ARTICLE

# UAV Autonomy in Turkey and Around the World: The "Terminator" Debate

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## Abstract

*Autonomous systems, particularly unmanned aerial vehicles (UAVs), present both opportunities and challenges for modern warfare. Although they lack the moral compass and flexibility of the human mind, they nonetheless provide great advantages in terms of range, precision, coordination and speed in land, naval and air warfare. The advantages of their relative autonomy removes certain limitations, particularly in the sphere of UAVs, both in Turkey elsewhere, while the same autonomy gives rise to the "Terminator" debate with regard to lethal autonomous weapon systems (LAWS)—often called "killer robots"—theoretically capable of targeting and firing without human supervision or interference. The purpose of this article is to help elucidate the challenges posed by the autonomy of the UAVs, and to discuss the advantages and disadvantages of UAV systems, particularly the debates, reservations and criticisms about handing over authority to unmanned systems, especially given that Turkey has been eagerly and successfully working to develop this technology. As the technology continues to evolve, becoming more efficient and expanding into new areas of application, the challenges in determining the level of autonomy that LAWS should have are likely to increase. Although it is not easy to articulate the balance between the hu-*

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*man and the machine in the division of authority, the best solution might be an efficient collaboration between the human mind and artificial intelligence (AI). Also, the law of armed conflict (LOAC) should be developed sufficiently and flexibly to regulate this kind of weaponry, particularly since, unlike nuclear arsenals that are kept under the strict control of states, it is easier to access and develop autonomous weapon systems (AWS). Therefore, permanent measures are needed in order to ensure that development in this field is consistent and ethical with respect to international humanitarian law.*

## Keywords

Unmanned aerial vehicles, Terminator debate, defense industry, Turkey, lethal autonomous weapon systems.

## Introduction

With recent developments in electronics and computer technology, the usage of unmanned aerial vehicle (UAV) systems in the battlefield has become more common and visible around the world. In Southwestern Asia, Syria and Iraq in particular, the extensive usage of drones by various countries (e.g., Turkey, the U.S. and Russia) has necessitated the development of new doctrines and concepts of operations (CONOP-S).[1]

Although UAV systems are relatively new, a considerable body of academic literature has emerged around the world to discuss this field. In Turkey, however, the number of studies on lethal autonomous weapon systems (LAWS), particularly UAVs, remains relatively small and is mostly limited to the publications of the production companies themselves. In this regard, the literature is divided into two main branches: One of these focuses on the capabilities of AWS, while the other addresses the usage of these systems and their position in international humanitarian law (IHL).[2] Both of these dimensions will be elaborated upon here, although it should be noted that it is beyond the scope of this article to try to cover all of the related concepts in detail.

To begin, some basic terminology will be helpful. A UAV, commonly known as a “drone,”[3] is basically an aerial vehicle able to convey the necessary payloads to execute different missions without a human pilot on the vehicle itself.[4] Without the need to carry a crew, and thus without the weight of the crew's accompanying life-support systems, UAVs have greater design permissiveness, and are efficient and safe, capable of greater range and endurance than manned vehicles.[5] Depending on the type of the UAV, there is usually a ground control unit with a controller, a communication system linking the drone with the ground control unit and a payload set up for a variety of tasks. The vehicle itself and its support units form the basic components of any type of UAV system. As there is no risk of human loss, since they carry no pilot, UAVs provide low-risk operations with mission flexibility, design flexibility, endurance and continuity. They are mostly cost-effective and personnel effective, because there is no need for personnel to be stationed inside the air vehicle. UAVs have the additional benefit of being able to conduct instant data transfers and stealth patrols. On the other hand, because UAV technology has been developed relatively recently, there are certain disadvantages, such as relying integration for the airspace, data link vulnerabilities (UAVs are sensitive to electronic warfare and electronic counter warfare), limited survivability, limited meteorology effectiveness and limited situational awareness.[6] In addition to these practical concerns, drones raise significant moral concerns by their very nature: some UAVs are automated weapons and some have already started to become autonomous in certain tasks. The difference between automated and autonomous systems will be discussed in more detail later in the article.

Although the usage and development of UAVs started before the 1960s, the main milestones in their history began after the 1980s with the development of the Israeli mini-scout drone.[7] Later, UAV development continued with rapid progress, from unarmed piston-engine scout drones to unmanned combat vehicles with turbojet engines like the U.S. Nortrop Grumman X-47B unmanned combat aerial vehicle (UCAV).[8] By 2018, 65 countries had become UAV producers of various types, hosting 702 different military/civilian firms producing approximately 3,121 various types of UAVs. Today, at least 24 countries are currently developing military unmanned aircraft.[9] In the U.S., the MQ-1 Predator and MQ-9 Reaper UAVs became manually controlled in 2005; requiring licensed pilots only for take-off and landing. Eight years later, the X-47B turbojet engine UCAV prototype successfully made an autonomous landing on an aircraft carrier. And in 2015, another X-47B succeeded in its first air-to-air refueling mission using specially developed software—dispensing with the need to land in order to refuel provides a considerable increase in the UAV's level of autonomy.[10]

In the case of Turkey, even a relatively cost-effective drone like the Bayraktar TB-2 now has the capability for autonomous take-off from and landing on an airbase.[11] This shows the level of progress Turkey has achieved in developing UAV systems. Moreover, these systems have proven to be advantageous in combat theatres. Even though they are mostly used for intelligence, surveillance and reconnaissance (ISR) missions and assassination tasks, UAVs were utilized by the Turkish Armed Forces (TAF) to assist in air superiority in an innovative manner for the first time in Syria. Although UAVs are relatively slow-moving and do not possess air-to-air capabilities, the TAF has overcome these disadvantages through intensive use of electronic warfare and F-16 AMRAAM Beyond Visual Range Missiles in the scanning range of airborne early warning and control aircraft.[12] Thus, while the capacity and autonomy of unmanned vehicles has improved in many ways, the auxiliary systems supporting UAV technology have also advanced; it is clear that, in the future, UAVs will play a crucial role in effective military networks, cooperating with other unmanned systems in a whole new area of conflict that includes land and sea, as well as space and cyberspace. Such developments will necessitate a new set of Rules of Engagement—which has already become the subject of debate.

## Limitations and Capabilities

UAVs may carry many different loads, but they all function with two fundamental components. The first is hardware, which includes the body, engine, payloads and other attachments. Depending on the purpose of the UAV in question, there are a number of possible classifications regarding its hardware, including the size of the flying component (micro, mini, small, tactical, operational, strategic), the type of payload (UAVs and UCAVs), the type of fuel used (internal combustion, turbojet, turbofan, electric, solar), the type of flight process (fixed-wing, rotary wing), the type of command system (autonomous, remote-controlled), the UAV's purpose (target detection/decoy; intelligence, ISR, logistics support), its desired take-off/landing procedures (launch from ramp, direct launch, take-off from runway, dropped from plane, thrown with hand, land on wheels, land on fuselage, land with parachute), its flight range and altitude (nano, micro, mini, close range, short range, medium range, medium range endurance, low altitude deep penetration, low altitude long endurance, medium altitude long endurance, high altitude long endurance) and special mission (combat, offensive, defensive, stratospheric, exo-stratospheric, space).[13] For military unmanned aircrafts, NATO made its classifications simply according to the weight of the UAV.[14] These classifications mostly have to do with the "limitations" of the drone and whether it has the ability to complete a specific task according to the feasibility of the vehicle itself. In this sense, the analogy of a sports car and a scooter could be used, as the former is much faster and reliable, while it consumes more fuel and is much more expensive.

The second fundamental component is the "software" of the system, which enables the drone to perform the operations necessary to accomplish its tasked objective by using the "hardware" that has the functionality to complete the mission. Software is also a must for performing maintenance tasks for the vehicle while it is in flight; software is responsible for executing commands and applications automatically or in response to a ground command.[15] Software may be categorized in two main branches in terms of its utilization in a UAV. The first branch is mainly reserved for the abilities that enable the UAV to perform its duties by using the hardware it possesses. For example, a Bayraktar TB-2 drone can automatically draw a circle around a specific target for hours without much interference from meteorological changes in its vicinity; a heavier and bigger (Class 3) UCAV Akıncı can perform take-off and landing even though there is no Ground Control Station in the area,[16] which is something that cannot be automatically executed by the smaller, older TB2 model.

Unlike a manned aerial vehicle, which includes all the constituents inside the vehicle, an unmanned system is a complex unit with support units, datalinks, control unit and human operator or monitor dispersed across a wide area. The first category of the software, then, is the main responsible linking element that provides communication and connection among all these components. Software also supports the unit in determining a safe and stable flight route, and provides flight stability during the fire-on mode.

The second category for the software is the vehicle's autonomy. UAV systems depend on a certain level of automation to execute given tasks. Machine involvement means machine speed in the decision-making process, although how to achieve optimum speed and precision while remaining under the control of a human mind is a serious question that remains to be answered.

## From Automation to Autonomy: Opening Pandora's Box

The difference between "automation" and "autonomy" needs to be described before evaluating what might constitute a "solid" decision on the levels at which a UAV operates. Automation is the ability of a system to operate under well-defined rules and algorithms predetermined by humans, and to achieve better, faster and more precise outcomes by relying on these preconditions without AI support. Therefore, automation refers to a certain standard operating procedure (SOP) that is conducted in a pre-planned manner and carried out in the command line of a machine. In terms of the unmanned military craft concept, automation does not exclude the human element; it only decreases the complexity of the specific tasks executed by the operator and prevents possible mistakes due to human nature.[17]

Autonomy, on the other hand, specifically refers to a machine's ability to make decisions and perform specific tasks without, or only under the supervision of, a human operator. Autonomy refers either to operating in predefined conditions with or without human assistance, or acting with totally independent decision-making processes with full awareness of the environment and conditions in the operation area. Autonomy not only means acting after observation, orientation and decision steps, but making autonomous decisions after having a full awareness of the situation.[18]

In politics and philosophy, issues about autonomy have been widely discussed; most of the literature about unmanned systems is based on these discussions. According to Mackenzie, individual or personal autonomy has three different but causally interdependent dimensions:

self-determination, self-governance and self-authorization. Self-determination includes the freedom to set preferences and the capability and propensity to choose values about the future of one's life. Self-governance, on the other hand, implies having the necessary background for making self-determined choices. Self-authorization refers to the behavior and attitude of a person in determining their decisions and actions.[19] When these three dimensions are reinterpreted for military systems, three distinct concepts emerge: the sort of task the machine/AI is designed to execute, the human-machine relationship while the task is being performed and the level of sophistication of the machine when executing the task. Just like a human being in sociology, a machine can increase its autonomy simply by increasing its level of autonomy in any of these three dimensions.

In terms of UAV autonomy, the sort of task being performed mostly serves a military or security-oriented purpose. The human/machine relationship is closely related with the first dimension and places a human being in the process of sensing the situation, deciding upon the necessary response to the situation and acting accordingly. In accordance with the place of a human in this process, machines can be called semi-autonomous or fully autonomous. Semi-autonomous systems are further divided into two categories; in one, humans are involved in the decision-making process as deciders and in the other, humans are involved in the decision-making process as supervisors.

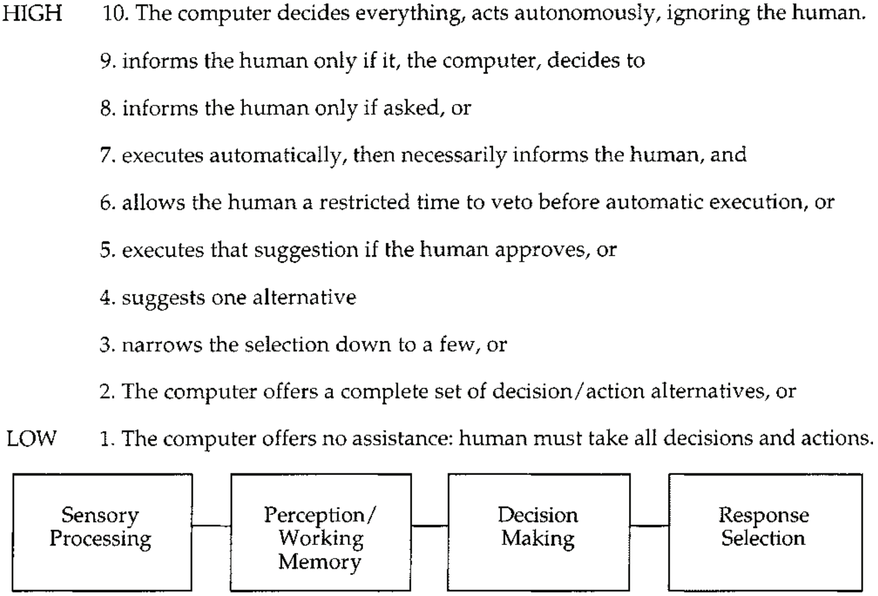
In semi-autonomous operations in which a human is the initiator, the machine (UAV/drone) performs a task and then waits for the operator's approval to continue or stop executing the operation. Such systems are limited to the specifics of a given task and cannot operate without the consent and direction of the operator. In contrast, in supervised autonomous operations, when the machine is activated, it continues performing the task until the human intervenes to halt the operation. Here, a human is in the role of a supervisor. In this kind of autonomy, human-machine communication as well as detailed information implementation is of crucial importance. With supervision, possible negative outcomes can be corrected and the behavior of the vehicle can be adjusted as a safety measure. In other words, in supervised semi-autonomous systems, a human observes the project and has the authority to interrupt if something goes wrong.

Lastly, "fully autonomous" refers to a task-performing machine that operates without human intervention. In this kind of automation, the machine starts to operate and the human does not have the authority to make decisions or even supervise the process and action.[20] For example, according to the U.S. Department of Defense, an AWS is "a weapon system that, once activated, can select and engage targets without further intervention by a human operator. This includes human-supervised autonomous weapon systems 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."[21]

In unmanned systems, autonomy is related to the ability to choose the best option from a set of possible decisions and perform a logical action accordingly. A truly autonomous system can perceive the environment around itself, make logical decisions based on the recognized environment and take an action or perform a manipulation that makes a distinct change in the environment in which it operates.[22] Therefore, autonomy includes a solid decision-making process with the help of advanced recognition of the conditions in the current environment and highly advanced Identifying Friend or Foe (IFF) procedures.

In the military sphere, certain references are used for evaluating degree of autonomy, and determining whether it is high, medium or low. According to Parasuraman, Sheridan and Wickens, one of the sources of evaluating the autonomy of a device or vehicle is the partial or full replacement of the control or function that had previously been executed by humans. This classification is provided in the figure below:

**Figure 1:** Levels of Automation of Decision and Action Selection



HIGH 10. The computer decides everything, acts autonomously, ignoring the human.
9. informs the human only if it, the computer, decides to
8. informs the human only if asked, or
7. executes automatically, then necessarily informs the human, and
6. allows the human a restricted time to veto before automatic execution, or
5. executes that suggestion if the human approves, or
4. suggests one alternative
3. narrows the selection down to a few, or
2. The computer offers a complete set of decision/action alternatives, or
LOW 1. The computer offers no assistance: human must take all decisions and actions.

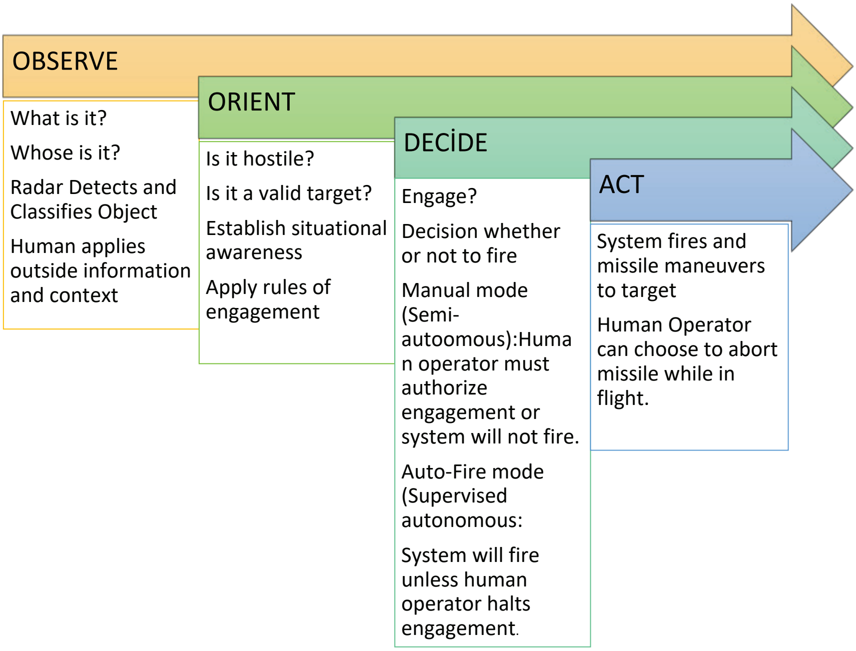
Source: Raja Parasuraman, Thomas B. Sheridan, and Christopher D. Wickens, "A Model for Types and Levels of Human Interaction with Automation," *IEEE Transactions on Systems, Man, and Cybernetics-Part A:Systems and Humans*, Vol. 30, No. 3 (2000), p. 287.

In the "Sense, Decide and Act" loop paradigm, the authors focus on the automation of determining the course of action mainly based on the output functions of the system. Therefore, the figure reflects a lower-level autonomy definition. Yet, when the input functions are put into use, we will likely witness automations so advanced that they have the ability to change their code and adapt to the new situation in accordance with their goals. This means that the automation will evolve at a speed with which the human mind cannot compete. Therefore, even though the figure above is accurate and consistent, it does not fully explain the benefits and challenges posed by the automation process.

A second model the military literature offers is the "Observe, Orient, Decide, Act" (OODA) loop paradigm of combat. This concept is introduced by Boyd.[23] Usually, victory on the battlefield belongs to the side that is able to complete this cycle faster and more effectively. In any case, the presence of AI in this loop brings the ultimate advantage in accelerating and fulfilling the cycle. According to the U.S. Air

Force Flight Plan 2009–2047, computing speeds and the capacity of non-organic intelligence agents will permanently change the OODA loop from supporting to fully participating in all aspects of the process. Therefore, the cycle will be reduced to micro or nanoseconds, and the "perceive and act" vector will depend on the AI capabilities that are used by the opposing sides. Humans will no longer be "in the loop."[24]

**Figure 2:** OOAD Cycle in a Patriot Air-Defense Autonomous System



Source: Paul Scharre, *Army of None: Autonomous Weapons and the Future of War*, New York: WW Norton & Company, 2018, p. 191.

In these models, predetermination raises two main issues regarding human/AI participation and control override preferences. The first issue is the degree of repetitiveness and uniformity of a task given to AI: The more repetitive a task is, the more successful automation becomes. In civilian air transportation, for example, all planes have Automatic Flight Control (AFC) systems installed on their computer system. Mostly these systems operate far more precisely and effectively than the human mind, because a large portion of the work is completed without human clumsiness and hesitation. But in extraordinary situations for which the automatic pilot has not been programmed, the human intervenes uses his/her own decision-making process to solve the problem.

The second issue is about the nature of the task given to the AI system and the capacity of a human to intervene and control the process. Although today almost every weapon with automation technology has semi-autonomous and fully autonomous modes, some tasks, like air and land defense missions, require a speed of engagement that overwhelms human operators. These systems include the U.S. Naval Aegis and Phalanx Close-in Weapon System, the land-based Israeli "Iron Dome" and U.S. "Patriot" air defense systems, counter-artillery and counter-mortar systems such as the German "Mantis" and active protection systems for tanks and other land vehicles such as the Aselsan "AKKOR" and Israeli "Trophy" systems.[25] Therefore, determining the type and level of automation depends on an evaluation that examines the effect of the human operator on the results. In the future, fully autonomous weapons may be developed that completely remove the human mind from the OODA loop and even forge their own codes, depending on the environment of the battlefield or arena.

## The "Terminator" Debate: What are the Dangers of an AWS?

The "Terminator" debate originates from the eponymous cult film starring Arnold Schwarzenegger, who plays the role of a killer robot fully independent of human control that aims to destroy the human race with directions received from a fully autonomous AI "Skynet" that determines the human race is a "danger" to its own existence.[26] Although achieving that kind of autonomy in AWSs does not seem possible in the short term, the speed and extent of technological advances should be a warning of possible risks. Moreover, although giant leaps have been made in the development of AI systems, there are still a lot of uncertainties regarding the natural environment in which they operate. And there are certain risks and dangers directly related to AWS in their current form. These include the "expandability" of an AWS, the human-AI relationship and the incredible machine speed of autonomous systems which in certain situations makes it impossible for humans to even supervise the actions committed by the AI.

AWSs are human-free systems; therefore, any country with autonomous technology has the ultimate advantage of managing human-free conflicts. This means that a leader who desires and plans to start an unlawful war, but hesitates because of the morally and politically negative implications of military casualties, will no longer fear because there will be fewer casualties and the aggressor will gain the ultimate upper hand. AWSs could thus make war more prevalent. Relatedly, AWSs have the capacity to start an uncontrolled arms race, which may even take place between nation-states and transnational/international terrorist organizations that could have access to sophisticated weaponry once AWSs are easily produced and accessed. The latter could also target civilians.[27]

The second risk is related to the precision and clarity of the machine's decision-making process. Automation complicates control over a task or mission because of the increased complexity of the overall mechanism, and nullifies the operator's supervision because the checks that need to be executed exceed the capacity of human reflexes in a limited time. This complexity leads to two other important problems: The first problem has to do with the complicacy of the system as the operator is indispensably reliant on the indicators. In today's most advanced systems, even the designers do not have the most complete knowledge and design structure of the system, which means there can be no direct inspection of any kind of advanced AI-based automations. The supervisor has the power to intervene, but this intervention can only be useful if the indicators successfully address the true nature of the problem. The second problem is the complexity of the computer codes that need to be written for a really sophisticated system. Considering that an F-22 fighter jet uses 1.7 million codes, and an F-35 fighter jet requires 24.7 million, this level of sophistication could bring inevitable errors. Codes can also make the system vulnerable to hacking and guided processing. Last but not least, the sophisticated logic and technology used in the coding system makes errors incomprehensible to and undetectable by the operators and engineers.[28]

NATO originally thought the UAV systems could be a solution to "conduct the dangerous, dull and dirty (D3) missions;" instead of asserting a certain limit of autonomy, they have preferred stringent control over the drones and have emphasized a reliable military communications network. Protti and Barzan argue that depending on the roles executed by the system, NATO plans to carry out a detailed analysis of the functionalities of a UAV to be autonomous, the level of autonomy required for these functionalities and the balance between the supervised human and AI machine. Dangerous missions mostly include ISR missions in the event of a high-level enemy Air Defense threat. Dull missions include surveillance missions that keep tabs on a target over a very long period of time (e.g., the house of a red category target). And dirty missions include ISR and operational missions in a CBRN dirty environment.[29]

Autonomy in any kind of device, whether robot or vehicle, becomes a topic of debate at the legal and ethical levels. In politics and social psychology, many thinkers have expressed reservations about using a device that is outside human control, even though it would be very useful in some cases. The image of the HK (Hunter-Killer) Aerial VTOL Drones armed with laser weapons searching for any kind of humanoid in the *Terminator* movie is still circulating in many people's consciousness.

For clear tasks, there is no doubt that any AI system with a certain amount of autonomy will be faster, more decisive and more precise than a human operator. But if an unconventional situation occurs, AI has a doubtful performance compared with a human being. The human mind's flexibility and capacity to operate under unexpected conditions is superior when dealing with new threats and circumstances. Based on this factor, governments and other potential clients of UAV systems prefer to depend on operators to control the drones, and the U.S. in particular—the world's leading manufacturer of drone technology—opposes the idea of increasing the autonomy of unmanned systems.[30] Therefore, considering the military loop as the basis for UAV systems, the question as to *where* the human should be placed in this cycle becomes the main subject of the debate.

One should also touch upon the concept of "meaningful human control," which was first used in the 2013 report of a non-governmental organization that focused on how the UK conceptualizes autonomous weapon systems.[31] Although there are different opinions about the concept, two schools elaborate on human control in autonomous systems. The minimalist school defends the free usage of any kind of LAWS that can obey the basic rules of IHL. For this school, if a weapon has the capability to comply with the rules of international law, it is unimportant whether a human delivers the lethal blow by pressing the button on an unmanned system, or whether s/he activates a LAWS that operates on its own while selecting and engaging with the targets. Conversely, the maximalist school argues that all kinds of autonomous systems should be considered like nuclear weapons and categorically banned.[32] As a major UAV producer, it is not surprising that Turkey's perspective regarding UAVs is closer to the minimalist school.

The place of the human mind in the decision-making loop is an important concept, one that raises debates regarding the relationship between IHL and armed conflict. Since some basic principles like military necessity, humanity, proportionality and distinction are generally understudied in the field of international law, UN bodies have shown a growing interest on this subject. For instance, the first official LAWS Group of Governmental Experts (GGE) came together in Geneva in November 2017. In 2019, the group accepted 11 guiding principles in the area of LAWS—particularly that human responsibility could not be transferred to LAWS and that countries should pledge to develop future LAWS in accordance with IHL. In addition, it agreed that there should be a certain balance between military necessity and humanitarian considerations. The group's report stated that the development and production of LAWS should be strictly tackled within the context of the IHL—even though the broad scope of IHL could sometimes blur certain limitations in LAWS.[33] Despite diplomatic initiatives like the Geneva meeting, however, the boundaries in this sphere remain vague, making it hard to create a practical legal background regarding meaningful human control over LAWS. In addition, it should be noted that these debates—like those over nuclear weapons—are dominated by major arms producers and militarily powerful states, rendering it difficult to reach an agreement to put limits on the production of such systems.[34]

In today's world, UAVs are used in many fields, from the observation of forest fires to the control of autonomous irrigation projects; however, in the much more complex environment of a battlefield, the consequences of failing performances and faulty decisions are very different and potentially even appalling. This is because the main objective of military UAVs and other unmanned systems is to neutralize a human target or some other weapon that could affect a human target. Taking these facts into consideration, excluding autonomous defense systems like the AEGIS naval defense system or the PATRIOT missile defense system, the human element becomes a crucial part of an information network and the decision-making process to avoid any irrecoverable flaw in the AI infrastructure. Currently, there are no machines with the consciousness or the ability to reevaluate a situation in the presence of uncertain variables. In other words, automation is not a black-and-white question and there are many debatable grey areas at every level.[35]

## Turkey's UAVs and the Autonomy Debate

Although Turkey has not been a pioneer in the development of unmanned systems in general, or UAVs in particular, like the U.S. or Israel, it would not be an exaggeration to claim that it has achieved a certain level of expertise in a considerably short time and has become quite experienced in the production of Medium Altitude Long Endurance (MALE) class UAV systems, such as the TUSAS ANKA series or Baykar's Bayraktar TB2 UAV systems. ANKA UAVs belong to the MALE class; they have an operational altitude of 30,000 feet and a 24-hour flight capability with a 200 kg payload.[36] They have been used in numerous Turkish cross-border military operations and are regarded as one of the "combat proven" units of Turkey's unmanned fleet. With over 300,000 hours of operational flight capacity, Bayraktar UAVs have also been acquiring "combat proven" status. The latter has an operational altitude of between 18,000 and 27,000 feet and the capacity to carry 650 kg with up to 27 hours of endurance.[37]

It is remarkable that Turkey has designed, developed and produced its own unmanned systems, which have proven to be very efficient both in countering terrorism inside its borders and in conducting military operations outside its borders—especially in Iraq and Syria. For instance, as part of Operation Spring Shield launched in Syria in 2020, the Turkish military staff introduced a brand new unmanned air doctrine by operating UAVs as air-to-surface weapons in a non-air-superiority environment. In other operations in Syria, like Euphrates Shield, Olive Branch, Peace Spring and Spring Shield, Turkish UAVs proved to be precise and hard to counter: even Short-Range Air Defense Systems

(SRADS) were not considerably effective against the massive campaign of the Turkish unmanned systems.[38]

It should be noted that although Turkey has long been aware of the importance of unmanned systems, the indigenous development of these systems and Turkey's ascension as a "drone power" [39] is largely the result of the reluctance of the U.S. and Israeli governments to sell such systems (The MQ-1 Predator and MQ-9 Reaper for the U.S. and Heron Systems for Israel), which Turkey wanted to use in its counter-terrorism operations.[40] Today, with its self-developed UAV systems, Turkey has been working to enlarge its fleet with both larger (TUSAS Aksungur and Bayraktar Akıncı) and smaller (Alpagu, Kargu and Bayraktar Mini İHA) unmanned systems and is continuing to invest in more advanced systems, which will certainly enhance the autonomy level of its drones.

Turkey's currently operational UAVs and new prototypes should be analyzed in terms of automation. As indicated by Protti and Barzan, NATO defines four levels of autonomy: [41]

1. Remotely-controlled system: system reactions and behavior depend on operator input.
2. Automated system: reactions and behavior depend on fixed, built-in functionality (pre-programmed).
3. Autonomous non-learning system: behavior depends on built-in functionality or upon a fixed set of rules that dictates system behavior (goal-directed reaction and behavior).
4. Autonomous learning system: system with the ability to modify rule-defining behaviors (behavior depending upon a set of rules that can be modified for continuously improving goal-directed reactions and behaviors within an overarching set of inviolate rules/behaviors).

Turkey's two currently operational MALE UAVs, the Bayraktar TB2 and the ANKA, cannot be categorized into any one of these definitions, since they do not include a compact operational body. Instead, they are both built from various components, each with different automation capabilities. These two MALE models can best be defined as a harmonious combination of drone, payload and weapon with different automation levels in every piece of equipment. The Baykar firm's website states that the Bayraktar TB2 drone can be categorized as an autonomous, non-learning system with fully autonomous landing and take-off capability, fully automatic taxiing and parking, GPS-independent navigation, automatic navigation and route tracking capabilities.[42] In terms of the OODA loop, its operators occupy only the role of a supervisor or director; therefore the system can be considered semi-autonomous. In extreme conditions for which the UAV system is not designed, operators can manually take control of the joystick and throttle—although in many cases that kind of intervention has caused negative outcomes. The Bayraktar TB2 uses a Wescam MX-15D Electro-Optic Camera, a completely remote-controlled system, as its surveillance device. As payload, the camera has no initiative in the decisions made by the operator. The payload operator has total control over the optics, which seek the target in a designated area; after acquiring the target, it aims at it with a remote-control system. As for the weapon, the MAM-L and MAM-C smart micro-precision-guided munitions used by the TB2 can be categorized as an automated system with a semi-active laser seeker and optional inertial navigation/global positioning systems.[43] The smart munition, when fired, follows the track of the laser marker created by the optic system and the maneuverability is totally under autonomous control while following the laser tracker. The munition cannot be deactivated after firing, but it can be directed to a safer place if the decision of the human changes after hitting the fire button.

With additional supporting avionics and other systems, these three main components with different levels of autonomy have been combined to make a remarkable UAV weapon that has proven itself in real ISR and air-to-ground missions. Stringent human control over the firing mode places questions about the law of armed conflict (LOAC) (necessity, distinction of target, proportionality, accountability and liability, and other moral and ethical issues) squarely in the realm of the human operator. In Turkey's drones, targets are identified, surveilled and hit totally under the control of military authorities. Necessity is determined by the process of carefully selecting and identifying targets within hours (sometimes days) of ISR missions. The distinction and proportionality of the weapon in the military offensive is provided perfectly with precision-guided and limited-effect munitions. Bayraktar drones are impeccably reliable and accountable systems with autonomous functions that prevent them from causing harm to friend or foe even when command and control (C/C) is lost. And for moral and ethical issues, humans instead of machines press the button, which means that the hostile target is not eliminated by the machine, but by the operator who uses the system.

There are ongoing ethical debates about the autonomy of unmanned systems, which have no conscience or reasoning power; some argue that this makes it impossible for a target to surrender to an unmanned system on the rapidly changing battlefield. Under LOAC, an important principle is to "provide for and do not harm those who surrender, are detained or are otherwise under your control."[44] Yet it is indeed possible for a target to surrender to a Turkish drone, because it is operated by a human; there is even video footage of a terrorist surrendering to a Bayraktar TB2 UAV in the Afrin region in Syria.[45]

When it comes to the development of new prototypes and projects, it is almost certain that Turkey will pay special attention to AI utilization. On Baykar's website, many AI features, including visual posture detection without the help of GPS systems, basic object detection (with the use of deep learning technology), gimbal object detection and operation beyond the line of view and landmark recognition are mentioned as ongoing projects. The new prototype UCAV Akıncı, with a 20-meter wingspan, 40,000 feet operational altitude, 24-hour operational flight and a 1,350 kg payload capacity will be a much larger and stronger UAV than the Bayraktar TB2. In the future, the Akıncı will be equipped with air-to-air missiles, enabling it to be used in air superiority missions.[46] However, in the field of autonomous systems, this capability may cause some problems regarding the decision-making process. First, until now, UAVs have been designed to conduct ISR missions, which do not require a quick decision-making stage in the OODA loop. But in air-to-air combat, the air vehicle has to react instantly to its adversary, which is equipped with weapons of a similar sophistication level. Because the Akıncı has two propeller engines with limited speed, it will have a low probability of survival against turbojet-engine manned fighters. Therefore, it would be logical to think that the air-to-air capability of the Akıncı will be limited, like propeller-engine CAS manned crafts, helicopters and other UAVs.

After serial production, the Akıncı will be equipped with an indigenous AESA radar system, making it easier to detect and react to other manned/unmanned aircrafts with its Gökdoğan/Bozdoğan air-to-air missile arsenal. However, these "hardware" elements may still not be enough to deal with manned air targets. First of all, UAV sight over the battle scene is very limited compared to manned aircraft because the UAV operator has to rely on the remote camera system that must transfer visual data; there may be only a lag of milliseconds, but this small timelapse is enough for a manned aircraft pilot, who is using his/her eyes and other sensor avionics on board, to destroy the UAV system. The second problem with air-to-air engagements has to do with the possibility of losing connection between the UAV and the operator. This is an unacceptable risk for any kind of unmanned system, because it could ultimately lead to the loss of an expensive device. The Baykar website indicates that these challenges should be overcome by the extensive usage of AI components that can provide more autonomy to the aircraft in certain situations. For instance, in an air-to-air combat situation, the Akıncı will be equipped with full air-to-air internal and external payload, and will be autonomous in specific combat situations. This relative independence will likely raise many of the questions previously mentioned in this article. Indeed, the TUSAS Aksungur, a Medium Altitude Very Long Endurance (MAVLE) system that is regarded as the Akıncı's "brother," will probably be a subject of the ongoing "Terminator debate" in the very near future.

Turkey's leading UAV firms, Baykar and TUSAS, have both announced their objective of developing turbojet-engine UAVs (Baykar's MIUS and TUSAS' Göksungur) capable of conducting air-to-air warfare. In his conference, Baykar's technical manager Selçuk Bayraktar stated that the MIUS will be capable of strategic offense, CAS (close air support), SEAD/DEAD (Suppression Enemy Air Defenses/Destruction Enemy Air Defenses) and missile attack capabilities.[47] Although these projects are still in the design and planning stage, it is assumed that highly capable and autonomous AI will be installed in these advanced systems.

## Conclusion

Today, the use of AI has become widespread all around the world, as it is an easy-to-use and rapidly evolving technology. And just like most cutting-edge technologies, automation and AI have found their first extensive usage in a military context. Modern low-level conflicts and battles are witnessing an increasing use of military drones in ISR as well as offensive and propaganda missions. The more tasks a military UAV/drone undertakes, the more intelligent and capable AI it has to use.

Turkey's military technology has been evolving constantly, like that of the rest of the world, and Turkish military designers have been working hard on the development of autonomous systems and ever more sophisticated AI technology. The lessons that have been learnt by the TAF in this field, particularly during their cross-border military operations in Iraq and Syria, indicate that the Turkish defense industry will continue to thrive in the development of new UAVs. In fact, negotiations are under way for the sale of Turkish-made UAVs to many other countries. Although the state still imposes strict control over weapon systems in Turkey, the achievements of Turkish military companies have been promising regarding the use of AI/automation systems. Turkey is becoming a leading UAV producer and user, developing new concepts and vehicles, in the context of a novel, evolving mode of warfare characterized by the use of military networks, AI collaboration between air-land-naval systems, unmanned offensives and other types of innovation.

To date, the usage of weaponry in UAV arsenals has been conducted under the strict supervision of a human mind, but the need for ever-increasing speed and precision is already revealing this supervision as a constraint to the true potential of machine speed. What we have to understand in this area is that there is no "conscience" or "mercy" in the AI architecture; therefore, even if the slightest autonomy is enabled in any kind of killer hardware, these machines will use this autonomy without hesitation or remorse to ensure victory for their side, since this is the main objective for which they are built. Both in Turkey and around the world, concept designers will have to decide where to stop the autonomy of killer machines—or, in the terms of the debate—at what point to terminate the Terminator.

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