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THE NEW EVOLUTION OF WARFARE: INTELLIGENT WARFARE

ABSTRACT: *With the rise of a new round of science and technology and industrial revolution, high-tech groups represented by artificial intelligence are bringing profound influence and changes to future wars. Based on the analysis of the inevitability of the evolution of intelligent warfare, this article focuses on the essential characteristics of intelligent warfare and proposes possible forms of the development of intelligent warfare.*

KEYWORDS: *warfare, intelligent, evolution*

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INTRODUCTION

At present, a new wave of technological development is surging and unstoppable. High-tech clusters represented by Artificial Intelligence (AI) are accelerating their development and are widely used in the military field. Countries around the world have issued guidance strategies to facilitate innovative breakthroughs in military intelligence. Whether actively embracing or passively accepting, the trend toward military intelligence is hard to resist. Its innovative development will profoundly change human cognition, thinking, and mode of combat, and trigger significant changes in the form of warfare.

THE INEVITABILITY OF THE EVOLUTION OF INTELLIGENT WARFARE

The second decade of the 21st century is a decade of the rise and rapid expansion of AI. With the rapid development of intelligent technologies such as AI, big data, cloud computing, biotechnology, and unmanned systems, as well as the in-depth integration with traditional technologies, it has changed the ability of human beings to understand and transform the world in terms of epistemology, methodology, and operating mechanism. Intelligentization will become a new stage in the development of human civilization following mechanization and informatization, leading the military field to achieve comprehensive innovation breakthroughs and accelerating the arrival of the era of intelligent warfare.

The transformation of social and economic forms laid the material foundation for intelligent warfare. Friedrich Engels argued that "As the mode of production, so the mode of combat."[1] Looking at the whole history of the development of human society and war, it is not difficult to find that humans usually employ similar tools for both production and combat. At present, the fourth Industrial Revolution is sweeping the world at an unprecedented pace. Some major disruptive technological innovations are creating new industries and new forms of business, transforming social production and consumption from industrialization and automation to intelligentization, and driving changes in social production methods and economic forms. German Industry 4.0, US reindustrialization, Made in China 2025, Japan's Robot Strategy, and the corresponding policies of other major countries will promote the technological revolution from the technological field to the entire economic and social fields. In the military field, new social production tools and methods will also greatly improve the efficiency of research and development, production, and procurement of war tools, and provide a material basis for the development of intelligent warfare.

A new round of global scientific and technological revolution is the fundamental reason for driving intelligent warfare. Friedrich Engels pointed out: "Once technological advancements can be used for military purposes and have been used for military purposes, they very immediately and almost necessarily, often violating the commander's will, cause changes or even transformations in the styles of warfare."[2] With the brewing and forming of a new round of scientific and technological revolution, the new generation of information technology represented by quantum information, 5G communication and Internet of Things (IOT) will accelerate the breakthrough, which will transform the way of information support on the battlefield; the accelerated development of life science represented by biotechnology, cognitive technology and brain science will make the cognitive domain a new battlefield focus; new damage mechanism weapons represented by technologies such as directed energy, hypersonic speed, electromagnetic cyberspace attack, etc. will cause major changes in strike modes; unmanned equipment technologies represented by environmental perception, intelligent control, and system coordination are gradually applied and popularized, the new model of "unmanned combat" will become possible. Breakthroughs in intelligent weapon systems represented by key technologies such as AI, autonomous intelligence, and autonomous control will give birth to new concepts of autonomous operations. These high-tech breakthroughs in the military field will bring unprecedented transformative and disruptive changes, accelerate the comprehensive remodelling of the operational theory, mode of operation, weaponry, and organizational structure, and drive the evolution of intelligent war.

The great powers competing for the strategic commanding heights have become the background of the times to promote intelligent warfare. At present, the world's major military powers have elevated the development of artificial intelligence to a national strategy, and made military intelligence a focus of national defence and military construction to seize the initiative in future intelligent warfare. In recent years, the United States has successively released the *National Artificial Intelligence Research and Development Strategic Plan*, *FY2009-2034 Unmanned Systems Integrated Roadmap* and *The Department of Defense's*

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[1]   Byely, B. et al. "Marxism-Leninism on War and Army (A Soviet View)." Honolulu: University Press of the Pacific, 2002. 282.

[2]   "Marx and Engels Military Anthology, volume 2." (in Chinese) Beijing: Soldier Press, 1981 edition, p. 362.

Artificial Intelligence Strategy,[3, 4, 5] comprehensively promotes the development of intelligent weapon systems and unmanned combat systems. Russia has issued *National Strategy for the Development of Artificial Intelligence for the period until 2030*, *2018-2025 State Armament Plan* and other strategic plans, clearly proposing to increase the proportion of unmanned combat systems in the Russian military's weaponry to 30% by 2025.[6] NATO Science & Technology Organization released *Science & Technology Trends 2020-2040* to analyse and evaluate the development trends and potential impact of Emerging and Disruptive Technologies (EDTs) in 8 fields, including big data, AI, and autonomous technology in the next 20 years, in order to strengthen NATO decision makers' understanding of the impact of technological development on military capabilities.[7] The fierce competition among the world's major military powers and international organizations for the right to speak in military intelligence will inevitably stimulate the militaries of other countries to take preventive measures, intensify military competition and accelerate the development of intelligent warfare.

Prospective military theoretical design provides catalytic guidance for the evolution of intelligent warfare. At present, the major military powers represented by the United States have an unprecedented degree of innovation in the concept of combat. In September 2013, retired U.S. Air Force Lieutenant General David Deptula proposed the concept of "Combat Cloud";[8] in 2014, Paul Scharre, a researcher at the Center for a New American Security, launched a report *Robotics on the Battlefield Part II: The Coming Swarm*, proposing the concept of "Robot Swarms Operation";[9] in early 2015, the U.S. Navy proposed the concept of "Distributed Lethality";[10] since 2016, the concept of "Multi-Domain Battle, MDB" has become a hot topic of research and discussion by the US Army.[11] In November of the same year, it was formally included in the newly issued U.S. Army Doctrine Publication

3   "The National Artificial Intelligence Research and Development Strategic Plan." National Science and Technology Council. October 2016. https://www.nitrd.gov/PUBS/national_ai_rd_strategic_plan.pdf Accessed on 12 December 2020.

4   "FY2009–2034 Unmanned Systems Integrated Roadmap." Department of Defense. April 2009. https://www.globalsecurity.org/intell/library/reports/2009/dod-unmanned-systems-roadmap_2009-2034.pdf Accessed on 12 December 2020.

5   "Summary of the 2018 Department of Defense Artificial Intelligence Strategy." Department of Defense. 12 February 2019. https://media.defense.gov/2019/Feb/12/2002088963/-1/-1/1/SUMMARY-OF-DOD-AI-STRATEGY.Pdf Accessed on 12 December 2020.

6   "Emerging Military Technologies: Background and Issues for Congress." Congressional Research Service. 10 November 2020. https://fas.org/sgp/crs/natsec/R46458.pdf Accessed on 11 December 2020.

7   "Science & Technology Trends, 2020-2040." NATO Science & Technology Organization. 4 May 2020. https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdf Accessed on 11 December 2020.

8   "Deptula: Combat cloud is new face of long-range strike." Armed Forces Journal. 18 September 2013. http://armedforcesjournal.com/deptula-combat-cloud-is-new-face-of-long-range-strike Accessed on 12 December 2020.

9   "Robotics on the Battlefield Part II: The Coming Swarm." Center for a New American Security. 15 October 2014. https://www.cnas.org/publications/reports/robotics-on-the-battlefield-part-ii-the-coming-swarm. Accessed on 12 December 2020.

10 "Distributed Lethality." U.S. Naval Institute. January 2015. https://www.usni.org/magazines/proceedings/2015/january/distributed-lethality. Accessed on 12 December 2020.

11 "The Multi-Domain Battle." *Defense News.* 3 October 2016. https://www.defensenews.com/digital-show-dailies/ausa/2016/10/03/the-multi-domain-battle/ Accessed on 12 December 2020.

ADP 3-0 Operations;[12] in April 2017, Bob Work, the Deputy Defence Secretary, proposed the concept of "Algorithmic Warfare", which is essentially an "intelligent +" operation based on AI;[13] in December 2018, the US Army released document *"Multi-Domain Operations, MDO",* and renamed the MDB concept to MDO;[14] in the second half of 2019, on the basis of the MDO, the concept of "Joint All-Domain Operations" emerged.[15] All these innovative theories attach great importance to the research and development of AI and autonomous capability, which will play an important leading role in the development of intelligent warfare.

The recent practice of local warfare provides a practical stage for the exploration of intelligent warfare. At the end of 2015, the Russian army used the "Andromeda-D" automated command system to command 6 "Platform-M" and 4 "Argo" combat robots in Syria. With the support of self-propelled artillery groups and several drones, they carried out the world's first ground combat based on a cluster of combat robots and successfully completed the mission.[16] On 9th January 2018, Russia's Khmeimem Air Base and Tartus Naval Facility in Syria were attacked by 13 Unmanned Aerial Vehicles (UAVs) by Syrian militants. The Russian army responded with electronic attacks and firepower in a timely manner. The control of six drones was taken over, and another seven drones were destroyed by Russian air defence forces.[17] In addition, the "pre-practice" of training is also rehearsing future wars and operation methods. For example, since November 2019, the U.S. Defense Advanced Research Projects Agency (DARPA) has regularly organized Alpha Dogfight man-machine confrontation, aiming to explore the simulated air combat AI algorithms within visible range. From the results of the first three simulation confrontations, AI Algorithms defeated human pilots in a crushing victory in the virtual air combat.[18] Through the lessons learned from many related wars and the "pre-practice" of training, the buds of intelligent warfare are emerging and gradually growing.

THE ESSENTIAL CHARACTERISTICS OF INTELLIGENT WARFARE

The future war is developing towards intelligence, but the academic circle has not reached a consensus on the definition of intelligent warfare. Many combat styles discussed at present belong to either information operation or intelligence operation, which still need to be

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[12]   *ADP 3-0 Operations.* Washington DC.: Department of the Army, 2016. https://www.atec.army.mil/otc/ADP3-0. pdf Page 6. Accessed on 12 December 2020.

[13]   "Algorithmic Warfare: DSD Work Unleashes AI On Intel Data." *Breaking Defense,* 28 April 2017. https:// breakingdefense.com/2017/04/dsd-work-unleashes-ai-on-intel-data-algorithmic-warfare/ Accessed on 12 December 2020.

[14]   "The U.S. Army in Multi-Domain Operations 2028." Department of the Army. 6 December 2018. https://www. tradoc.army.mil/portals/14/documents/mdo/tp525-3-1_30nov2018.pdf Accessed on 12 December 2020.

[15]   "The Army Shapes Joint All-Domain Operations." AFCEA(Signal). 1 August 2020. https://www.afcea.org/ content/army-shapes-joint-all-domain-operations Accessed on 12 December 2020.

[16]   "Russian Robot Technology in Syria." CERPESC (Centre européen de recherche pour la PESC). 15 February 2012. https://europavarietas.org/csdp/csdpblog/russian_robot_technology_syria, Accessed on 11 December 2020.

[17]   "Syria: Drone Swarm Attacks Russian Military Bases." TRIPwire Technical Resource for Incident Prevention. 12 January 2018. https://tripwire.dhs.gov/news/209478 Accessed on 11 December 2020.

[18]   "Alpha Dogfight Trials Foreshadow Future of Human-Machine Symbiosis." DARPA (Defense Advanced Research Projects Agency). 26 August 2020. https://www.darpa.mil/news-events/2020-08-26 Accessed on 11 December 2020.

discussed. It is generally believed that intelligent warfare is an integrated war on land, sea, air, space, electricity, network, and cognitive fields based on the Internet of Things (IOTs) information system, using intelligent weapons and equipment and corresponding combat theories and methods.[19] Intelligent warfare is a new form of war that is different from mechanized warfare and information warfare. It has some iconic features that distinguish it from them.

Infrastructure of the Internet of Everything (IoE). Under intelligent conditions, various combat, command, and support entities such as personnel, equipment, systems, and materials distributed on the battlefield will be closely connected as needed through Cyber-Physical Systems (CPSs) such as IoT terminals and mobile IoT covered in all time and space. At the same time, a low-latency, high-capacity, and highly reliable basic network link is constructed in a complex environment to form real-time automatic collection, transmission, and processing of battlefield data. The IoT terminal is dynamically connected, has random access, functional reorganization, self-healing, rapid self-organization and other capabilities to provide services for intelligent operations. On the one hand, the IoE will produce the big data needed for intelligent combat. While each entity on the battlefield outputs its own data through various sensors, the real-time detected target environment information data is gathered and transmitted to nodes and the cloud through the network. These full-time, automatically collected, and aggregated data will collectively form operational big data, providing a "mine" for algorithm training, pattern mining, and optimization analysis for intelligent operations. On the other hand, the IoE will provide powerful computing capabilities and algorithm support for intelligent operations. The computing and algorithm combat resource clouds deployed at different levels and scales will be connected to the ubiquitous IoT through CPSs, which can not only gather operational big data for algorithm training, but also provide required computing power and algorithm model support for operations and command at different levels.

Iteratively evolved combat system. With the establishment and improvement of the intelligent battlefield ecosystem, the single-task system will have the characteristics and functions of life-like bodies, and the multi-task system will be like a forest with ecological cycles and evolutionary functions similar to nature. The future evolvable combat system is not only a quasi-ecosystem composed of multiple mission systems with different functions and similar life forms, but also a game system that can compete, confront, survive, and repair. Each system can quickly form response strategies and take actions based on the changes in the battlefield environment, the threats they face, their own capabilities, the accumulated experience and knowledge in the past, and the model algorithms established by a large number of simulation, confrontation, training, enhanced learning, and continuous revision, optimization and self-improvement in practice. Because an intelligent combat system is not exactly the same as a living body, a single intelligent system is similar to the living body, but the multi-system combat system is more like an "ecosystem + confrontation game system", which is more complex than a single living body and more social, group-like, and emergent. The evolution of the combat system will show a progressive relationship from easy to difficult, simple to complex. Under certain time and space conditions, evolution is not infinite but usually converges, the model algorithm converges to the relative optimum, the platform and cluster converge to their

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[19] Li, Minghai. "The Winning Mechanism of intelligent war." *Frontier.* 2019(02). 35–38.

maximum capability and potential, the mission system converges to the specific goal, and the combat system converges to the mission, demand, and winning.

Organic symbiotic relationship between people and equipment. In the age of intelligence, the relationship between humans and weapons will change fundamentally, becoming more and more distant physically and closer cognitively. The equipment form and development management model will be completely changed. Human thoughts and wisdom will be deeply interlinked with weapons and equipment through AI, fully advanced in the equipment development stage, optimized and iterated in the training and use stage, and further upgraded and perfected after combat verification, and so on. On the one hand, humans and weapons get gradually separated from each other physically, but gradually merged into organic symbionts cognitively. Human thought and wisdom will be involved in the whole process of weapon system design, development, production, training, use, and support. Unmanned combat systems will perfectly combine human creativity and thought with precision, rapidity, reliability, and fatigue resistance of a machine. The organization form of traditional weapons and equipment, on the other hand, will completely change. Back-end cloud support, diverse front-end functions, virtual and real interaction, online and offline CPS and human-computer interaction systems based on front and back AI will become the new structure and form, and eventually, it will form a complex that integrates machinery, information, network, data, and cognition.

Algorithm-led battlefield dominance. Under intelligent conditions, combat elements represented by "AI, cloud, network, cluster, and terminal", and diversified combinations form a new battlefield ecosystem. Among them, AI systems based on models and algorithms are the core combat capabilities. The traditional human-oriented warfare will be mostly replaced by AI models and algorithms. Algorithmic warfare will play a decisive role in a war, and the traditional land dominance, air dominance, sea dominance, and information dominance will also be transferred to the intelligence dominance or cognitive dominance. On the one hand, algorithmic advantage will dominate cognitive advantage. Big data can be quickly transformed into useful information and cognition after being processed by high-performance, high-efficiency algorithms. Therefore, the party with the algorithm advantage can dispel the "fog of war" in time,[20] making cognition deeper. On the other hand, algorithmic advantages will dominate decision-making advantages. Algorithms will gradually replace people's "thinking" and repeated explorations to a large extent, thereby accelerating cognitive iteration, quickly proposing flexible and diverse combat plans and countermeasures in response to changes in the situation, continuously disrupting the enemy's established attempts and deployment, and ultimately shape cognitive advantages and decision-making advantages into action advantages.

Unmanned combat mode. Under the conditions of intelligent warfare, unmanned combat will become the basic mode. Generally speaking, unmanned operations may experience three stages of development. The first is the initial stage of human-led and unmanned system assistance, that is, unmanned operations under the leadership of humans, and operations are completely controlled and led by humans. The second is the intermediate stage led by unmanned systems and assisted by humans, that is, unmanned operations under limited

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[20] Carl von Clausewitz is credited with coining the term "the fog of war," although he never actually used it. He did speak of fog as a metaphor for war's ambiguities. http://www.strategybydesign.org/fog-of-war Accessed on 14 December 2020.

human control. The control by humans in the whole process of operations is limited, auxiliary but critical, and in most of the cases depends on the autonomous action capability of the platform. The third is the advanced stage where the rules are manned and the actions are unmanned, that is, humans have made overall design in advance to clarify the autonomous behaviour and game rules under various combat environment conditions, and the unmanned platform and forces will perform autonomously in the implementation stage. With the continuous upgrading of the integration and development of AI and related technologies, unmanned technology will develop rapidly in the directions of autonomy, bionics, clusters, and distributed collaboration. It needs to be emphasized that although human platforms will always exist in intelligent warfare, bionic robots, humanoid robots, swarm weapons, robotic forces, and unmanned system operations will become the norm in the intelligent era. At the same time, unmanned technology based on AI will gradually expand to other fields, such as network offense and defence, electronic countermeasures, public opinion analysis, and infrastructure management and control.

POSSIBLE PATHS FOR THE DEVELOPMENT FORMS OF INTELLIGENT WARFARE

The development of warfare is never accomplished in one move. There is a process from quantitative change to qualitative change, from primary change to advanced change, and intelligent warfare is no exception. By comprehensively analysing the general law of the development of military technology in the world, and combining with the development trend of high-tech groups represented by AI, the future development of intelligent warfare may roughly go through three forms.

Automatic form. The form of automation is the initial stage of intelligent warfare. It is mainly marked by the intelligentization of weapon systems, command automation, and combat systemization. AI technology is mainly applied at equipment level, that is, through upgrading and transforming the combat capability of existing equipment, significantly reducing or even getting rid of its dependence on people, and improving the comprehensive strike effect and the ratio of combat efficiency and cost. In this form, weapons and equipment or combat systems can automatically run rules, processes, and styles after receiving instructions, but the whole process of operation still relies on human intervention to a high degree. At this time, the combat system only has the pre-designed functions and capabilities, and there are obvious indicators and capability boundaries. The automatic form can ensure that the weapon system has better control ability and combat ability in the complex confrontation environment, and ensure that the system can effectively fight, so as to improve the combat performance of the system, which mainly includes full-automatic process, full-automatic function, and over- limit function design of the weapon system. The realization of the automatic form focuses on technical fields such as the interconnection and intercommunication of various weapon systems, information transmission, remote control, embedded technology, and real-time operating systems. At present, major powers in the world have relatively mature technical reserves in these fields, and the development of weapons and equipment is in the stage of automatic development.

Autonomous form. The autonomous form is the intermediate stage of intelligent warfare. It is marked by equipment autonomy, unmanned battlefields, power integration, and human-machine coordination. It can realize highly self-organized and coordinated operations

among multiple types of unmanned equipment and systems, and develop mutual trust and coordinated operations between manned and unmanned systems. AI has begun to fully integrate into all aspects of offensive and defensive systems. At this stage, a weapon system has certain perception and cognition capabilities, and its dependence on human intervention in the entire process is greatly reduced. The combat system can independently complete multiple links or a specific task after setting the working mode. At this time, the capability indicators and boundaries of the combat system will gradually be broken, and its performance may greatly exceed people's expectations. The realization process of the autonomous form will emphasize the automatic perception and cognitive capabilities of weapons and equipment, and will focus on technical fields such as fuzzy logic, pattern recognition, feature extraction, and decision support represented by AI technology. It is currently in a stage of rapid development, and the world's military powers have invested a lot of resources in the related fields.

Self-evolving form. The self-evolution is the advanced stage of intelligent warfare, which will realize all the elements and multi-level intelligent control of the combat system, and form a fast linkage organization and deep coordination of multiple combat forces and multiple types of combat elements, such as land, sea, air, space, network, and electric space. After the system starts, it can independently accomplish all the functions and tasks, and has the ability of self-optimization and improvement. Compared with the autonomous form, the self-evolving form will have stronger ability of experience-based learning and self-improvement, can basically get rid of human intervention and be independent in a specific field. The self-evolving form is the highest level of intelligent development of weapon systems and the final stage after the highly developed AI technology. At this stage, the weapon system has extremely strong autonomous perception and cognition capabilities, and many unexpected new capabilities will continue to emerge on this basis. The arrival of the self-evolving form will completely change the existing combat mode and form of warfare. The realization of a self-evolving combat form requires a considerable period of technological accumulation and progress. In this form, the development of weapons and equipment may be out of human control and become individuals with independent cognitive capabilities. By then, how to limit the self-evolving direction of the system and reasonably control its intelligence level will become a new topic for the development of intelligent warfare.

FINAL THOUGHTS

In the development journey of human war and peace, the train of intelligent war is speeding up. Looking back at the starting point of intelligence, we see that the original intention of human beings is to try to overcome the weakness of human functions by extending human intelligence to machines. With the development of technology, this goal is not so far away. However, what price do we need to pay to overcome these weaknesses, and are these costs worth it? Does the interaction and collaboration between humans and intelligent weapon systems extend human's territory or make humans lose their original territory? Is the human-machine civilization under the joint action of humans and intelligent machines to insist that human civilization move forward according to its existing track, or to create a new civilization with harmonious co-existence between humans and machines, or to let machines lead us to an unknown new world? Although we will not have the answer now, our actions will determine the answer in the future.

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