). pp. 157-167. Louisville, CO: Educause.

Marcus, R. D. "Military Innovation and Tactical Adaptation in the Israel–Hizballah Conflict: The Institutionalization of Lesson-Learning in the IDF." *Journal of Strategic Studies* 38, no. 4 (2015). pp. 500-528.

McGrath, J. R "Twenty-First Century Information Warfare and the Third Offset Strategy." *Joint Force Quarterly* 82, (2016): pp. 16-23.

Miller, R., M. Hobday, T. Leroux-Demers, and X. Olleros." Innovation in Complex Systems Industries: The Case of Flight Simulation." *Industrial and Corporate Change* 4, no. 2 (1995): pp. 363-400.

Mukunda, G. "We Cannot Go On: Disruptive Innovation and the First World War Royal Navy." *Security Studies* 19, no. 1 (2010): pp. 124–159.

Murray, W. (1996). Innovation: Past and Future. In W. Murray and A. Millett (Eds.), *Military Innovation in the Interwar Period.* Cambridge: Cambridge University Press. pp. 306-310.

Naughton, J. "The Evolution of the Internet: From Military Experiment to General Purpose Technology." *Journal of Cyber Policy* 1, no. 1 (2016): pp. 5-28.

Oswalt, I. "Current Applications, Trends, and Organizations in U.S. Military Simulation and Gaming." *Simulation & Gaming* 24, no. 2 (1993): pp. 153–189.

Oudshoorn, N and T. Pinch. *How Users Matter: The Co- Construction of Users and Technology*. Cambridge: MIT Press, 2003.

Petrelli, N. "Deterring Insurgents: Culture, Adaptation and the Evolution of Israeli Counterinsurgency, 1987–2005." *Journal of Strategic Studies* 36, no. 5 (2013): pp. 666-691.

Posen, B. *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars.* Ithaca: Cornell University Press, 1984.

Rosen, S. P. "New Ways of War: Understanding Military Innovation." *International Security* 13, no. 1 (1988): pp. 134-168.

Rosen, S. P. *Winning the Next War: Innovation and the Modern Military*. Cornell University Press, 1994.

Scharre, P., and M. Horowitz. An Introduction to Autonomy in Weapon Systems. Center for a New American Security, 2015.

Silver, D., J. Schrittwieser, K. Simonyan, I. Antonoglou, A. Huang, A. Guez, and Y. Chen. "Mastering the Game of Go Without Human Knowledge." *Nature* 550, no. 7676 (2017): p. 354.

Smith, R. "Technology Disruption in the Simulation Industry." *The Journal of Defense Modeling and Simulation: Applications, Methodology, Technology* 3 no. 1 (2006): pp. 3–10.

Tredinnick, L. "Artificial Intelligence and Professional Roles." *Business Information Review* 34, no. 1 (2017): pp. 37-41.

Williams, T. "Understanding Innovation." *Military Review* 89, no. 4 (2009): pp. 59-67.