Autonomous Warfare – A Revolution in Military Affairs

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Abstract

The world is on the cusp of an epochal shift from an industrial to an information based society and this is having a fundamental impact on the way war is conducted and what technologies are becoming available to the Military.

The fundamental nature of war remains immutable. As Carl von Clausewitz characterized it "war is essentially an interactive clash or two-sided duel between independent, hostile, sentient wills dominated by friction, uncertainty, disorder and highly nonlinear interactions". Nothing alters the fact that war is a human endeavor, with decidedly deadly consequences for all involved. New technology does not make war more clinical, it makes it more deadly. What technology does do is to make the battlefield more complex.

Public debate is heating up over the future development of lethal autonomous weapon systems. Some advocate a complete ban on any further development, others a more gradual development and evolution of codes of conduct based on traditional legal and ethical principles governing weapons and warfare. On the other hand, there will always be those who will develop and deploy such future systems with scant regard of ethics and legality.

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Analysis

Previous Revolutions in Military Affairs

The systematic study of technology's' impact on war is a relatively new phenomena. The definitive work is perhaps van Creveld`s "Technology and War: From 2000BC to the Present". In his book van Creveld divides military history into four eras: "Age of Tools", "Age of the Machine", Age of Systems" and "Age of Automation". During the "Age of Tools", which lasted until around 1500 AD, most technology was driven primarily by muscles of humans or animals. The "Age of the Machine" was defined by greater professional skills and the substitution of firepower mass rather than manpower mass. In the "Age of Systems" the emphasis shifted to the integration of technology (machines) into complex networks. This era culminated in World War II with the innovative application of aviation, ground forces and communication technology.

Since 1945 the importance of systems has taken a great leap forward and has culminated in the Age of Automatisation. This era culminated in the Persian Gulf War, where the United States and her allies overwhelmed the world`s fourth largest army in remarkably short time with insignificant casualties and loss of equipment. That conflict was dominated by the use of guided munitions and unmanned systems. Many of the deployed system were automated, but all required human input during at least one stage of deployment. All the deployed systems had been around in one form or another for a good period of time and were – simply put – further developments of legacy systems. Aircraft used in the conflict were 4th rather than 3rd Generation, the Main Battle Tanks improvements on those developed to counter the Soviet threat, much as the Artillery was a refinement of a similar development dating back to the 1950s.

The Age of Autonomous Systems

We are now entering an entirely new era of Warfare which will be dominated by unmanned and autonomous systems. Such systems will replace existing unmanned air, sea and ground vehicles in all physical operating domains and across the full range of military operations. Such a regime has the potential to change the concept of defense strategy and will have a profound impact on how decision makers consider decisions about the use of force. It is sure to trigger debates regarding operational concepts, the relationship between offensive and defensive military strategies and the ethical and moral implications of deploying such systems.

The debate over the use of armed UAVs continues to dominate discussions about the future of Warfare. Only few nations have deployed such systems and many Governments and political parties reject the use of such systems on moral grounds. Future systems will not only be unmanned, they will have no human in the decision making loop at all. It is understandable, that the use of autonomous UAVs and other systems such as autonomous land and sea systems is divisive in the extreme.

The principles of "Just War" are the basis of ethics and law that govern armed conflict and they can accommodate the use of such autonomous systems currently under development. Under the laws of war, appropriate use of force is judged not only by assessing the results of force, but also by the proportionality of employing that force. A UAV might kill a non-combatant on the battlefield, which is tragic. However, if such force had been deemed to be proportional according to the situation and threat, the death would be both morally and legally acceptable. If autonomous systems are programmed to act according to the laws of war, such systems pose no new ethical dilemma if deployed on the battlefield.

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The Drivers of Autonomous Systems

The main drivers of this Age of Autonomous Systems is the recognition that the dominance enjoyed by the United States up until the early 2000s in the area of high-end sensors, guided weaponry battle networking, cyberspace systems and stealth technology has started to erode. The reason for this development is the shift from government-directed security research and development to the private sector. Companies focused on producing consumer goods and business-to-business services are driving key enabling technologies such as advanced computing, big data handling, autonomy, artificial intelligence, miniaturization, nano technology and high density power systems. All these developments can be exploited by clients to build increasingly sophisticated and capable weapons systems. Some of the clients are defense companies outside the US.

A further driver is the continued development of guided munitions. Such weapons trace their origin back to the Second World War and came in the form of guided conventional weapons that actively corrected their trajectories after release. In 1943 German submarines first used passive acoustic homing torpedoes sinking several merchant ships in the process. For the first time such weapons demonstrated accuracy regardless of the range and could be fired beyond the range of the defenders counter measures. A parallel development was the concept of battle networks as demonstrated in 1940 during the Battle of Britain. The development of Radar and the establishment of a rudimentary command, control and coordination network took surprise and chance out of the equation and allowed the outgunned and outnumbered RAF to effectively counter German attacks.

Following World War II the combination of guided weapons and battle networks spurred tactical and technological improvements in all operating domains. This culminated in the development of bombs and missiles with reliable Global Positioning System and internal navigating systems which could be deployed day or night and in all weather conditions. During Operation Iraqi Freedom the percentage of guided weapons rose to nearly 65% of all munitions expended.

This development has not gone unnoticed by countries such as China and Russia. They too have developed state of the art munitions and systems and are exporting these to their client states. At the same time they are also developing advanced cyber warfare tools and counter-stealth technologies designed specifically to exploit perceived vulnerabilities in existing western systems. Such countermeasures are designed to cut lines of communication between operator/controller and weapon, be it manned or unmanned. It is this threat which is leading to the development of autonomous systems.

A driver in the development of autonomous systems which should not be ignored is demographic changes in the West which will result in fewer recruits being available to join the armed forces. German population, for example, is set to decline from 82 Million to 75 Million by 2050 and the average age of the population will be 50. This trend (fewer and older) has already had an impact on the cost of personnel. In the United States the average pay and benefits for the armed forces has risen from $ 44,200.- in 2001 to $ 81,600.- in 2013 – an increase of 85%. It is estimated that some 50% of the total defense budget of the US is wage related. Clearly the introduction of autonomous systems will serve to reduce the proportion of money spent on employing and retaining personnel.

The final driver of autonomous systems is the rapid advancements in computing, big data management and miniaturization. The fusion of advanced computing and data management with sensor technology has enabled platforms to become more aware of their environment and interact with it in the absence of human control.

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Current Autonomous Weapons

Current autonomous weapon systems have autonomous modes, and therefore only operate autonomously for short periods. They are also constrained in the tasks they are used for, the types of targets they attack and the circumstances in which they are used.

The development of the Brimstone air to ground missile is a good illustration of how autonomous weapons evolve. Brimstone was originally designed as a "fire and forget" weapon against formations of armored vehicles using a millimetric wave active radar homing seeker to ensure accuracy against moving targets. Experience in Afghanistan led to the addition of laser guidance thus allowing the operator to distinguish between targets in order to reduce the possibility of civilian casualties. Brimstone can be programmed by the operator to adapt to specific mission requirements and thus gives the weapon the ability to distinguish between targets and to self-destruct if it is unable to find a target in the designated area. Brimstone has an autonomous target selection capability once released from the aircraft and has the capability to determine where on a target best to impact causing the most damage.

Brimstone was used extensively during Operation Ellamy over Libya in 2011 and currently by the Royal Air Force over Iraq. In all over 120 missiles were fired over Libya with a success rate of 98%. The missile has been tested on a MQ-9 Reaper, the first time an autonomous weapon has been fired from a remotely guided platform.

In April 2015 the Office of Naval Research in Arlington announced that it had tested its LOCUST UAV Swarming Technology programme. The LOCUST programme includes a tube-based launcher that can launch low-cost UAVs in rapid succession. The breakthrough technology then utilizes information-sharing between the UAVs, enabling autonomous collaborative behavior in either defensive or offensive missions. The demonstrations took place in multiple locations in the spring of 2015 during which up to 9 UAVs worked together completely autonomously in synchronized flight. The LOCUST programme uses three-foot long Coyote drones made by BAE Systems which are electrically powered and weigh around 15 pounds. The UAV has a cruising speed of 60 knots and a dash speed of 85 knots and can operate at altitudes of up to 20,000 feet. The Navy is now planning a ship-based demonstration in 2016 using up to 30 swarming UAVs.

There are today a wide range of missile defensive systems which can be described as operating autonomously. The Phalanx close in weapon system is in active service with 25 navies and was first deployed in 1980. The Aegis combat system was introduced in 1983 and Patriot in 2002. There are furthermore a number of ground vehicle active protection systems in operation or under development. Such systems are designed to detect and intercept missiles, rockets (RPGs) or artillery rounds before they impact on the target. Such systems are out of the loop of human control given the extremely short response times required to neutralize the threat. The SHARK Active Protection System developed by Thales and IBD Deisenroth Engineering is a good example of such systems. A combination of radar and optronic sensors detects threats at very short ranges and destroys incoming fire by releasing a pyrotechnical charge. The incoming round disintegrates and the remaining energy is absorbed by the armor of the vehicle. Similar systems have been developed by KBP Instrument in Russia, Artis and Raytheon in the United States and Rafael in Israel.

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The Definition Problem

There is no internationally agreed-upon definition for an autonomous weapon which complicates the debate on this topic. From a common sense perspective, it makes sense to define an autonomous weapon as one that selects and engages targets on its own, and a semi-autonomous weapon as one where a human is selecting the specific targets for engagement. Given that definition it becomes clear, that there are today only very few truly autonomous systems in operation. Such systems are currently defensive and can be described as being human-supervised with physical access to the system if necessary.

It is also becoming apparent, that the above common sense definition is not sufficient in setting exactly where the line is between autonomous and semi-autonomous weapon systems. In order to define more clearly, a further definition might sharpen the distinction between autonomous and semi-autonomous systems, a human-supervised autonomous system. Thus the above described Brimstone missile would fall into this category, as the operator makes a decision to engage a specific target or not. In the case of an autonomous system, however, the operator makes a decision to launch a weapon to seek out and destroy a general class of target over a wide area, but is not taking a decision about which specific targets are to be engaged. The LOCUST project would seem to fit the definition of a truly autonomous system.

Conclusion

Rapid technological advances and changing threats mean that capabilities that today seem impossible will come to fruition much sooner than we realise. Remotely controlled vehicles on ground in the air or in water will soon be replaced by increasingly autonomous operating systems. The Franco-German plans to develop a "new" MALE-UAV for operational use in around 10 years' time is a step in the wrong direction, unless such a system can perform its intended operations in an autonomous mode. The current political view, at least in Germany, is however to ban autonomy in future weapons without any clear evidence that such systems are harmful. In fact, human-supervised autonomous systems such as Brimstone have actually reduced civilian casualties in war. Brimstone was developed precisely with this in mind.

In the heat of battle, technical indicators have, at times, proven more reliable than human judgment. In 1988, for instance, the USS Vincennes shot down an Iranian airliner after the crew believed the aircraft was descending to attack. In fact, computers on board accurately indicated it was ascending to pass-by harmlessly. In the case of the USS Vincennes the human operators overrode the automatic Aegis system and created a human and diplomatic disaster.

The incremental development and deployment of autonomous weapon systems is inevitable, and any attempt at a global ban will be ineffective in stopping their use by those states whose acquisition of such weaponry would be most dangerous. For this reason, the United States and some other Western allies will continue to develop and increasingly deploy autonomous weapon systems. Some view this emergence of autonomous weapon systems as a crisis for the law and for the ethics of war. Provided we start now to incorporate legal and ethical norms adapted to weapons that incorporate emerging technologies of automation and autonomy, the incremental movement to autonomous weapon systems can both be regulated and made to serve the ends of law on the battlefield of the future. Autonomous systems both in civilian life and on the battlefield are here to stay, as uncomfortable that fact might be to the general public.

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Remarks: Opinions expressed in this contribution are those of the author.

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