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Will War's Nature Change in the Seventh Military Revolution?

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ABSTRACT: This article examines the potential implications of the combinations of robotics, artificial intelligence, and deep learning systems on the character and nature of war. The author employs Carl von Clausewitz's trinity concept to discuss how autonomous weapons will impact the essential elements of war. The essay argues war's essence, as politically directed violence fraught with friction, will remain its most enduring aspect, even if more intelligent machines are involved at every level.

Over 25 years ago, Manuel De Landa wrote in *War in the Age of Intelligent Machines*, that when we move past cruise missiles that merely hit their intended targets to the day when "autonomous weapons begin to select their own targets, the moment the responsibility of establishing whether a human is friend or foe is given to the machine, we will have crossed a threshold and a new era will have begun."[1] More recent works also indicate the era of disruptive technologies, with the potential to change both the nature and character of war, is swiftly approaching.[2] The combined impact of artificial intelligence (AI) and unmanned systems might quickly evolve into the age of autonomy, and consequently raise critical ethical and moral issues. But this article addresses the rising awareness in the national security community about the technologies' prospective impact. This perspective is followed by an examination of the scale of the potential changes caused by lethal weapons in the context of Carl von Clausewitz's invaluable trinitarian framework.

The major technological breakthroughs that could occur in robotics as well as information, cognitive, and material sciences are, by themselves, truly revolutionary.[3] In the context of one construct, such emerging opportunities and challenges reinforce a theory of five military revolutions (see table 1). Defined as uncontrollable, unpredictable, and unforeseeable changes in politics and society, these eras "recast society and the state as well as military organizations. They alter the capacity of states to create and project military power. And their effects are additive."[4] Stopping at five historical cases, the construct alludes to the ongoing sixth revolution, the Information Age.

Dr. F. G. Hoffman, a former Marine infantry officer, retired from the Marine Corps Reserve in 2001 as a lieutenant colonel. He served 40 years as a national security analyst, with tours at Headquarters, Marine Corps, the Department of the Navy, and the Office of the Secratary of Defense. He is currently a Distinguished Research Fellow at National Defense University.

1 Manuel De Landa, *War in the Age of Intelligent Machines* (New York: Zone Books, 1991), 46.

2 Jeffrey L. Caton, *Autonomous Weapons Systems: A Brief Survey of Development, Operational, Legal and Ethical Issues*, Letort Papers (Carlisle, PA: Strategic Studies Institute, 2015).

3 James Kadtke and Linton Wells II, *Policy Challenges of Accelerating Technological Change: Security Policy and Strategy Implications of Parallel Scientific Revolutions* (Washington, DC: National Defense University [NDU], 2014).

4 MacGregor Knox and Williamson Murray, eds., *The Dynamics of Military Revolution, 1300–2050* (New York: Cambridge University Press, 2001), 6–7.

Military Revolution	Implications
First Revolution	
Westphalian System	Revenue generation, banking and taxes for financing wars, and professional militaries
Second Revolution	
French Revolution	National mobilization, levy en masse, and large-scale armies with conscription
Third Revolution	
Industrial Revolution	Mass production, standardization, and large-scale economic exploitation
Fourth Revolution	
World Wars I & II	Combined arms, armored blitzkrieg, carriers, bombers, and jets
Fifth Revolution	
Nuclear Revolution and missiles	Nuclear weapons and intercontinental ballistic missiles
Sixth Revolution	
Information Revolution	Command and control, connectivity and instant global reach, imagery, and cyber levy en masse by violent extremists
Seventh Revolution	
Autonomous Revolution	Autonomous weapons, swarms of robotic vehicles in multiple domains, self-organizing defensive systems, automated weapons, big data analytics, and machine and deep-learning programs

Table 1. Military Revolutions[5]

A seventh revolution, the autonomous revolution, looms ahead of us. By combining machines and computers in ways thus far envisioned mostly through science fiction, this era will merge the changes generated by the Industrial Revolution and the Information Age with potentially significant alterations in how war is conducted. Of particular salience in this new era are developments in artificial intelligence, especially machine learning and deep-learning AI, combined with unmanned systems.[6] These developments are the underlying breakthroughs that

5 This table expands on the information provided by Knox and Murray in *Dynamics of Military Revolution*, 13.

6 Artificial Intelligence means computers executing tasks traditionally left to human cognition and reasoning. Machine learning means computer systems improving their performance by automatically discovering patterns in large amounts of data. Deep-learning software attempts to replicate human brain activity. Adapted from David Schatsky, Craig Muraskin, and Ragu Gurumurthy, "Demystifying Artificial Intelligence: What Business Leaders Need to Know about Cognitive Technologies," Deloitte Insights, November 4, 2014.

make self-driving cars and operational robots possible, with greater functionality and self-learning. Only after examining the progress in AI being made today do functioning androids seem to be more of a reality than like something out a science fiction movie.[7]

The Autonomous Revolution

Senior Pentagon leaders have already grasped the enormous potential of applying AI to enhance decision-making, improve intelligence production, and safeguard computer systems. A common understanding of "autonomy" enables the discussion to proceed. "To be autonomous," a government advisory body notes, "a system must have the capability to independently compose and select among different courses of action to accomplish goals based on its knowledge and understanding of the world, itself, and the situation."[8]

Autonomous systems are not entirely new. During World War II, the Germans employed a torpedo with an acoustic homing seeker that was recognized as the first guided and autonomous weapon.[9] Other weapons during that war also approached some degree of independence. The US Navy and US Army now field defensive missile systems with degrees of autonomy built into their controls. The US Joint Chiefs of Staff identifies this area as a critical trend:

> The next two decades will see significant advances in autonomy and machine learning, to include the emergence of robots working together in groups and as swarms. New and powerful robotic systems will be used to perform complex actions, make autonomous decisions, deliver lethal force, provide [intelligence, surveillance, and reconnaissance] coverage, and speed response times over wider areas of the globe.[10]

The Army forecasted the upcoming revolutionary shifts in technology "may even challenge the very nature of warfare itself."[11] A British assessment noted "the increased capability of robots is likely to change the face of warfare" and some countries may replace large numbers of troops with robots by 2045.[12]

While the potential of AI has been hyped for more than a generation of very halting progress, breakthroughs during the last five years alone suggest an age of autonomy is much closer than previously anticipated.[13] Yet, while legal, ethical, and moral dimensions are being debated,

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7 For a comprehensive and balanced assessment of the moral, political, and military implications, see Paul Scharre, *Army of None, Autonomous Weapons and the Future of War* (New York: W. W. Norton, 2018).

8 Defense Science Board, *Final Report of the Defense Science Board (DSB) Summer Study on Autonomy* (Washington, DC: Department of Defense, 2016), 4.

9 I thank Dr Andrew Ilachinski, *AI, Robots and Swarms: Issues, Questions and Recommended Studies* (Arlington, VA: CNA, 2017), v. For additional detail, see John Campbell, *Naval Weapons of World War Two* (London:, Conway Maritime Press, 1985), 264.

10 Joint Force Development, *Joint Operating Environment JOE 2035: The Joint Force in a Contested and Disordered World* (Suffolk, VA: Joint Chiefs of Staff, 2016), 17.

11 US Army Training and Doctrine Command (TRADOC), *The Operational Environment and the Changing Character of Future Warfare* (Fort Eustis, VA: 2017), 6.

12 Development, Concepts and Doctrine Command, *Strategic Trends Programme: Global Strategic Trends—Out to 2045, 5th ed.* (Shrivenham, UK: Ministry of Defence, 2016), 67.

13 Samuel R. White, Jr., ed., *Closer Than You Think: The Implications of the Third Offset Strategy for the U.S. Army* (Carlisle, PA: Strategic Studies Institute, 2017); and Larry Lewis, *Insights for the Third Offset: Addressing Challenges of Autonomy and Artificial Intelligence in Military Operations* (Arlington, VA: CNA, 2017).

little work addresses operational concepts, organizational and tactical reforms, or verification and validation tests for the emerging systems.

Presently, human cognition is perceived to be superior to autonomous technologies in situations that are complex, ambiguous, and dynamic. We know human beings are very talented at making decisions in closed systems with repeatable data and feedback, including complex games like chess. But our decision-making and cognitive processes can be skewed negatively or produce irrational decisions because of bias, attribution, optimism, framing, and anchoring influences.

The computational power of computers is accelerating, and machines can now defeat humans in intellectual contests. Deep Blue defeated chess master Garry Kasparov more than 20 years ago. Advancing from a system with more than 100,000 replications of previous Go strategies that achieved early victories, a newer AI-based version was merely programmed with the basic rule set and developed its own strategies by playing simulated games over three days. With unorthodox moves, the AI crushed the human Go masters pitted against it.[14] Machine learning even composes quality musical symphonies.[15]

Advances in autonomous systems should continue to outsmart humans where routine, known, "predictable tasks are being performed, where reaction time is critical."[16] One source emphasizes, "Increased automation or autonomy can have many advantages, including increased safety and reliability, improved reaction time and performance, reduced personnel burden with associated cost savings, and the ability to continue operations in communications-degraded or -denied environments."[17] The greatest advantages of autonomy will come from eliminating the need for mundane tasks and augmenting human decision-making, not replacing it. This outlook suggests combinations of humans and machines represent the future. As former Deputy Secretary of Defense Robert O. Work concluded, "Rapid advances in artificial intelligence—and the vastly improved autonomous systems and operations they will enable—are pointing towards new and more novel warfighting applications involving human-machine collaboration and combat teaming."[18] The role of educated humans will begin to concentrate on the higher cognitive tasks of processes such as mission analysis, operational planning, and assessments.

Yet, our appreciation of the implications of the seventh military revolution is weak.[19] Time may not be on our side, as these technologies—with new commercial and military applications—are already available. The Chinese realize the inherent opportunities of these advances, and

14 Christof Koch, "How the Computer Beat the Go Master," *Scientific American*, March 19, 2016.

15 Yuval Noah Harari, *Homo Deus: A Brief History of Tomorrow* (New York: Harper, 2017).

16 Robert O. Work and Shawn Brimley, *20YY: Preparing for War in the Robotic Age* (Washington, DC: Center for a New American Security, 2014), 24.

17 Brian Hall, "Autonomous Weapons Systems Safety," *Joint Force Quarterly* 86 (3rd Quarter 2017), 87.

18 Robert O. Work, foreword to *DoD Artificial Intelligence, Big Data and Cloud Taxonomy* (Washington, DC: Govini, 2017), 2.

19 See Shawn Brimley, Ben Fitzgerald, and Kelley Sayler, *Game Changers: Disruptive Technology and U.S. Defense Strategy* (Washington, DC: Center for a New American Security, 2013).

are pursuing each of them with varying degrees of emphasis.[20] The People's Liberation Army is also moving beyond informationalization of warfare into smart, or intelligentization of, warfare to pursue the same lines of effort identified by America's science and technology community and national security officials. This focus includes shoring up currently disadvantaged sectors, such as anti-submarine warfare. The Russians think AI has enormous potential, with President Vladimir Putin claiming a state that monopolizes this dimension could dominate the globe.[21] The notion of a Sputnik moment involving AI is only a slight bit of hype, but it does serve to alert us to the dangers of complacency.

The Nature and Character of War

The professional military community generally differentiates between an objective *nature* and a subjective *character* of war by drawing upon Clausewitz.[22] The former describes what war is, and the latter describes how it is actually fought. The nature captures war's essence—the things that differentiate war, as a type of phenomenon, from other things. War's nature is violent, interactive between opposing wills, and driven by politics. War's character, its conduct, constantly evolves under the influence of technology, moral forces (law or ethics), culture, and military culture, which also change across time and place.

Colin Gray captures this essence cogently: "There is a unity to all strategic experience: nothing essential changes in the nature and function (or purpose) in sharp contrast to the character—of strategy and war."[23] Clausewitz observed every age has its "own kind of war, its own limiting conditions and its own peculiar preconceptions."[24] In his day, the major changes in conditions were social and political, but he was aware that technological advances generate changes in war character.

Close adherents of Clausewitz remain extremely skeptical that war's objective nature can be modified. They insist war's fundamental nature cannot change. They contend war is inherently human, a clash of wills, politically driven. Technology cannot mitigate its essence, or shed reliable insights to remove its uncertainty. Historian Williamson Murray is skeptical the Information Age can dissipate war's nature, especially battlefield uncertainty. He contends war's nature includes the fog and the friction of war, and that arguments contending its nature can be altered are false.[25] Murray argues, "No amount of computing power can

20 Elsa B. Kania, "Chinese Advances in Unmanned Systems and the Military Applications of Artificial Intelligence—the PLA's Trajectory towards Unmanned, 'Intelligentized' Warfare" (testimony, *Hearing on China's Advanced Weapons, Before the U.S.-China Economic and Security Review Commission*, February 23, 2017).

21 Associated Press, "Putin: Leader in Artificial Intelligence Will Rule World," AP News Archive, September 1, 2017, http://www.apnewsarchive.com/2017/Russian-President-Vladimir-Putin-says-that-whoever-reaches-a-breakthrough-in-developing-artificial-intelligence-will-come-to-dominate-the-world/id-bb5628f2a7424a10b3e38b07f4eb90d4.

22 Christopher Mewett, "Understanding War's Enduring Nature alongside Its Changing Character," War on the Rocks, January 21, 2014, http://warontherocks.com/2014/01/understanding-wars-enduring-nature-alongside-its-changing-character/.

23 Colin Gray, *Modern Strategy* (New York: Oxford University Press, 1999), 362.

24 Carl von Clausewitz, *On War*, trans. and ed. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 593.

25 Admiral William A. Owens, *Lifting the Fog of War,* with Edward Offley (New York: Farrar, Straus, and Giroux, 2000).

anticipate the varied moves and the implications of an enemy's capacity to adapt in unexpected ways."[26]

A new generation has entered the debate, and these modern-day heretics argue for capabilities in robotics, artificial intelligence, and human-machine teaming that will change more than just the way warfare is waged. As deputy secretary of defense, Work identified AI and human performance enhancements as potential breakthroughs in defense technology: "We believe we are at an inflection point at artificial intelligence and autonomy."[27] He later told an AI conference, "I am starting to believe very, very deeply that it is also going to change the nature of war."[28]

But what does asserting that the nature of war has changed or that the essence of war is immutable mean? Does it mean revolutionary changes that alter the weight, or entirely eliminate the objective elements Clausewitz defined nearly two centuries ago, cannot occur? Or by overemphasizing war's unchangeable essence, are we suggesting these aspects are completely unalterable, even in degrees? Does the standard for changing war's essential nature stand too high, with the elimination of a central tendency?

Other Clausewitzian scholars contend the terminology and method used by the Prussian theorist makes the "nature" distinction irrelevant.[29] They point out that Clausewitz compared war's objective (essential) nature to its subjective (expressed) nature, which deals with how warfare is conducted.[30] Clausewitz did distinguish between types of elements, but he believed each interacted and influenced the others. As Antulio J. Echevarria II has stated, "Under Clausewitz's concept, the objective and subjective natures of war are closely connected to one another and interact continuously. New weapons or methods, for example, can increase or diminish the degree of violence or uncertainty, though probably never eliminate them entirely."[31] Note this increase or decrease is a change in degree. Echevarria also adds an important insight: "War's internal tendencies, on the other hand, can change in intensity, proportion, and relative role as the external features themselves transform."[32] This contrast captures how war's nature may be altered, at least in degree and in relation to other factors.

The early philosopher of war thought of war, and warfare, as a series of interactions: the nature of war never existed in isolation but was always the product of the interactions of the various elements.[33] Clausewitz did

26 Williamson Murray, *America and the Future of War: The Past as Prologue* (Stanford, CA: Hoover Institution Press, 2017), 34–35.

27 Robert O. Work, "Reagan Defense Forum: The Third Offset Strategy" (speech, Reagan Presidential Library, Simi Valley, CA, November 7, 2015), https://www.defense.gov/News/Speeches/Speech-View/Article/628246/reagan-defense-forum-the-third-offset-strategy.

28 Sydney J. Freedberg Jr., "War without Fear: DepSecDef Work on How AI Changes Conflict," *Breaking Defense*, May 31, 2017.

29 Antulio J. Echevarria II, *Clausewitz and Contemporary War* (Oxford: Oxford University Press, 2013), 61–83.

30 Antulio J. Echevarria II, "Globalization and the Clausewitzian Nature of War," *European Legacy* 8, no. 3 (2003): 317–32, doi:10.1080/10848770309442.

31 Antulio J. Echevarria II, *Globalization and the Clausewitzian Nature of War* (Carlisle, PA: Strategic Studies Institute, 2003), 8.

32 Echevarria, *Globalization and the Clausewitzian Nature of War*, 8.

33 Azar Gat, *A History of Military Thought: From the Enlightenment to the Cold War* (New York: Oxford University Press, 2001), 237–38; and Clausewitz, *On War*, 605.

not limit the reciprocal nature of war to a clash of opposing trinities, but expressed interaction within the trinity. In short, a change in character could impact an essential element, and could, to a degree, be changed by it. Thus, such a change in the character and the conduct of war could influence war's nature.

An Analytical Framework

To explore the possible dynamics of warfare in an age of autonomy, we can use Clausewitz's remarkable trinity model.[34] The trinity captures the interactive elements at the core of violence: irrational forces of "primordial violence, hatred, and enmity"; nonrational forces per "the play of chance and probability" and the genius of the commander, which produce friction; and purely rational forces from war's subordination to policy and reason.[35] Clausewitz associated each of these elements with actors or components of the state—policy, the military, and the people. These components are the main loci of each factor, but not its only source. Clearly, passions stir the military, and irrational factors affect even the most deliberative policy-making process. But the true trinity and the association with actors is secondary.[36]

The three essential elements interact with each other to influence the most essential nature of war, its primordial violence. The persistence of this framework suggests its strong analytical utility across time.[37] The concept is often presented graphically as a hierarchy that implies fixed relationships in an isosceles triangle.[38] Even avowed disciples of Clausewitz will mistakenly refer to the trinity as a triangle. This representation is at odds with Clausewitz's interactive and nonlinear description of war.[39] Clausewitz insisted:

> These three tendencies are like three different codes of law, deep-rooted in their subject and yet variable in their relationship to one another. A theory that ignores any one of them or seeks to fix an arbitrary relationship between them would conflict with reality to such an extent that for this reason alone it would be totally useless.[40]

The reciprocity between the three elements shapes the violence that makes war so unique, and drives each case contextually. Clausewitz noted "the conduct of any war affects its character, and its altered character feeds back into the political ends that guide its conduct."[41] His description of three suspended magnets represents how the three elements attract and repel each other. This interaction, changing the nature or relationship of the other, is central to understanding Clausewitz's holistic theory of war.

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34 Christopher Bassford and Edward J. Villacres, "Reclaiming the Clausewitzian Trinity," *Parameters* 25, no. 3 (Autumn 1995): 9–19; and Andreas Herberg-Rothe, "Clausewitz's 'Wondrous Trinity' as a Coordinate System of War and Violent Conflict," *International Journal of Conflict and Violence* 3, no. 2 (2009), 204–19, doi:10.4119/UNIBI/ijcv.6.

35 Clausewitz, *On War*, 86; and Echevarria, *Clausewitz and Contemporary War*, 192.

36 Hew Strachan, "A Clausewitz for Every Season," *American Interest* 2, no. 6 (July 2007).

37 Christopher Bassford, "The Strange Persistence of Trinitarian Warfare," in *International Security and War: Politics and Grand Strategy in the 21st Century*, ed. Ralph Rotte and Christoph Schwarz (Hauppauge, NY: Nova Science, 2011), 45–54.

38 Murray, *America and the Future of War*, 47.

39 Clausewitz, *On War*, 89; and Beatrice Heuser, *Reading Clausewitz* (London: Pimlico, 2002), 52–55.

40 Clausewitz, *On War*, 89.

41 Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," *International Security* 17, no. 3 (Winter 1992/93): 69, doi:10.2307/2539130; and Clausewitz, *On War*, 87.

The other metaphor Clausewitz employed, which is often misunderstood, is a chameleon: "War is more than a true chameleon that slightly adapts its characteristics to the given case."[42] A cursory reading might lead the undisciplined reader to think this metaphor is a reference justifying the idea that war merely changes its color slightly in response to the environment. But a more detailed reading supports an interpretation that the phenomenon can escalate into a substantially different form. Werner Hahlweg translated Clausewitz as this: "War is thus *not only* a genuine chameleon, since it *alters its nature* somewhat in each particular case."[43]

The Impact on War's Nature

The trinity offers a useful analytical framework for understanding how the emerging age of autonomy, the seventh military revolution, can impact the objective and subjective nature of war.

Passion/Enmity. Domestic policy leaders may find AI conducive to targeted cyber and social media strategies that suppress or inflame populations. This element in war is not new, but its impact is now felt more quickly. Because of the public's growing use of social media and the internet as a principal source of information, these technologies become an ideal vector for automated information attacks and influence tactics. Additional automated methods supported by algorithms will increase the mass, frequency, and customization of messages.[44] As noted in a recent US Army War College study, "Human perceptions and the relative value of truth have increasingly become ripe territory for low risk/high impact manipulation of strategic outcomes," which gives small actors with limited resources the promise of disproportionately high strategic effects.[45]

Of course, America's adversaries indicate they may try to do the same. China is blatant about the potential for using AI to control its population: "'The Communist Party of China (CPC) hopes AI will have utility in enhancing the 'intelligentization' of 'social management' and protecting social stability.'"[46] Russia also has few qualms about exploiting its population via state-controlled television and other media outlets for the same purpose.

Extensive use of robots and unmanned systems, however, could not only reduce public interest but more importantly weaken public support for the armed services. The population may feel less engaged or tied to a nation's policy actions if robotic forces are employed. At the same time,

42 Clausewitz, *On War*, 89. Hew Strachan notes Clausewitz actually used "*natur*" and the original text implies something more significant than the Paret and Howard translation does. See Hew Strachan, *Clausewitz's On War: A Biography* (New York: Atlantic Monthly, 2007), 194.

43 Carl von Clausewitz, *Vom Kriege Hinterlassenes Werk des Generals Carl von Clausewitz: vollständige Ausgabe im Urtext, drei Teile in einem Band*, ed. Werner Hahlweg, 19th ed. (Bonn: Dümmlers Verlag, 1980), 213 (emphasis added); Echevarria, *Clausewitz and Contemporary War*, 69; and Antulio J. Echevarria II, "Globalization and the Clausewitzian Nature of War," 317–32.

44 Rand Waltzman, "The Weaponization of Information: The Need for Cognitive Security" (testimony, *Hearing on Cyber-Enabled Information Operations, Before the Senate Armed Services Committee, Subcommittee on Cybersecurity*, April 27, 2017).

45 Nathan P. Freier, "Strategic Insights: Speed Kills, Enter an Age of Unbridled Hyperconnectivity," Strategic Studies Institute, June 9, 2017, http://ssi.armywarcollege.edu/index.cfm/articles/Speed-Kills/2017/06/09.

46 Elsa Kania, "Chinese Advances"; and Elsa B. Kania, "China's Artificial Intelligence Revolution," *Diplomat*, July 27, 2017.

cabinet wars that entail few core national interests are more likely to occur since they may be perceived as politically low-risk. Such conflicts can also be protracted because of the government's desire to keep the nation's sons and daughters out of harm's way. Overall, the impact of these convergent technologies may impair the connection between a population and its government while severing the relationship between the military and the community it serves.

The populace may ultimately see the need to send humans into combat as an indication of policy failure, further restricting the government. The infusion of machinery, the reduction of human decision-making, and the rise of remote standoff warfare could erode the identity of the military as professionals with a unique social responsibility that involves risk and danger. The corrosion of this role might undermine the ideal of the profession of arms, accelerating the impact of the post-heroic age on the military.[47]

*Chance/Friction***.** The introduction of new information-based technologies and robotic systems will not reduce strategic friction or eliminate the potential for chance; however, friction from human sources at the tactical level may be trimmed. Even if machines only clash with other machines, unpredictable interactions with adversaries or a nation's own robots will ensue. Both sides, even when fully autonomous, will contain flaws and vulnerabilities, with avenues for opponents to inject uncertainty deliberately.

At the strategic and operational levels, AI is expected to enhance the clarity of intelligence and reduce human biases in assessing small changes in big databases. Some improvement in decision-making quality can be expected. Yet, one potential impact is a higher chance for miscalculation by decision-makers or headquarters whose information sources or databases are compromised.

At the tactical level, contingency factors emanating from human fatigue or fear will be reduced. That said, new sources of friction will be introduced by mechanical failure, algorithmic degradation, and learning and adapting in a way inconsistent with intent. Moreover, the second order effects of the nonlinear developments of deep learning AI being introduced at this time are entirely unknown.

Artificial intelligence and computer support are not necessary to remove human judgment at any or all levels of warfare decisions, but may be used simply to improve the efficacy of human judgement. Such technology could be used to eliminate wasted human cognitive capacity on mundane tasks. The challenge for warfighting applications involves building learning systems that recognize when to break the algorithms and the rule set inherent to their programing. Within this decision point resides the human genius of warfare. Thus, decision-making in the age of autonomy will rely upon human-machine teaming.

Since warfare is an exercise in organizational learning and adaptation, the ability of AI to automatically update programming with the results of each engagement or operation should be a positive influence. The availability of this information will promote faster learning and

47 Edward N. Luttwak, "Towards Post-Heroic Warfare," *Foreign Affairs* 74, no. 3 (May/June, 1995): 33–44.

dissemination of experiences than existing human-based methods. Thus, if learning and adaptation are positively correlated with success in warfare, AI should help.

At the tactical level, machine learning will also support human decision-making, and begin to displace some decision-making as deep learning is introduced. As Work once pointed out, "learning machines are going to give more and more commanders *coup d'oeil*."[48] Warfare will become less human-centric as it becomes more automated and autonomous. This capability can absolve commanders and their staffs from menial tasks, enabling the application of creative strengths to more critical tasks.

Another possible change may influence the Clausewitzian ideal for intuition and coup d'oeil—"the quick recognition of a truth that the mind would ordinarily miss or would perceive only after long study and reflection."[49] Clausewitz observed "this type of knowledge cannot be forcibly produced by an apparatus of scientific formulas and mechanics; it can only be gained through a talent for judgment, and by the application of accurate judgment to the observation of man and matter."[50] Natural talent and judgment in his day were gained by exposure to actual war as well as to critical study.

In the seventh military revolution, a commander's intuitive grasp of the battlespace will be augmented, but rarely displaced entirely, by intelligence and decision support systems that are AI enabled. The natural and experientially developed coup d'oeil of the human will be replaced—or at least augmented by—a data-infused, automated, "cyber d'oeil" that supports human decision-making at all levels of warfare. This evolution will not happen overnight, and there will be instances of "artificial stupidity" along the way as AI matures.[51]

Those who embrace Clausewitz's description of the role of the commander and intuition will question the algorithms' ability to respond to creativity and to override the rules.[52] Or, probably more important, they will consider how AI will help senior commanders create new rules, especially in relation to new circumstances in the evolution of warfare.[53]

Clausewitz argued a military commander could gain talent "through the medium of reflection, study and thought" without experiential learning.[54] Will deep learning programs now provide that rapid recognition, that discernment of truth, and augment deep study and reflection? While Clausewitz emphasized many attributes—determination, courage, and presence of mind—the one he prized the most for a commander was combat experience. Does a deep learning program substitute for seasoning and experience?[55]

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48 Work, quoted in Freedberg, "War without Fear."

49 Clausewitz, *On War*, 102.

50 Carl von Clausewitz, *On War*, ed. Beatrice Heuser (Oxford: Oxford University Press, 2007), 97.

51 Sydney J. Freedberg Jr., "Artificial Stupidity: Learning To Trust Artificial Intelligence (Sometimes)," *Breaking Defense*, July 5, 2017.

52 Clausewitz, *On War*, 136.

53 Echevarria, *Clausewitz and Contemporary War*, 119.

54 Clausewitz, *On War*, 146.

55 Clausewitz, *On War*, 122.

Reason/Political Direction. At the strategic level, politics will remain the womb in which war develops.[56] Unmanned precision strike platforms may lessen the human and domestic political costs of going to war, and make it easier for leaders to go to war. As Chris Coker has noted, political leaders may "become so intoxicated by the idea of precise, risk-free warfare that we believe what we want to believe."[57] We can expect decision-making to be perhaps more challenged by the blurring modes of warfare and the speed of events. Cyber and hypersonic missile attacks will compress decision-making time lines for both strategic and operational leaders. In such situations, the necessity for preplanned delegation and engagement authorities is clear.

Analysts have for several decades been aware that the role of human decision-making will be increasingly challenged by advanced automation and artificial intelligence.[58] Years ago US Marine Corps General James E. Cartwright "predicted that 'the decision cycle of the future is not going to be minutes. . . . The decision cycle of the future is going to be microseconds."[59] This sheer speed, across the critical infrastructure of both society and the armed forces, may be the most profound change forced by advanced forms of cyberwarfare.

The instantaneous decision-making implied in high-intensity operations, in cyberspace, and in the employment of missiles and unmanned vehicles moving at velocities greater than the speed of light have led to warnings about "hyperwar."[60] This need for speed raises important questions: does this radically accelerated decision-making take civilians and policy out of the conflict, and thus is political direction simply delegated to machines, is it weakened or entirely eliminated in the process? If so, would not the nature of war be changed, or just its conduct, because both political direction and human guidance would be weakened?

The potential for disinformation and cyberwarfare to stress traditional forms of strategic control is growing higher, and war may escalate more rapidly than in the past. Suspicions about the influence of cyberintrusion into everyday operations will breed mistrust in our most basic command systems. This doubt could also permeate civil society if future adversaries attack banks, air traffic control systems, hospital records, and civilian targets. Even if directed only at government targets, the loss of accurate information could breed instability in times of crisis.[61]

Clausewitz provides an "intellectual armory" of analytical weapons, especially his wondrously useful trinity, to examine the dynamics of war.[62] Looking at the foregoing discussion, the character of warfare will clearly change, and these changes could significantly influence the Clausewitzian elements that frame our understanding of war's nature.

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56 Clausewitz, *On War*, 149.

57 Christopher Coker, *Humane Warfare* (London: Routledge, 2001), 150.

58 Thomas K. Adams, "Future Warfare and the Decline of Human Decisionmaking," *Parameters* 41, no. 4 (Winter 2011–12): 7–19.

59 Quoted in Peter W. Singer, "Tactical Generals: Leaders, Technology, and the Perils," *Brookings Institution*, July 7, 2009.

60 John R. Allen and Amir Husain, "On Hyperwar," *Proceedings* 143, no. 7 (July 2017): 30–37.

61 David C. Gompert and Martin Libicki, "Cyber Warfare and Sino-American Crisis Instability," *Survival* 4, no. 56 (Summer 2014): 7–22.

62 Peter Paret, *Clausewitz and the State: The Man, His Theories, and His Times* (Princeton, NJ: Princeton University Press, 1985), 5.

But to benefit from Clausewitz's trinity, we should appreciate its existence in a state of tension not equilibrium.[63]

Strategic	Tactical
Reason/Direction	
Speed for decisions may increase to compress cycles. Conflict initiation increases possible with perceived low costs. Cyber disinformation possibilities greater with increased opportunities. Political subordination may degrade if self-learning robots act independently.	Tactical defensive systems respond in critical time periods, displacing human decisions to initiate warfare. Technology possibly makes more rational decisions with less"human" genius.
Chance/Genius	
Inherent nature retained as machines clash and unknowingly interact with adversaries. Miscalculation potential increased for decision-makers unprepared for high-speed decision-making. Clear intelligence possible with reduced human biases.	Contingency factors emanating from human fatigue or fear will be reduced. Algorithms and machine learning will reduce the need for humans' tactical decision-making.
Passion/Enmity	
Passions exploited by cyberbots and social media strategies suppress or manipulate populations. Media shaped by AI becomes more potent, frequent, and diverse. Postheroic warfare syndrome cases rise.	Civic engagement may decrease if robotic forces are winning or losing in battle. Long wars become easier to sustain if there are fewer human casualties.

Table 2. Summary of How Autonomy Impacts the Nature of War

To sum up this discussion, autonomy will change the nature of war in several ways. First, it could weaken the role of political direction by forcing response delegation to lower echelons for faster forms of attack. Autonomy can lessen the ability of governments to gain the support and legitimacy of their populations, while making it easier for foreign governments to manipulate their adversary's populations. More significantly, deep-learning forms of AI will augment the intuition and judgment of experienced commanders. At the same time, automated

63 Rob Johnson, "The Changing Character of 'Liberal' War" (paper, Liberal Way of War Conference, University of Reading, Reading, Berkshire, United Kingdom, July 2012).

technologies could reduce popular support for professional military institutions, which paradoxically could free governments to employ force more readily since the political consequences are reduced. As with the earlier ages, friction and uncertainty will endure.[64] Possibly, the age of autonomy will even introduce new forms of friction while reducing human factors in tactical contexts.

The Unchanging Elements

We should not anticipate battles devoid of human contestants, with swarms of robots directed by their own superior intelligence. As long as humans are responsible for directing war, for writing code, and for fielding and maintaining machines, warfare will remain an instrument of policy and the province of warriors. Those warriors may have machine augmentation, delegate decisions to cyberassistants, and operate more remotely; but they will be directing the fight. The most significant elements of war—violence, human factors, and chance—will certainly remain. So, too, will fog and friction.[65] Despite brilliant machines, we can count on the continuity of friction and contingency. War's essence as politically directed violence will remain its most enduring aspect, even if more machines are involved at every level. Both friction and "the flash of the kingfisher" will remain fundamental to war.[66]

Conclusion

While we remain at least a decade or more away from deep-learning AI becoming a reality, we should recognize its significant impact. As this examination suggests, the nature and character of war will be changed. The interaction of each factor or tendency of the paradoxical trinity will be affected in some way. Numerous implications for the conduct of war will emerge. We will neither anticipate nor control every one of these implications as AI matures along an expected "thorny path."[67] We should be wary of hysteria or hype about AI: predictions about this aspect of computer development have been predicted for decades.[68] But complacency about its impact is not warranted.

In the upcoming military revolution of autonomy, we will have to consider new sources of combat power and assess how they impact each level of war. The biggest impacts will be at the tactical level; however, landpower may be the least impacted of the domains of warfare given its intimate interactions with populations and combatants. Yet, landpower is not immune from unmanned systems and autonomy; both the opportunity and the threat they pose will only grow. Those who are prepared to employ autonomy smartly will be at a competitive advantage as this age unfolds.

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64 Echevarria, *Globalization and the Nature of War*.

65 Barry D. Watts, *Clausewitzian Friction and Future War*, McNair Paper 68 (Washington, DC: NDU Press, 2004), 78, 86; and T. X. Hammes, "The Future of Conflict," in *Charting a Course, Strategic Choices for a New Administration*, ed. Richard D. Hooker, Jr. (Washington, DC: NDU Press, 2016), 17.

66 T. E. Lawrence, *Seven Pillars of Wisdom: A Triumph* (New York: Anchor, 1991), 193.

67 M. L. Cummings, *Artificial Intelligence and the Future of Warfare*, Research Paper, (London: Chatham House, 2017).

68 Rodney Brooks, "The Seven Deadly Sins of AI Prediction," *MIT Technology Review*, October 6, 2017.