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**The Prohibition and Control of Autonomous
Weapons Systems in Future Warfare**

By MAJ Ng Chong Yak

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ABSTRACT

In this essay, the author argues that currently, while there are limitations in Artificial Intelligence (AI) decision-making, it is too late to prohibit the use of autonomous technologies for future warfare. This is due to the potential of Autonomous Weapons Systems (AWS) as the next Revolution in Military Affairs (RMA) for both State and Non-State actors. However, the author feels that it is crucial to control the use of AWS. He argues this in his essay which is divided into three parts—firstly, he will define both AI and AWS, and suggests why current technical challenges of AI decision-making will not be a long-term limiting factor for its use by the military. Second, he will examine the applications and implications of AWS in future warfare. Thirdly, he will explain why the ‘game-changing’ impacts of AWS to warfare will make it unlikely for international bans on AWS to succeed. Finally, he will propose some mitigating measures to control the use of AWS.

Keywords: Limitations, Autonomous, Cost, Potential, Capabilities

INTRODUCTION

In the blockbuster movie *Terminator 2: Judgement Day*, a cyborg known as Terminator T-800 was sent back into time from 2029 to protect the young John Connor, the future resistance leader who will lead humanity’s fight against *Skynet* and its army of machines. *Skynet* was a neural network, a general AI system initially designed to ‘safeguard the world’. However, *Skynet* subsequently gained self-awareness, and in an act of self-preservation, took over control of the entire automated system and began a systematic extermination of all mankind. It believed that destroying humanity was the only way to fulfil its initial coded mandate to protect the world. Although it is a science-fiction movie, the ‘*Terminator Conundrum*’ or the debate on whether robots or AWS should be allowed to decide and kill independently without human intervention is a controversial topic within the Pentagon.¹

This essay argues that while there are limitations in AI decision-making presently, it is too late to prohibit

the use of autonomous technologies for future warfare due to the potential of AWS as the next Revolution in Military Affairs (RMA) for both State and Non-State actors. However, it is crucial to control the use of AWS. This essay will be divided into three parts. First, we will define AI and AWS, and suggest why current technical challenges of AI decision-making would not be a long-term limiting factor for its use by the military. Second, we will examine the applications and implications of AWS in future warfare. Next, we will explain why the ‘game-changing’ impacts of AWS to warfare will make it unlikely for international bans on AWS to succeed. Finally, we will propose some mitigating measures to control the use of AWS.

DEFINING AI AND AWS

There is no commonly agreed definition of AI even though it has been 60 years since John McCarthy, also known as the father of AI, first introduced the term in the 1956 Dartmouth Conference.² In this essay, we adopted the United States (US) Defense Science Board’s definition of AI as ‘the capability of a computer system to perform tasks that normally require human

intelligence, such as visual perception, speech recognition and decision-making.³ There is scepticism if AI will ever be able to approximate human intelligence or perform even better than humans in ambiguous situations. However, we will assume that it is a matter of time that Moore's law and new breakthroughs in AI research such as quantum information science, neuromorphic computing chips, and exascale computing will advance the ability of AI to perform at human or even superhuman level.⁴



A Gladiator Tactical Unmanned Ground Vehicle.

States and non-states actors will likely leverage on AI to enhance their war-fighting capabilities, and it will fundamentally change the character of warfare. The Pentagon has identified that there are five vital military applications for AI, namely 'weapons, decision aids, planning systems, logistics, and surveillance.'⁵ We will focus our discussion on the applications and implications of AWS on the future of warfare. There are debates over the definition of 'autonomous' and also arguments to explain why machines cannot be autonomous, both of which are lengthy discussions that will not be elaborated in this essay.⁶

Nonetheless, it is important to note that the AWS in this essay refers to the 'autonomous functioning of a weapon system, platform or software for military use.'⁷ AWS is defined by the 'ability to complete the engagement cycle—searching for, deciding to engage, and engaging targets—on its own.'⁸ Autonomy encompasses three distinct concepts: (1) 'type of task the machine is performing', (2) 'human-machine command relationship', varying from 'man-in-the-loop' to 'man-out-of-the-loop', and (3) 'complexity of the machine's decision-making'.⁹

APPLICATIONS OF AUTONOMOUS TECHNOLOGIES IN THE MILITARY

There are multiple military applications of autonomous systems for future warfare, but we will highlight three critical applications. They are (1) Human-Machine Combat Teaming, (2) Swarming Warfare, and (3) Intelligentised Warfare.

Human-Machine Combat Teaming

The US military has already introduced Manned-Unmanned Teaming (MUM-T) in operations. One example is the AH-64 Apache helicopters that connect and communicate with Unmanned Aerial Vehicle (UAV) platforms such as the MQ-1C Gray Eagle for targeting operations.¹⁰ The US Army also conducted a demonstration in August 2017 to show the possibility of using unmanned ground vehicles or robotics to support land operations.¹¹ While current unmanned vehicles are all remotely piloted, we can expect that more of the unmanned systems will become autonomous, thereby reducing the workload and operator manpower required. Apart from manpower savings, these autonomous vehicles can be bolder and more persistent than humans as they are emotionless and will not get tired.

States and non-states actors will likely leverage on AI to enhance their war-fighting capabilities, and it will fundamentally change the character of warfare.

Instead of working with the UAV pilot or remote operator, the human pilots or soldiers will give the uninhabited autonomous vehicle the general mission instructions and define the operational objective. The autonomous vehicle will be able to determine how it will accomplish the goal by selecting from a pre-programmed set of actions, but it will also have the ability to respond to any unexpected challenges using its internal decision-making matrix or machine-learning capability. This will enable the humans to improve their situational awareness, improve safety and operational effectiveness by delivering the lethality overmatch and decisive lethality during combat.¹²

Furthermore, as these machines are uninhabited, it is likely to be cheaper than manned versions due to the reduction in armour protection requirement from enemy attacks. Also, unlike unmanned systems which requires data linkage between the drone and its controller, autonomous vehicles are not as susceptible to electromagnetic jamming as it shoulders more decision-making responsibilities. The AI system in future autonomous vehicles can also enable the processing of data for intelligence analysis to be conducted at the 'front end', without having to transmit it back to its control centre.¹³ Hence, these machines can be deployed for more extended stealth missions in more dangerous environments for anti-submarine warfare or establish a persistent presence in contested waters during peacetime.

Swarming Warfare

Using swarming warfare to overcome a more advanced adversary is expected to be the next evolution in combat doctrine.¹⁴ Inspired by how small insects or animals behave in nature, swarming warfare allows dispersed individuals or small groups to coordinate their actions in a highly organised and coordinated manner to fight coherently as a whole. This can enable the military forces to use 'large numbers of simple and low-cost objects' to overcome a 'small number of complex objects' that belong to the adversary.¹⁵ By incorporating autonomous and cooperative behaviour into robotics system, there are multiple advantages that militaries can unlock on the battlefield. For example, AI-controlled swarms can be used to saturate enemy defences with waves of co-ordinated attacks from multiple directions. Similarly, swarms of small boats can shift in response to the perceived threat by harnessing the swarm intelligence to defend surface vessels from enemy attack.¹⁶ Multiple military and civilian research institutes in China are currently developing swarm intelligence technology and hope to 'achieve the disruptive advantage on the battlefield' eventually.¹⁷

Intelligentised Warfare

Perhaps the last and possibly most 'game-changing' application of decision-making AI for military use is intelligentised warfare. Coined by the Chinese,

they believed that the advent of AI will be the new military revolution as it will change the way of warfare from 'informatised' to 'intelligentised'.¹⁸ Military analysts are overwhelmed by the amount of surveillance data and video to process to sieve out military or terrorist threats daily. With AI-enabled data fusion, information processing and intelligence analysis over the global network, intelligentised military command and control information system in the form of a superintelligence AI can tap on deep machine learning capability to autonomously decide and counter security threats such as cyber attacks, electronic warfare or incoming high speed missiles threats, at much faster speed than humans.

IMPLICATIONS OF AUTONOMOUS AI FOR THE FUTURE OF WARFARE

Moving on, we will discuss three critical implications for the future of warfare if the adoption of AWS becomes a reality. They are (1) legal and ethical issues, (2) advent of the hyperwar, and (3) 'costless' war.¹⁹

Legal and Ethical Issues

The legal and ethical issues surrounding the use of AWS is a hotly debated topic among the western world, especially within the US. From an ethical perspective, a number of prominent scientists and business leaders such as Stephen Hawking and Elon Musk signed an open letter to voice their concerns that AWS can threaten the survival of the human race when deployed incalculably.²⁰ From the legal perspective, some experts proposed that the use of the AWS should be consistent with International Humanitarian Laws (IHL) or *Jus in Bello* for the employment of combatants in war. The AWS must also be deployed in a manner that complies with the Laws of Armed Conflicts (LOAC) principles.²¹

However, other more ambiguous issues are raised with AWS. If the AI malfunctions and lead to the accidental death of civilians, will the accountability lay with the State, the Commanding Officer who authorised the AWS deployment or the Manufacturer? Additionally, research has shown that AI can be easily fooled, leading to the term 'AI stupidity'.²² Similarly, there are also concerns about AI biasness against

particular race groups or that the machine can turn rogue and adopt extremely aggressive play to achieve its objectives.²³ If such mistakes occur and lead to actions that contravene IHL, the difficulties will be to determine the stakeholders who will bear the responsibility.

As algorithms within AWS gets more complicated due to deep learning, the challenge lies in the ability of the system engineer or programmer to isolate the reason within the 'black box' and to explain why the machine 'did what it did'.²⁴ Contrastingly, there are alternate views that argued that human errors and 'fog of war' have long existed since the origin of warfare, and having human-in-the-loop will not necessarily reduce the risk of collateral damages caused by AI failure.²⁵ Conversely, some believed that AWS will perform better in reducing the tactical errors caused by human miscalculations.²⁶



Uran-9 combat unmanned ground vehicle at the Military-technical forum ARMY-2016.

These are some of the likely scenarios that will have legal and ethical implications to the state actors deploying AWS. The implications have to be debated in greater detail at the national and international level. However, it is also worth mentioning that unlike the western world, China is less constrained by the different types of legal or ethical debates for the military uses of AI, as evidenced in the relatively limited discussion of these issues to date by China's People Liberation Army (PLA).²⁷

Accelerated Pace of War

The research progress made in next-generation AI technologies such as 'quantum-accelerated machine learning' and 'brain-inspired neural network

architectures' can result in a paradigm shift in warfare or 'transform the character of conflict'.²⁸ Some PLA thinkers predict the coming of 'singularity' on the battlefield when human cognition can no longer keep up with the speed of machine decision-making and tempo of combat in future warfare.²⁹ This necessitates increased autonomy to be given to the AI to transit towards a new model of intelligentised command and control which will engage in more rapid decision-making and operate in an accelerating tempo of operations to achieve the initiative in battle.³⁰

Using swarming warfare to overcome a more advanced adversary is expected to be the next evolution in combat doctrine.

Similarly, retired US Marine Corps General John R. Allen predicted the advent of the hyperwar, where 'human decision-making is almost absent from the Observe-Orient-Decide-Act (OODA) loop during the conflict,' so that the 'time associated with an OODA cycle will be reduced to near-instantaneous response'.³¹ He believed that future warfare would see humans providing the 'broad and high-level inputs', while the AI machine will do the 'planning, execution, and adapting to the evolving mission' autonomously, and make thousands of individual decisions with no additional human inputs.³²

This ever-increasing automation will result in an 'accelerated pace of war', and humans will lag behind the faster reaction times of machines.³³ In essence, both the Americans and Chinese believed that shrinking engagement timeline and the need to protect against short-warning saturation attacks will compel increased autonomy to be given to the AI for decision-making and counteraction, and potentially remove the 'man-in-the-loop' entirely. While some argued that automated decision-making may not always result in decisions that are better or even as good as human decisions, most believed that the more speedy response by the machine will help gain a sufficient advantage on the battlefield.³⁴

However, the lure of quicker reaction times and increased autonomy given to machines can lead to an autonomous weapons arms race as it becomes a

‘winner takes all’ situation. Furthermore, there may be disastrous consequences caused by an unanticipated interaction between AWS or hacking. This can lead to instabilities and ‘flash war,’ as conflicts spiral beyond human control quickly.³⁵ Hence, the tactical use of AWS will not make sense if it leads to strategic disasters.

‘Costless’ Wars

The last and perhaps most important implication of AI is the way it will reshape how war is perceived. Traditionally, the decision to take military actions for most democratic nations involves the opinion of the general public through the elected representatives. There is a need to ‘ensure broad public support for wars’ and ‘willingness among the citizens to share and endure the human and economic cost of wars.’³⁶ In recent years, we have seen how the US war in Iraq has been affected by the negative public opinion which focused on the monetary and human cost imposed on the country.³⁷ However, as the political risk of having ‘boots on the ground’ are replaced by AWS, this may gradually lead to the marketisation of war, which are more ‘shock and awe’ talk to sidetrack the discussion of the real costs of the war. As the use of AWS dramatically limits the death toll of own soldiers on the battlefield, it eliminates a considerable element of psychological burden that accompanies the nation going to war.



A BAE Systems Corax during flight testing.

The public may then perceive wars as ‘costless’. There are two resultant factors. First, the use of AWS such as robots will ‘further disconnect the military from society.’³⁸ Second, nations may become overconfident and support the use of military forces more easily, increasing the probability of using wars to settle conflicts. Additionally, the overconfidence may cause national leaders to fall into the ‘technology trap’ and

forget that its adversary can also adapt and change. Conversely, the nation that suffers from the autonomous attacks may regard the attackers as ‘cold-hearted, cruel and coward.’³⁹ Some may turn to extremism to seek revenge by conducting terror attacks against the attackers in their backyard.⁴⁰

TOO LATE TO BAN MILITARY USES OF AUTONOMOUS TECHNOLOGIES

China’s State Council announced a ‘New Generation Artificial Intelligence Development Plan’ (NGAIDP) in July 2017, a top-down high priority strategy to propel China into the ‘premier global AI innovation centre’ by 2030.⁴¹ In a video message in 2017, Russian President Vladimir Putin said that: “Whoever becomes the leader in this (AI) sphere will become the ruler of the world.”⁴² In the light of the AI arms race, some academics opined that it is too late to impose a ban on producing and using AWS.⁴³ For the ban to be successful, three key factors are necessary: ‘the perceived horribleness of the weapon’; ‘its perceived military utility’; and ‘the number of actors who need to co-operate for a ban to work.’⁴⁴ I will highlight two reasons below to explain why bans on AWS will likely fail.

Ease of Conversion for Military Uses

Based on a finding by Mckinsey Global Institute, approximately \$30 billion was spent on AI R&D in 2016, with the majority funded by tech giants such as Google and Baidu.⁴⁵ These investments will continue to grow at a high rate. The most significant challenge to ban AWS is the dual-use capabilities of AI, as AI technologies that were initially meant for commercial applications can be easily re-programmed for military uses.⁴⁶ Using China as an example, its strategy of military-civil fusion under the NGAIDP seeks to synergise and support both military and commercial advances and application in AI. There are cross-sharing of resources and institutionalising linkages among PLA, defence partners, the private sector and academia.⁴⁷ Additionally, nations will not want to give up the potential of a war-winning weapon.⁴⁸ As long as there is commercial value in AI technologies and high ‘perceived military utility’, it will be difficult to ban nations from converting it for military uses.

Furthermore, when compared to nuclear or biological weapons, development of AWS does not require very expensive laboratories or access to controlled materials.⁴⁹ It can be purchased off-the-shelf, modified and easily replicated since the critical value of AWS is in the software. Hence, even non-state actors such as terrorist groups can get their hands on it easily, and it will be impossible to ban.

Major Military Powers Protecting Own Interest

Earlier on, we highlighted that there are differing views on the definition and characteristics of AWS. These differences are anticipated to delay the international community to come together with a universal consensus to ban military uses of autonomous technologies entirely.⁵⁰ Additionally, major powers such as the US have already been deploying weapon systems such as the Phalanx close-in weapon system that is 'capable of autonomously performing its search, detect, evaluation, track, engage and kill assessment functions.'⁵¹ Although the Department of Defense issued a directive in 2012 to enforce 'man-in-the-loop' for autonomous weapons, it is believed that the PLA could be less opposed to taking humans out-of-the-loop to achieve a battlefield advantage.⁵² Hence, with so much national emphasis placed on AI development, Russia and China will most likely veto or contest any proposed ban on AWS. This is evident from past failed attempts to include AWS in the United Nations Convention on Certain Conventional Weapons as major military powers will try to protect their national interests. There is no reason to believe that international agreement to prohibit AWS will gain traction anytime soon.

CONTROL MILITARY USES OF AUTONOMOUS TECHNOLOGIES

Military history has shown that using bans to stop advances in weapons were ineffective—examples such as direct air bombing on cities and submarines sinking merchant ships without warning, allowed us to crystal-gaze that merely banning military applications of autonomous technologies will not prohibit the use of AWS.⁵³ Instead, mutual restraint generated by the fear of retaliation or mutually assured destruction will be

more effective. Three conditions need to be fulfilled to control the use of AWS effectively: (1) simple and clear focus points for co-ordination, (2) the 'horribleness' of AWS to humanity must outweigh its military value and (3) transparency and ease of verification.⁵⁴ Two control measures are proposed below.

This ever-increasing automation will result in an 'accelerated pace of war', and humans will lag behind the faster reaction times of machines.

Limit Use of Anti-Personnel AWS

Although it is unlikely to reach consensus to ban the use of fully autonomous weapons, restraining its use against humans will be more appealing to the international community. There is no anti-personnel AWS such as antipersonnel homing missiles in use around the world currently. Hence, the control will probably be more straightforward and precise to implement. Furthermore, anti-personnel AWS runs the higher risk of abuse by those who may use it to attack civilians. And this mental image of 'killer robots' that could target and kill humans may create public revulsion and eventually build crucial political support to restrict its use. Additionally, the military value of anti-personnel AWS is much lower than anti-materiel AWS, where split-second response to high-speed missiles attack will make a difference to the operational outcome. However, transparency will be challenging as it will be difficult to verify if there is a software patch that can enable the AWS to target personnel autonomously. Nonetheless, it will be difficult to hide the large-scale industrial production of anti-personnel AWS, if it ever happens. Thus, restricting mass manufacturing of these weapons will be a possible control measure to restrain the use of AWS against humans.⁵⁵

Impose Meaningful Human Control

The next control measure is to develop a broad principle to guide military commanders to make

proportionate and precautionary human judgement in wars involving AWS so that they remain legally accountable for their actions.⁵⁶ 'Meaningful human control' argued that there is a fundamental role for humans to be involved in lethal force decisions on the battlefield.⁵⁷ Humans are obligated under IHL to make informed, conscious decisions about the lawfulness of military action and this obligation cannot be delegated to a machine. Additionally, humans also need to have sufficient information about the target, weapon and the context for the military action to determine its lawfulness.⁵⁸ Finally, the legality of the autonomy given to the AWS should be bounded in certain human approved conditions such as space, time, possible targets and means of attack".⁵⁹ This broad principle will be helpful as a starting point to evaluate future AWS technology as it evolves.

CONCLUSION

As autonomous technologies begin to materialise with increased emphasis and funding by the major military powers, a complete ban of AWS is no longer a viable option. Humanity is forced to choose between a restrained use of AWS that reinforces mutual security or a poorly managed one that can lead to disastrous implications for the world. It is ultimately up to humans to decide how we want to use AI technology. We can either be lured to delegate our authority to the 'perfect' killing machines, or we can make a conscious choice to preserve human decision-making in war. There are no perfect solutions and compromises have to be made by all involved parties. The future may seem bleak for humanity, but in closing, I will lift a quote from Sarah Conner in the *Terminator 2* movie: *'The future's not set. There's no fate but what we make for us.'*⁶⁰

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