International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Autonomous Weapons System in Warfare

Sree Laxmi A J

Advocate, High Court of Madras

Abstract

Autonomous Weapons System refers to that technology where the weapons may be automated depending on the degree of automation. Though today it has been widely deliberated regarding its legal and ethical implications, the fact that since ancient times humans have resorted to the use of automated mechanisms in order to facilitate their functions. With the rapid boom in the Artificial Intelligence technology, the collaboration of AI along with Autonomous Weapons have resulted in the technology of fully autonomous weapons system which requires no human intervention. This paper purely focuses on the evolution of Autonomous Weapons System since ancient times to the present.

Keywords: Autonomy, Meaningful Human Control, Munitions.

INTRODUCTION

The concept of Autonomy in weapons system is widely debated nowadays. The traces of human willingness to have equipment capable of functioning autonomously dates back to the ancient Greek period. Autonomous weapons in today's warfare is prominently evolving. International discussions on autonomy in weapons system have gained more prominence in the recent years. But the problem is that legal safeguards may not be adequate to address these evolutions which happens due to technological developments. It is evident that the developments of such weapons is gaining prominence in land, at sea and in the air.

DEVELOPMENT OF AUTONOMOUS WEAPONS SYSTEM

The role of AWS in today's warfare is gaining momentum. Many countries have started to equip themselves with the latest technological weapons. Cruise missiles are single use weapons which also performs under similar principles as that of unmanned aerial vehicles. UAVs are intended to be recovered after a mission whereas once a cruise missile hits the target, it is gone. Drones are carriers and users of armaments or other equipment, depending on their given role.[1] Nowadays long range targets have been successfully engaged using remotely operated technologies.

Historically, there are mentions of automated devices such as the one mentioned in the book 'Hero's Automata' written by the famous Greek inventor Hero of Alexandria (50 CE to 200 CE). Heron's numerous surviving writings are designs for 'automata machines' operated by mechanical or pneumatic means. These included devices for temples to instil faith by deceiving believers with "magical acts of the gods", for theatrical spectacles, and machines like a statue that poured wine. Among his inventions were: 'A wind wheel operating a pipe organ—the first instance of wind powering a machine and the first

[1] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)

automatic vending machine. When a coin was introduced through a slot on the top of the machine, a set amount of holy water was dispensed. When the coin was deposited, it fell upon a pan attached to a lever. The lever opened up a valve which let some water flow out. The pan continued to tilt with the weight of the coin until the coin fell off, at which point a counter-weight would snap the lever back up and turn off the valve.[2] Even before this era, many philosophical discussions were made regarding some artificially created invention. Thus it is understandable that since ages human had a desire to make something artificially which aids in carrying out human activities. Even, one among the prominent personalities of Renaissance, Leonardo Da Vinci, had mentioned about automation. He advocated automation as he believed that mechanical systems offer greater accuracy and efficiency, and higher rates of output than their human counterparts. It may justifiably be said that he prefigured the industrial revolution, hundreds of years before its time.[3] It is believed that the first major contribution to the discovery of autonomous mechanisms occurred during the period of Pythagoras. It is attributed to Archytas of Tarantas as he had implemented a set of geometrical concepts which led to the creation of the first UAV in 425 BC which was a mechanical bird which could fly by a mechanism placed in its stomach. Also historical documents provide for the proof that in the year 400 BC China had documented the idea of a device that can achieve vertical flight, which was later referred to by Mikhail Lomonosov and had designed an axial impeller and in 1783 Bienvenue Launoy and a counter-model propeller[4]

War brings overall destruction. So when humanitarian principles were evolving in the modern times, States also looked for various means to reduce the sufferings of their soldiers and to prevent increasing causalities. But at the same time States wanted to destroy the enemy forces.

As an outcome of renaissance and industrial revolution many advancements were made with respect to the means and methods of warfare. States started to focus on automated weapons. The oldest automatically triggered lethal weapon is the land mine which is believed to have been used since at least the 1600s, and naval mines, since at least the 1700s. The use of landmines can be traced back to the American Civil War (1861-1865). Later, during World War I mines were deployed to defend against tanks.[5]

Unmanned aerial vehicles, popularly known as drones, are most often associated with airstrikes in modern warfare, but their history goes much further back than that. While drones came into the spotlight during the early years of the 21st century the idea of a remotely-operated flying machine was developed much earlier. A forerunner of what is considered today to be an unmanned aerial vehicle was an Austrian balloon used during the siege of Venice in 1849. In 1849 the Austrians had attacked the Italian city of Venice with 200 unmanned balloons which was loaded with bombs fitted with timer devices.[6]

The balloons were filled with explosives and launched from an Austrian ship anchored near Venice. The wind was intended to carry the balloons, which would be triggered by electromagnetism through a long

[2] Automata Invented by Heron of Alexandria, *available at:* https://www.historyofinformation.com/detail.php?id=10 (last visited on April 7, 2025)

[3] Automation, *available at:* https://www.madatech.org.il/en/automation (last visited on April 7, 2025)

[4] The History and the evolution of UAVs from the beginning till the 70s, *available at:* http://journal.dresmara.ro/issues/volume8_issue1/15_Vasile_PRISACARIU.pdf (last visited on April 10, 2025).

[5] The History of Landmines, *available at:* https://www.unmas.org/sites/default/files/History-of-mine-action/. (last visited on April 7, 2025)

[6] The History and the evolution of UAVs from the beginning till the 70s, *available at:* http://journal.dresmara.ro/issues/volume8_issue1/15_Vasile_PRISACARIU.pdf (last visited on April 10, 2025).

copper wire. Due to unpredictable weather, the project was a limited success, but the idea remained suitable for further development.[7]

Nikola Tesla's work with remote control, particularly his 1898 demonstration of a radio-controlled boat (the "tel-automaton"), is seen as a precursor to modern automated weapons systems, although he didn't explicitly intend his invention for military use. [8]

The usage of automated weapons was developed during the World war I and World War II. During WWI many eccentric weapons were developed on all sides of the conflict. One was the pilotless aircraft that operated with the help of Archibald Low's revolutionary radio controlled techniques. The Ruston Proctor Aerial Target represented the cutting edge of drone technology in 1916. Low, nicknamed "the father of radio guidance systems," was happy for the project to be developed further and used in kamikaze-style ramming strikes against Zeppelins.

Another project led the way for further research of UAVs. It was the Hewitt-Sperry Automatic Airplane, also known as the "Flying Bomb," or the "Aerial Torpedo", which was integrated in the control of a gyroscope. It went from Britain to the USA in 1917, resulting in an upgraded American version named the Kettering Bug. [9] In 1917 Charles F. Kettering of Dayton, Ohio, invented the unmanned Kettering Aerial Torpedo, nicknamed the "Bug". It was launched from a four-wheeled dolly that ran down a portable track. The Bug's system of internal pre-set pneumatic and electrical controls stabilized and guided it towards a target. After a predetermined length of time, a control closed an electrical circuit, which shut off the engine. Then, the wings were released, causing the Bug to plunge to earth - where its 180 pounds of explosive detonated on impact.[10] Although it was considered to be a large success, the war ended before it could be utilized. Not only these countries other important players such as France, Germany had also shown keen interest with respect to development of such weapons.

A prominent significance was given to the remote controlled weapons since the end of world war I and countries started developing them. Three standard E-1 biplanes, which were an early American Army fighter aircrafts were converted into UAVs. The then British Royal Navy had conducted tests of aerial torpedo designs such as the RAE Larynx. This was an unmanned aircraft that was going to be used as a guided anti-ship weapon. In 1927 and 1929 the Larynx was launched from warships under autopilot.[11]

Among the projects used for target practice was the "DH.82B Queen Bee". It was derived from the De Havilland Tiger Moth biplane trainer which was adapted to new radio technology. The name "Queen Bee" is considered to have introduced the term "drone" into general use. During the 1930s the term specifically referred to radio-controlled aerial targets.[12]

During the late 1930s the US Navy developed the Curtiss N2C-2. This unmanned aerial vehicle was remotely controlled from another aircraft, which made the design revolutionary. The US Navy named this class of drones NOLO (No Live Operator On Board). The US Army Air Force (USAAF) also adopted this

[7] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)
[8] A Revolutionary Demonstration, *available at:* https://www.pbs.org/tesla/ins/lab_remotec.html. (last visited on April 7, 2025)
[9] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)
[10] Kettering Aerial Torpedo "Bug", *available at:* https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198095/kettering-aerial-torpedo-bug/ (last visited on April 8, 2025)
[11] Brief Historical Milestones on the Evolution of UAV Systems: 1914 – 1939, *available at:* https://revista.unap.ro/index.php/bulletin/article/download/670/912/3565 (last visited on April 10, 2025)
[12] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)

concept and started improving it. The primary use of the technology was still as target practice for AA gunmen. However, as America was preparing for war, the UAV experiments were being redirected for combat use.[13]

In 1937 Nazi Germany attempted to develop a radio-controlled target drone the size of a large aircraft. Fieseler designed and built the Fi.157 target aircraft in a short time. It was a single-engine, low-power plane with two-blade metal propellers and fixed gear. The aircraft was about to be suspended under a carrier bomber and detached in flight from it. In 1937, three prototypes were built, which were soon destroyed for various reasons.[14]

During World War II any remotely-controlled pilotless aerial vehicle were referred to as Drones. Reginald Denny who was a Hollywood actor and aviator is known as "Prince of Drones". It was because of his pioneering work in developing radio-controlled aircraft. Together with his partners, he opened Reginald Denny Industries and a shop that specialized in model planes, called the Reginald Denny Hobby Shops. The business later on evolved into a Radio Plane Company. He offered the drones to the military. He believed the drones would be very useful, especially for training anti-aircraft crews. Denny and his company produced 15,000 target drones for the US army just before and during WWII. His most famous model was called Radio plane OQ-2.[15]

In 1940 the TDN-1 assault drone was capable of carrying a 1,000-pound bomb and was deemed fit for service. It was easy to produce and passed on tests. However, the drone was too hard to control, and as complications were expected once it entered combat conditions it never saw action.[16]

Germany used Fi-103(V1) in June 1944 known as the cruise missiles during the second world war. In October 1944, the first combat mission and the use of an UAV was made from the Ballad islands.[17] During Operation Aphrodite in 1944, some modified B-17 Flying Fortress and B-24 Liberator heavy bombers were used as enormous aerial torpedoes. It was a program which converted the US B-17 and PBY-4Y into bomb flying drones. But it was not so effective and wider service was not looked into. The Germans had the technological lead in the sky-borne weapons which surprised the US.[18] The US was mainly focusing on the development of atomic weapons at that time.

The development of pulsejet engines enabled the Germans to produce the fearsome V-1 Flying Bomb which at the time represented the pinnacle of guided missile systems. The Americans also introduced the pulsejet engine during the war, but once again only to produce target drones like the Katydid TD2D/KDD/KDH.[19] The V-1 Flying bomb is considered to be the first operational cruise missile.[20] The V1 missile, once launched, flew without a pilot until it ran out of fuel and came crashing down, blowing

[13] Brief Historical Milestones on the Evolution of UAV Systems: 1914 – 1939, *available at:* https://revista.unap.ro/index.php/bulletin/article/download/670/912/3565 (last visited on April 10, 2025)
[14] Brief Historical Milestones on the Evolution of UAV Systems: 1914 – 1939, *available at:* https://revista.unap.ro/index.php/bulletin/article/download/670/912/3565 (last visited on April 10, 2025)
[15] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)
[16] *Ibid.*
[17] The History and the evolution of UAVs from the beginning till the 70s, *available at:* http://journal.dresmara.ro/issues/volume8_issue1/15_Vasile_PRISACARIU.pdf (last visited on April 10, 2025).
[18] Operation Aphrodite, *available at:* https://warfarehistorynetwork.com/article/operation-aphrodite/ (last visited on April 10, 2025).
[19] The Early Days of Drones – Unmanned Aircraft from World War One and World War Two, *available at:* https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html (last visited on April 8, 2025)
[20] V-1 Cruise Missile, *available at:* https://airandspace.si.edu/collection-objects/v-1-cruise-missile/nasm_A19600341000 (last visited on April 10, 2025)

up. The V2 rocket was a long distance weapon that could travel at the speed of sound. Germany used these weapons to terrorise British civilians and undermine morale. They were known as 'revenge weapons'.[21]
The P-61 Black Widow was the first U.S. aircraft designed to locate and destroy enemy aircraft at night and in bad weather, using the technology of radar.[22] After the end of the World war two major powers arose, the US and the then USSR. The world was entering into a phase of arms race. Especially in atomic energy as the world had witnessed its impacts with the atomic bombing of Japan by the US. The Countries also started investing in technologies to further the development of such unmanned weapons system.
In 1955, Radio plane developed the Model RP-7l Falconer as a derivative of the OQ-19/MQM-33 series of target drones. The drone was launched by a solid rocket booster from a zero-length launcher, and was recovered by parachute. It had a camera on it and was used by the US Army as the surveillance drone of the AN/USD-l system. Series production of the SD-l for the US Army started in 1959. In June 1963, the RP-71 drones of the AN/USD-lA and AN/USD-lB surveillance systems were designated as MQM-57A and MQM-57B, respectively. The MQM-57 remained in service until the mid-1970s, and a total of about 1500 MQM-57s of all versions were built by Northrop Ventura.[23]
UAVs were widely used in the Vietnam War in the tasks of reconnaissance, laser marking of targets and guiding manned aircraft to more important targets. The American Air Force started to plan the deployment and use of unmanned aerial vehicles in 1959 so that it would reduce the causalities of American soldiers. The Soviet Union overthrew the American Reconnaissance U-2 aircraft in 1960 which compelled the Americans to employ more sophisticated weapons. A highly sophisticated UAV development program, codenamed "Red Wagon", was soon launched. The military conflict in the Gulf of Tonka between the units of the American and North Vietnamese navies in August 1964 intensified the combat use of American drones in the Vietnam War.[24]
The latter half of the twentieth century saw the expansion and development of Precision Guided Munitions like the Wren in sea, air, and ground combat. Today, they are widely used by militaries around the world in various forms. They are also referred to as "smart missiles" or "smart bombs". PGMs utilize automation to correct aiming errors and assist in guiding the munition (missile, bomb, or torpedo) onto the intended target. Depending on their guidance mechanism, PGMs can exhibit varying degrees of autonomy. Also known as kamikaze drones or suicide drones, loitering munitions are equipped with a range of advanced sensors, guidance systems, and explosive warheads that enable them to locate, track, and engage high-value targets with pinpoint accuracy.[25]
The concept of military robots is gaining prominence with robots increasingly used for reconnaissance, surveillance, logistics, and even combat operations. These robots are categorized by their platforms (land, marine, and airborne). Advancements in artificial intelligence, automation, and sensor technology are driving their development. Autonomous robots are particularly valuable for intelligence, surveillance, and

[21] British Response to V1 and V2, a*vailable at:* https://www.nationalarchives.gov.uk/education/resources/british-response-v1-and-v2/. (last visited on April 10, 2025).
[22] Northrop P-61C Black Widow, *available at:* https://airandspace.si.edu/collection-objects/northrop-p-61c-black-widow/nasm_A19510044000 (last visited on April 10, 2025).
[23] Northrop Radio plane RP-71 Falconer, SD-1, *available at:* https://wmof.com/project/northrop-radioplane-rp-71-falconer-sd-i/ (last visited on April 10, 2025)
[24] Drone - Unmanned Aerial Vehicle (UAV), *available at:* https://ec.europa.eu/programmes/erasmus-plus/project-result-content/bbb7abc9-dd14-4b0a-afac-fa1689715702/ENG_2020-1-RS01-KA202-065370__1_.pdf (last visited on April 10, 2025).
[25] Paul Scharre, *Army of none: Autonomous Weapons and the future of war* 47 (W. W. Norton & Company, New York, 1st edn., 2018)

reconnaissance (ISR) due to their ability to minimize human risk and maintain operational efficiency in high-risk environments.

Loitering munitions represent a new generation of unmanned aerial vehicles designed to deliver unprecedented levels of flexibility and precision in modern warfare. Unlike traditional UAVs used primarily for reconnaissance or surveillance, loitering munitions are intended for direct target engagement, making them a game-changer in this field. With the capability to remain in the air for extended durations and perform autonomous missions, loitering munitions are swiftly becoming essential tools in the arsenal of contemporary militaries worldwide. They are also referred to as kamikaze drones or suicide drones. These munitions are outfitted with a variety of advanced sensors, guidance systems, and explosive warheads, allowing them to locate, track, and engage high-value targets with pinpoint accuracy.[26]

Unmanned Ground Vehicles (UGVs) are also known as mobile robots or armoured robots. They are vehicles that operate on the ground without a human on-board. They are used for various applications which are dangerous, inconvenient, or impossible to have a human operator.

Unmanned Surface Vehicles (USVs) are autonomous watercraft that operate on the surface of the water without human operators on-board. Initially developed by modifying existing manned vessels with remote controls, a diverse range of purpose-built USVs is now available. These vehicles offer a versatile and cost-effective solution, bridging the gap between buoys and fully manned craft, and are increasingly popular for various marine applications. Military applications for USVs include border and littoral zone patrol, minesweeping, submarine hunting, ISR, seaborne targets and offensive capabilities. USVs are also used in commercial sectors such as oceanography and environmental sciences, exploration and the oil and gas industry.[27]

Unmanned Underwater Vehicles (UUVs), also referred to as Unmanned Undersea Vehicles, are submersible vehicles that operate underwater without a human on-board. They are categorized into two main types: Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs). AUVs function independently, collecting data along a predetermined route without real-time human control. Some AUVs can even make decisions and adjust their mission parameters based on the data they receive, allowing for flexible and adaptive underwater operations.[28]

Autonomous weapons systems require “autonomy” to perform their functions in the absence of direction or input from a human actor. Artificial intelligence is not a prerequisite for the functioning of autonomous weapons systems. But, if AI is incorporated, it could further enable such systems. Not all autonomous weapons systems incorporate AI to execute particular tasks. Autonomous capabilities can be provided through pre-defined tasks or sequences of actions based on specific parameters, or through using artificial intelligence tools to derive behaviour from data, thus allowing the system to make independent decisions or adjust behaviour based on changing circumstances. Artificial intelligence can also be used in an assistance role in systems that are directly operated by a human. For example, a computer vision system operated by a human could employ artificial intelligence to identify and draw attention to notable objects in the field of vision, without having the capacity to respond to those objects autonomously in any way.[29]

[26] About Loitering Munitions, *available at:* https://uvisionuav.com/loitering-munitions/ (last visited on April 10, 2025)
[27] Unmanned Surface Vehicles (USV), *available at:* https://www.unmannedsystemstechnology.com/expo/unmanned-surface-vehicles-usv/ (last visited on April 10, 2025).
[28] Unmanned Underwater Vehicles UUVs, *available at:* https://www.unmannedsystemstechnology.com/expo/unmanned-underwater-vehicles-uuv/ (last visited on April 10, 2025)
[29] Lethal Autonomous Weapon Systems (LAWS), *available at:* https://disarmament.unoda.org/the-convention-on-certain-conventional-weapons/background-on-laws-in-the-ccw/ (last visited on April 10, 2025)

Machine learning is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behaviour. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems. ML is one way to use AI. It was defined in the 1950s by AI pioneer Arthur Samuel as "the field of study that gives computers the ability to learn without explicitly being programmed."[30]

Deep learning is a more advanced version of machine learning that is particularly adept at processing a wider range of data resources (text, as well as unstructured data including images). It requires even less human intervention, and can often produce more accurate results than traditional machine learning. Deep learning uses neural networks which is based on the ways of how neurons interact in the human brain, to ingest and process data through multiple neuron layers that recognize increasingly complex features of the data. For example, an early neuron layer might recognize something as being in a specific shape; building on this knowledge, a later layer might be able to identify the shape as a stop sign. Similar to machine learning, deep learning uses iteration to self-correct and to improve its prediction capabilities. Once it "learns" what an object looks like, it can recognize the object in a new image.[31]

Today the Artificial Intelligence is gaining momentum. States are incorporating AI into their Defense capabilities. It is because of the advantages it provides, such as, lesser involvement of Military personnel in the battlefield and thereby reducing the human cost of combatants, more precise targets, greater amount of damage to the enemy, etc. AI-powered cyber tools facilitate more effective and efficient cyber operations, including hacking, surveillance, disruption of enemy command and control systems. A cyber-attack is a cyber-operation, whether offensive or defensive, that is reasonably expected to cause injury or death to persons or damage or destruction to objects.[32]

Apart from the above there also exists AI-driven predictive analysis which enables the military commanders to predict enemy movements, to identify potential threats and to make data driven decisions, AI-powered command control systems which facilitate in making more effective decision-making, situational awareness and resource allocation, AI-driven Intelligence Surveillance and Reconnaissance systems which facilitates the collection, analysis and dissemination of critical information, etc. [33]

DEFINITION OF AWS

Automated or autonomous systems generally has two main components, the machine or process to be controlled and the device which directly governs the behaviour of that machine or process. The controller of an autonomous weapons system would be consisting of a hardware and software which manages the functions and operations based on a program provided by the developer respectively. The software-based control systems are special-purpose computers running programs which take the place of human operator in controlling the machine. Like the ordinary stored-program computers in which the instructions are

[30] Machine learning, explained, *available at:* https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained (last visited on April 10, 2025)

[31] What is deep learning? *available at:* https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-deep-learning (last visited on April 10, 2025)

[32] International Group of Experts, *Tallinn manual on the International Law Applicable to Cyber Warfare*, Part II, Section 2, Rule 30

[33] Kristian Humble, 'War, Artificial Intelligence, and the Future of Conflict' (2024) https://gjia.georgetown.edu/2024/07/12/ (last visited on 23 February 2025)

entered by a human programmer stored in the machine's memory and drawn to govern its operation, Autonomous systems also uses the same technology. [34]

'Autonomous Weapons can be defined as any weapon system with autonomy in its critical functions, that is , a weapon system that can select (search for, detect, identify, track or select) and attack (use force against, neutralize, damage or destroy) targets without human intervention.'[35]

The US Department of Defense (DoD) Directive 3000.09 (Autonomy in Weapon Systems) defines an autonomous weapon system as: A weapon system that, once activated, can select and engage targets without further intervention by a human operator. This includes human-supervised (AWS) that are designed to allow human operators to override operation of the weapon system, but can select and engage targets without further human input after activation.

Autonomous weapon systems, as the ICRC understands them, are any weapons that select and apply force to targets without human intervention. A person activates an autonomous weapon, but they do not know specifically who or what it will strike, nor precisely where and/or when that strike will occur. This is because an autonomous weapon is triggered by sensors and software, which match what the sensors detect in the environment against a 'target profile'. For example, this could be the shape of a military vehicle or the movement of a person. It is the vehicle or the victim that triggers the strike, not the user.[36]

The Russian Ministry of Defense in its military encyclopaedia divides robots into three generations: first-generation robots with software and remote control can only function in an organized environment; second-generation robots are adaptive, having some kind of sensory organ and being able to operate in previously unknown conditions, i.e. to adapt to a changing environment; third-generation robots are intelligent, having a control system with elements of artificial intelligence. Based on this classification, it may be assumed that third-generation robots might be referred to as autonomous weapon systems from the Russian military's point of view.[37]

The concept of Automated weapons is different from that of Autonomous weapons. ` One of the problems with respect to AWS is in its terminology. The term has not been defined. So it has created a confusion as to what to be included within its ambit. This was also recognized by the States that there was a lack of internationally agreed definition of Autonomous Weapons systems or lethal autonomous weapons system. There were also deliberations on whether to incorporate the word lethal along with Autonomous Weapons System or to maintain it as just Autonomous weapons system. Later the term lethal autonomous weapons system was used. Deliberations were also made with respect to the inclusion of Artificial intelligence as one of its characteristic.[38] It was also observed that failure to define the term can also mean the failure to regulate them.

[34] Tim McFarland, *Autonomous Weapon Systems and the Law of Armed Conflict: Compatibility with the International Humanitarian Law* 32-34 (Cambridge University press, New York, 2020)

[35] Neil Davison, A legal perspective: Autonomous Weapon systems under international humanitarian law, available at: https://www.icrc.org/sites/default/files/document/file_list/autonomous_weapon_systems_under_international_humanitarian_law.pdf (last visited on April 5, 2025)

[36] What is an autonomous weapon? *available at:* https://www.icrc.org/en/document/what-you-need-know-about-autonomous-weapons (last visited on April 8, 2025)

[37] Expert Meeting -Autonomous Weapon Systems: implications of increasing autonomy in the critical functions of weapons, *available at:* https://icrcndresourcecentre.org/wp-content/uploads/2017/11/4283_002_Autonomus-Weapon-Systems_WEB.pdf (last visited on April 4, 2025)

[38] UN Secretary General, *Lethal Autonomous Weapons Systems- Report of the Secretary General,* UN Doc A/79/88 (July 1, 2024)

AUTONOMY IN WEAPONS SYSTEM

Autonomous weapons are those weapons which use AI technology to automate some or all of their functions in carrying out military operations. Autonomy in a technical sense is simply the ability of a system to behave in a desired manner as provided by its operator without needing to receive further instructions from outside.

Military development proposals discuss the autonomy in terms of the observe, orient, decide and act (OODA) loop which is a model of a combatant's recurring decision-making cycle as developed by USAF Colonel John Boyd. The OODA model describes the mental and physical process involved in observing one's environment and to respond to the changes accordingly in order to pursue the respective goals. In a manual system all these steps of the loop are carried out by humans. But in the case of autonomous system either some or all the steps of this loop will be carried out by the respective programmed machine.[39] A weapon system consists of the components necessary to complete and entire combat OODA (Orient, Observe, Decide, Act) loop.[40] The classification of these weapons can be made based on their level of autonomy as Semi-Autonomous, Supervised Autonomous and Fully Autonomous.

SEMI-AUTONOMOUS WEAPONS SYSTEM

The semi-autonomous weapons system can be referred to those weapons system in which the full actions are carried out as programmed by the humans. These are those systems which once activated engages the individual or specific target groups that have been selected by a human operator. It is human-in the loop. 'It also includes those semi-autonomous weapon systems that employ autonomy for engagement-related functions including, but not limited to, acquiring, tracking, and identifying potential targets; cueing potential targets to human operators; prioritizing selected targets; timing of when to fire; or providing terminal guidance to home in on selected targets, provided that human control is retained over the decision to select individual targets and specific target groups for engagement'.[41]

Homing munitions are those which has some autonomy but are not considered as autonomous weapons in actual sense because of the fact that the decision to attack a specific target is still with the humans. Many of them are "fire and forget". It means that if they had been launched once they cannot be called back. But the concept is that many traditional and conventional weapons may be characterised under "fire and forget" because of the fact that they cannot be undone. For example, rocks, arrows and bullets cannot be recalled after being released. The behaviour of the homing munition is controlled by their on-board intelligence. The homing munitions can be considered to be a simple robot in the sense that 'they can sense their environment (the target), determine the right course of action (which way to turn), and then act (manoeuvring to hit the target)'. These are considered to have limited autonomy because of the fact that their level of autonomy is tightly constrained and they are not designed to search for and hunt potential targets on their own. There is a compulsion that a human operator should be aware of the specific target in advance. An example could be the Harpoon anti-ship missile. The Harpoon is a widely used, all-weather, over-the-horizon anti-ship missile developed by Boeing. It is known for its versatility, being

[39] Tim McFarland, *Autonomous Weapon Systems and the Law of Armed Conflict: Compatibility with the International Humanitarian Law* 35 (Cambridge University press, New York, 2020)

[40] Paul Scharre, *Army of none: Autonomous Weapons and the future of war 50* (W. W. Norton & Company, New York, 1st edn., 2018)

[41] DOD Is Updating Its Decade-Old Autonomous Weapons Policy, but Confusion Remains Widespread, *available at:* https://www.csis.org/analysis/dod-updating-its-decade-old-autonomous-weapons-policy-confusion-remains-widespread (last visited on April 8, 2025).

launched from ships, submarines, shore batteries, and aircraft. The Harpoon can also be used for land-strike missions. Homing munitions have a very limited ability in time and space to search for targets.[42]

SUPERVISED AUTONOMOUS WEAPONS SYSTEM

A supervised autonomous weapon system is also known as human-on-the-loop. It is a weapon system that can select and engage targets autonomously, but allows human operators to intervene and override its operation, potentially preventing attacks or weapon malfunctions. These systems once activated can search for, detect, decide to engage and can engage targets on their own, but, if necessary, intervention can be made by humans. These systems can be physically disabled by humans if it stops responding to their commands. Examples include defensive systems that automatically detect and intercept incoming threats, or loitering munitions that can autonomously search for targets but allow for operator intervention. They include ship-based defenses, such as the U.S. Aegis combat system and Phalanx Close-In Weapon System (CIWS); land-based air and missile defense systems, such as the U.S. Patriot; counter-rocket, artillery, and mortar systems such as the German MANTIS; and active protection systems for ground vehicles, such as the Israeli Trophy or Russian Arena system.[43]

FULLY AUTONOMOUS WEAPONS SYSTEM

Fully autonomous weapons are weapon systems that can select and fire upon targets on their own, without any human intervention. It is normally referred to as human-out-of-the loop. Fully autonomous weapons can independently assess battlefield situations and make decisions on targeting and attack based on the information they process, without human intervention or oversight. In these types of weapon system humans cannot intervene once it has been activated. Fully autonomous weapons would act on the basis of an "artificial intelligence". Artificial intelligence is basically created by arithmetic calculations and programming of the robot. Fully autonomous weapons are distinct from remote-controlled weapon systems such as drones—the latter are piloted by a human remotely, while fully autonomous weapons would have no human guidance after being programmed. Several states support and fund activities targeted at the development and research on fully autonomous weapons for instance, China, Germany, India, Israel, Republic of Korea, Russia, and the United Kingdom. Robotic systems with a various degree of autonomy and lethality have already been deployed by the United States, the United Kingdom, Israel, and the Republic of Korea.[44]

Loitering munitions are an example. Loitering munitions does not require precise intelligence on enemy targets before launch. A loitering munition can be launched without the knowledge of any specific targets beforehand. Some loitering munitions may be semi-autonomous if they get approval for engagement from humans by radio connection, however some are fully autonomous. Israeli "Harpy" is an example of an autonomous weapon. In it no human approves the specific target before engagement. The difference between a fully autonomous loitering munition and a semiautonomous munition can be tracked down from its time to search, distance etc. For instance, comparison can be made between the semi-autonomous weapon HARM (High-Speed Anti-Radiation Missile) and Harpy. Both of these weapons have the same

[42] Paul Scharre, *Army of none: Autonomous Weapons and the future of war* 48-49 (W. W. Norton & Company, New York, 1st edn., 2018)
[43] Paul Scharre, *Army of none: Autonomous Weapons and the future of war* 52-53 (W. W. Norton & Company, New York, 1st edn., 2018)
[44] Fully Autonomous Weapons, *available at:* https://www.reachingcriticalwill.org/resources/fact-sheets/critical-issues/7972-fully-autonomous-weapons (last visited on April 8, 2025).

type of target (the enemy radars) but their freedom to search for targets is hugely different. There are various other examples of such systems. For instance, the loitering anti-ship missile deployed by the U.S. Navy in 1980s. The tomahawk Anti-Ship Missiles considered to be the first operational fully autonomous weapon. Tacit Rainbow, Low Cost Autonomous Attack System (LOCAAS), Tomahawk Land Attack Missile (TLAM) are other some examples of US developed loitering munitions.[45]

AWS AND MEANINGFUL HUMAN CONTROL

Despite the diversity and complexity of systems it is the functionality of the weapon rather than the form that poses the threat. Using sensors and calculations it is a machine that determines when and where an attack should occur. A machine does not perceive the world as people do as it relies only on reductionist data. The comparison can be made with a landmine where if the sensor detects a certain pressure it detonates with no concept or care for what or who triggers an explosion. New more complex weapons might use multiple sensors analyzing heat, shape and motion to determine if it is a target. But they cannot understand or evaluate the whole picture in human terms. And they cannot take legal or moral responsibility for their actions. Machines are tools for achieving human goals and people must be held responsible for their use. Human control requires a user to adequately understand how a system will function in the context where it will be used. This means understanding the system itself, how it works and setting boundaries as to where and when it will operate. What will trigger the system to apply force.

Meaningful Human Control (MHC) refers to the ability of humans to exercise control over autonomous systems, such as Autonomous Weapons Systems (AWS), in a way that ensures accountability, transparency, and responsibility. “Meaningful human control over individual attacks” is a phrase which was coined by the non-governmental organization “Article 36”. The concern was placed over the increasing autonomy in weapons system. The requirement of meaningful human control was evolved from two basic premises, that is a machine which applies violent force and operates without human control is generally considered unacceptable and the decision taken by humans to press the “fire” button without the application of mind and cognitive clarity does not contribute to “human control” in a substantive sense. The key elements which constitute the “human control” is based on the principles of predictability, reliability and transparent technology.[46]

Meaningful human control is required because of the fact that “meaningful human control” is a recognized principle in the laws of war regarding the legality of the use of a weapon. The existing legal framework is not sufficient to address the issues raised by increasing autonomy which again emphasizes the requirement of meaningful human control. Due to its significance there is a requirement of a definition of the term “meaningful human control” in international law.[47]

The ICRC defines “meaningful human control” in the context of autonomous weapon systems as the degree of human involvement and the level of autonomy in a weapon system that enables a human to maintain control over the use of force, ensuring adherence to legal and ethical obligations. This implies that a human must retain the capacity to make informed, conscious decisions about the use of force,

[45] Paul Scharre, *Army of none: Autonomous Weapons and the future of war* 53-55 (W. W. Norton & Company, New York, 1st edn., 2018)

[46] Expert Meeting -Autonomous Weapon Systems: implications of increasing autonomy in the critical functions of weapons, *available at:* https://icrcndresourcecentre.org/wp-content/uploads/2017/11/4283_002_Autonomus-Weapon-Systems_WEB.pdf (last visited on April 10, 2025)

[47] Meaningful Human Control in Weapons System: A Primer, *available at:* http://www.jstor.com/stable/resrep06179 (last visited on April 3, 2025)

including the selection of targets, the evaluation of potential harm, and the ability to intervene and deactivate the system. The key aspects regarding meaningful human control according to ICRC includes, retention of human judgment and input, human supervision and ability to intervene, transparency and accountability, predictability and reliability, legal and ethical implications and considerations.[48]

Under the expert meeting on implications of increasing autonomy in the critical functions of weapons the key elements of human control were recognised as the information on the military objective, understanding of the technology, including predictability and reliability, information on the context including time and space limitations, analysis and understanding of how the technology and the context would interact including risks to civilians and a framework of accountability.[49]

Meaningful human control is required as fully depending on technology can lead to catastrophic impacts if there existed any technical glitches or such other technological errors. Human mind cannot be substituted with even the most sophisticated technology.

CONCLUSION

When looking into the brighter side of Autonomous weapons system, they are considered to act as force multipliers. These help in reducing the number of combatants to be engaged in a mission thus potentially reducing casualties and saving costs. The AWS can be more effective as it is free from human limitations such as fatigue, preconceived notions etc. But despite its benefits there are various disadvantages and challenges related to its functioning and operation. Other examples of Autonomous weapons system include, missile and rocket-defense systems, vehicle "active-protection" weapons and anti-personnel "sentry" weapons, sensor fused munitions, missiles and loitering munitions, torpedoes and encapsulated torpedo mines, etc.

[48] Autonomous weapons and human control, *available at:* https://blogs.icrc.org/law-and-policy/2018/07/18/autonomous-weapons-and-human-control/ (last visited on April 12, 2025)

[49] Expert Meeting -Autonomous Weapon Systems: implications of increasing autonomy in the critical functions of weapons, *available at:* https://icrcndresourcecentre.org/wp-content/uploads/2017/11/4283_002_Autonomus-Weapon-Systems_WEB.pdf (last visited on April 10, 2025)