

Controlling Robots: It's Not Science Fiction

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Introduction

New weapons appearing on the battlefield often give rise to discussion on the legality and morality of their use. This is also the case with unmanned systems, which are becoming more prevalent on the modern battlefield. The United States and Israel, the leading countries in the development and use of these systems, benefit from their various inherent advantages, including increased precision and reduced loss of human life (both soldiers and innocent civilians). For these and other reasons, there has been increasing development and use of these tools by the armed forces of many states, and recently, by violent non-state actors as well.

The development and use of unmanned systems, some of them robotic, is an established and at this point inevitable fact. Yet notwithstanding its many advantages, this advanced technology also raises concerns and questions in moral, legal, social, and other spheres. More than anything else, the autonomy of some of these tools – their ability to carry out tasks independently, without human intervention – is what arouses the greatest fears and opposition, and has even encouraged an initiative by international organizations to promote restrictions or prohibitions on their development, use, and trade.¹

The need to restrict use of these tools is discussed mainly by human rights experts, and there is a lack of serious, professional discussion that takes into account the unique nature of this technology and its accelerated and beneficial development in the civilian realm as well as in the military. This one-sided discussion has led to a situation in which on the one hand there is a general campaign of intimidation against the technology, and on the other hand, its development has continued in various places without oversight in a manner that could allow it to become dangerous. This dissonance raises

the question of whether military robots should be restricted and whether it is sufficient to restrict their use in the military context without restricting it in the civilian context.

This article describes the issues that are the basis for opposition to the use of unmanned systems, including robots, for combat purposes, and cautions that the unique nature of this technology renders control of its use in the military ineffective in the absence of restrictions on its use for civilian purposes. If it is decided to place restrictions on this technology, more comprehensive and far-reaching steps will be needed than those that are customary for other types of weapons. In other words, new tools are needed for arms control and restriction.

The Robotic Revolution

In the past two decades, in the wake of technological developments and the miniaturization of powerful computing capabilities, the use of unmanned systems and robots has greatly increased in a variety of fields: in industry, medicine, and transportation, in the home, and on the battlefield. Since about 2000, there has been a significant increase in the use of unmanned systems, mostly aircraft, in warfare. These tools do not always meet the accepted definition of “robots,” but there is often a failure to distinguish between them. While some disagree on the definition, the accepted definition of an unmanned platform is “an air, land, surface, subsurface, or space platform that does not have the human operator physically onboard.”² A robot is also an unmanned platform, but in order to fit the definition of a robot, a system must have three key components: sensors, processors, and effectors.³ These components allow the robot a certain amount of autonomous action. This is in contrast to an unmanned platform that may need an operator and is not capable of any independent activity in a changing environment.

Unmanned tools have a variety of advantages. Among these are the fact that they reduce and sometimes even eliminate the risk there would be to a human being in carrying out an action; they are usually more accurate than their manned counterparts; and in some cases, because their operation does not entail a physical or physiological burden, they make possible a variety of actions that could not be carried out in the past by means of manned systems. Their many advantages have led to their increased use; a prominent example is the increase between 2005 and 2012 in the number of countries employing unmanned aerial vehicles, from forty to more than seventy-five.⁴

The United States is at the forefront of increased use of unmanned platforms on the battlefield, some of them robotic, and has deployed a large number of such systems over the past two decades. Their use is especially prominent in air warfare against terrorist organizations in Afghanistan, Pakistan, and Yemen, where unmanned aerial vehicles have been used extensively for missions of surveillance, intelligence gathering, and attacks on targets on the ground. As of 2010, the United States possessed 12,000 unmanned ground systems and more than 8,000 unmanned aerial vehicles.⁵ In the same year, the ratio of robots to US troops in the battlefield in Afghanistan was 1:50 (one robot to every fifty soldiers), and it has been reported that it is likely to rise within a few years to 1:30.⁶

Notwithstanding this significant increase, the use of unmanned platforms is not free of ethical dilemmas and issues, particularly in regard to remote operation that is risk-free for the operator. The following ethical question hovers over this trend: Is it appropriate to fight with such extreme asymmetry, with one side exposed and vulnerable in the battlefield, and the other side striking from a remote and protected position? Questions concerning the use of autonomous systems that operate without any human involvement and that can cause loss of human life are even more complex. There are those who claim that such actions are not fair or dignified, that they are cowardly, or that it is not sportsmanlike to attack the enemy from a protected location, whether with planes or submarines or unmanned systems. However, according to international law these are not illegal acts.⁷

Autonomy

Autonomy in unmanned systems is the ability of a system to carry out a task independently, without human intervention, and can be divided into four main levels: systems that are remotely but completely human operated and are therefore not autonomous at all; systems capable of carrying out very specific operations relatively independently; systems capable of performing a variety of activities independently under human supervision; and systems that barring initial activation are completely independent and do not require the intervention of a human operator to carry out their mission (although a human operator can intervene and influence events if necessary, for example, by ordering that the mission be aborted).⁸

Of the elements noted earlier that define a robot, what in fact enables autonomous activity more than anything else is the computing capabilities

of the computer processor. Algorithms (computerized instructions on how to perform a task or tasks) are usually responsible for the actions of an autonomous system. Software-based, this capability is therefore fundamentally a cyber (computational) capability, and in a world of cyber threats, there is a risk of its being stolen or hacked into or disrupted as a result of a malfunction. Nevertheless, when tools are developed by serious companies under the supervision of the countries ordering them, we can rationally assume that the required steps are taken to protect them from possible threats, although malfunctions do sometimes occur.⁹

Most of the systems in use today in the service of modern armies are autonomous to a limited extent only. In other words, a high level of human intervention is needed to operate them. For example, the American Predator (an unmanned aerial vehicle), used for attacking targets on the ground (since 2012, mainly in Afghanistan), controls and supervises landing, takeoff, and time in the air with a certain level of autonomy. However, planning of the mission, identification of the target, and the attack itself are guided and controlled by a human operator from a control room on the ground (located usually within the United States, while the aircraft flies in another country).

While most military unmanned systems today are remotely controlled, there are a limited number of completely autonomous systems that have the ability to choose their targets independently, without human intervention. These systems are either very simple or highly sophisticated. Examples of the latter include the American Patriot and the Israeli Iron Dome, anti-missile defense systems that identify their targets independently and use algorithms to calculate independently the most effective way to strike. (These systems raise almost no objections, apparently because they do not operate against human beings.) There are very few such systems active in the battlefield today, and most of them actually require the approval of a human operator to carry out an action.

In contrast, most autonomous systems choose targets by identifying movement, heat, or other relatively simple parameters. Thus, for example, using heat and motion sensors, South Korean robots in the demilitarized zone between South and North Korea can identify and shoot people without human intervention.¹⁰ Most of these systems are able to be more selective in choosing their targets than, for example, land mines, which make no distinction between targets, and therefore are prohibited by the United Nations Convention on the Prohibition of the Use, Stockpiling, Production,

and Transfer of Anti-Personnel Mines and on their Destruction, which has been signed by 139 countries.¹¹ Likewise, unmanned aerial systems, for example, are considered to be different from missiles, even guided missiles, mainly because they can be used more than once, but also because of their ability to be selective about their targets.

According to publications on this topic, lethal autonomous robots exist today in the United States, Israel, South Korea, and Great Britain, and will soon be used by technology leaders such as China and Russia.¹² These systems evoke the greatest opposition by human rights groups and other organizations, which object to the use of robots in the battlefield and are at the forefront of the struggle to ban their use.

Objections to Autonomy

In November 2012, Human Rights Watch, in collaboration with the International Human Rights Clinic at the Human Rights Program at Harvard Law School, published a report called *Losing Humanity: The Case against Killer Robots*, which calls for a ban on the use of killer robots and for outlawing the use of armed autonomous systems on the battlefield. The report was accompanied by a widely publicize international campaign.

The authors of the report state that within twenty to thirty years, there may be fully autonomous weapons that will be able to select their targets without human intervention, and that in spite of claims by military officials that human beings will always remain involved in the process, the direction of technological development indicates that this is not the case.¹³ The report's authors claim that the absence of human intervention in the decision making process on the use of lethal force in armed conflict will deny civilians existing non-legal protective mechanisms that derive from human qualities such as compassion and empathy, lacked by robotic tools. This, they claim, could lead to increased harm to innocents.¹⁴

Another organization prominent in the opposition to armed robotic systems is the International Committee for Robot Arms Control (ICRAC). Members of the committee, which was established in September 2009, have called on the international community to launch an urgent discussion on an arms control regime for unmanned systems. They propose to address the following topics: the potential of these systems to lower the threshold for armed conflicts; a ban on the development, deployment, and use of armed autonomous systems, because machines should not make the decision as

to whether to kill people; limitations on the range of unmanned systems by adding an element of human involvement in their operation; a prohibition on arming unmanned systems with nuclear weapons; and a ban on the development, deployment, and use of robotic weapons in space.¹⁵ ICRAC's recommendations call on the leading countries in the field to institute self-imposed restrictions, or alternatively, for the international community to lead the move for restrictions. The first report even addresses an appeal to engineers and developers to apply ethical rules to their own work.

The ICRAC's reservations are legitimate but problematic. Both the report and the committee completely ignore the fact that if autonomy presents such a great danger, then the military realm and its subsets of human rights and the laws of war are only the tip of the iceberg; given the development of autonomy in many other areas, including transportation, industry, the home, medicine, nano-robots, and civilian aviation, it could spill over into military applications even if these are subject to restrictions.

The fact that only officials from the fields of human rights and military affairs are discussing the matter and highlighting its importance may obscure other urgent issues. The most conspicuous example of this is displayed by the United Nations. The UN is the most important international organization with the ability to coordinate handling of issues such as weapons restrictions. However, two UN committees that deal with unmanned aerial vehicles and robots are led by people from the field of human rights and address the issue from the point of view of defending innocents. Their perspective is largely limited to the battlefield, and does not take into account the challenge of monitoring the development of autonomy in other areas.

What follows are a number of highly pertinent facts not noted in these reports that should not be overlooked:

- a. There is currently nothing in international law or any other framework that would enable restrictions or a total ban on the arming of states. The international arena is violent by nature, and therefore, superiority in weaponry is not only completely legal but also necessary for military forces.¹⁶ Given this, as long as weapon systems are used subject to international law or are not banned specifically in conventions or in customary law, they are entirely legal. As of 2013, attempts by various organizations and officials to assert that unmanned systems are illegal have been based mainly on their extensive use in the war on terror for the

- purposes of targeted killings. The dispute surrounding the ethical aspects of such killings is not connected to the weapons used to carry them out.
- b. Autonomous systems are programmed by human beings and carry out commands as given to them by these human beings. If they are programmed with the necessary attention to minimizing malfunctions and the commands are given in accordance with the appropriate laws, they might even reduce the harm to innocents because they are more precise and faithful to instructions than a human soldier.¹⁷
 - c. In spite of the multiplicity of asymmetric conflicts and battles in urban areas over the past two decades, not every battlefield contains civilians, is located near civilians, or endangers civilians. Therefore, the attention to the risks to innocents greatly reduces the scope of the overall discussion.¹⁸
 - d. The various organizations dealing with this subject ignore the uniqueness of the technology and the fact that autonomous properties, like chemicals or nuclear capability, have a dual use, military and civilian. However, autonomous properties are likely to be simpler to transfer or to steal because they are partly computational, rather than physical. A restriction upon autonomy, and within autonomy, upon the learning abilities of weapon systems, is not sufficient because this feature may be imported or stolen from other applications and easily implemented in violent ways.
 - e. The current trends in unmanned technologies toward reduced costs and increasing availability are having a favorable effect on civilian robotics and enabling almost any household to have a robot. This could also mean that in the future there will be autonomous capabilities that could spill over from non-military uses and reach those who ignore the laws of warfare and international law, such as violent non-state actors and others. Anyone with internet access and a credit card has the capability to purchase a range of unmanned aircraft for personal use, without supervision or control. In some cases, it is possible to purchase components that could, with home customization and assembly, produce tools that are banned for sale by multi-state regimes that aim to limit the export of unmanned aircraft. Examples of these regimes are the Missile Technology Control Regime (MTCR), which has thirty-four signatories, and the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, which has forty-one. Both are based on an agreement by the signatories to restrict the export of sensitive technologies

that appear on the restricted list, including technologies for producing missiles and unmanned aircraft.¹⁹

An additional problem with these requirements and with the UN committees investigating the use of unmanned aircraft and restricting the use of combat robots is that the organizations that have taken action on this issue have succeeded in persuading various elements, including international public opinion and decision makers, that these tools are more dangerous than manned systems used today in violent conflicts. The problem stems from the fact that these systems are used today mainly by democratic countries in their war on terror. Therefore, attention is diverted from the discussion of the technology itself and the risks it involves, to a discussion of targeted killings and possible harm to innocents. This sometimes results in self-imposed restrictions in democratic countries, precluding an orderly development of international policy on the issue for the good of humanity, led by the pioneering countries in this field.

Arms Control and Restriction of Weapons in the Field of Robotics *The Problematic Nature of Legal Restrictions*

Article 36 of Protocol I of the Geneva Convention states:

In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party.²⁰

Although one can argue about the interpretation of this article or even about the classification of armed autonomous systems as new weapons, means, or methods of warfare, this does not require a decision that using them is prohibited in some or all circumstances.

Weapons and various means are generally restricted because they do not conform to the laws of warfare or to the principles of ethics and morality in the battlefield as defined throughout history. Nevertheless, in order to make a restriction legal, it is necessary to receive the consent of states, as reflected in their signing and ratification of treaties. The interest of these countries is usually a result of domestic pressure due to their liberal democratic foundations, or a desire to avoid prolonged, costly arms races (as with the

agreements signed between the United States and its allies and the Soviet Union and its allies in the late stages of the Cold War).

Nonetheless, even in cases in which there is relatively broad agreement there is not always a consensus. A good example of this is the ban on the use of land mines. The use of these lethal weapons was restricted because they completely lack the ability to distinguish between targets, and they can cause serious harm to innocents. In addition, they have a long term impact that remains even after violent conflicts have ended (as seen in the cases of land mines in the Middle East and in Africa). However, not all countries in the world are signatories to the relevant convention, and they cannot be forced to sign.

In order to make restrictions effective, it is also necessary to monitor their implementation once they are agreed upon. This is problematic in and of itself because of the lack of a sovereign in the international arena. Thus, for example, implementation of the Nuclear Non-Proliferation Treaty (NPT) is overseen by the International Atomic Energy Agency (IAEA), but as evidenced in the past decade in the cases of North Korea and Iran, in order for these restrictions to be effective, there is a need for every state to cooperate. A sovereign state may choose not to cooperate with treaties and restrictions, and the chances that international sanctions, particularly violent sanctions, will be imposed on it are slim. Furthermore, a long time is required for approval to set sanctions in motion and to carry them out, sometimes longer than the time to develop and acquire the capability itself in a manner that is not reversible.

In addition to the international restrictions that states accept of their own volition, particular states are restricted or adopt restrictions for themselves. Sometimes restricted states lack the technological or economic capability to develop a particular system, and they forego it or purchase what they are able and what other states agree to sell them. The self-imposed restrictions of states sometimes result from international pressure, but usually, they stem from a mood prevailing in the country. This generally happens in liberal democratic states in which some of the public, influential and articulate, is relatively opposed to the use of violence internationally or believes that an investment in these areas will come at the direct expense of other areas such as welfare, education, or health, which in their view are more important. The most influential factor in states' restrictions on themselves is public opinion, which stems from concern for human rights and opposition to the

use of certain methods. A clear example of this is the set of restrictions that the US Department of Defense placed on itself in the area of autonomous weapon systems in November 2012.

US Restrictions and their Disadvantages

Given the small number of international restrictions on unmanned systems today, the limitations the United States has placed on itself concerning autonomous weapon systems is particularly noticeable. The United States, which is the leading country today in the development, manufacture, and use of robots in the battlefield, imposed restrictions on itself in response to published reports, the campaign to stop killer robots, and media coverage on the subject. According to directive number 3000.09 of the US Department of Defense, published on November 21, 2012, a relatively short time after publication of *Losing Humanity*, US forces will not purchase or make use of autonomous weapon systems that do not involve a human being in the cycle of operation.²¹

Despite the good will that is perhaps implicit in this declaration, it cannot truly restrict the field of autonomous weapons for a number of reasons. First, the directive applies only to US forces under the Department of Defense, and therefore, it is not binding on other states or organizations in the international sphere. Second, the directive concerns only “purchase and use,” and therefore it does not prevent the development and production of such systems. This allows commercial companies, even if they are American, to continue to work on development and to sell to anyone not subject to the DoD, and also to be prepared with off-the-shelf products in the event that the DoD changes its mind and cancels the directive. Third, the directive addresses only weapon systems, and therefore it does not apply the restrictions to autonomous systems in a general way. This does not eliminate the risks of development of autonomous systems without oversight or the risk of leakage between fields and between countries. Finally, the main problem with this directive is that it creates an appearance of restriction and established procedures when in fact, it deals only with a specific point; it thus has no real ability to have an impact, even in the narrow domain it purports to address.

Given the difficulty in creating international restrictions and the problematic nature of specific restrictions, the question becomes clear: Is it perhaps worthwhile to leave the field open, to cancel all existing restrictions (such

as the MTCR, for example) and to allow an arms race and the creation of a deterrence-based balance of terror, as during the Cold War?

The Lethal Potential of an Arms Race and a Deterrent Balance

During the Cold War, there were scholars and statesmen who believed that more is better. The most prominent representative of this idea was the neo-realist scholar Kenneth Waltz, who claimed that given the existence and inherent risks of technology, widespread proliferation of nuclear weapons among states should be permitted because it would lead to a better balance of deterrence and thus increase the chances of preventing wars in general, and the use of nuclear weapons in particular.²²

This approach is less appropriate in the case of robot technology because of risks that today resemble science fiction but are beginning to take hold in reality. In contrast to weapons dependent on nuclear fission, autonomous robotic technology is developing in a variety of civilian fields as well. In order to develop algorithms that will allow a tool to function independently and also to learn to improve its performance, there is no need for centrifuges and large, costly facilities, only for computer know-how and technologies that are becoming less and less expensive. Given the fact that today this field is wide open and not restricted, there is a risk that learning capabilities will be programmed irresponsibly and that independent development will slip out of control.

One could claim that even with atomic, biological, or chemical materials (for purposes of war or peace) there are risks that do not stem from their use as weapons, but from the chance of a technical malfunction or poor maintenance and the potential for theft. These are real risks, but they are fundamentally different from the risks inherent in robotics. First, technologies from non-military autonomous systems may leak into weapon systems. Second, autonomous systems, military or non-military, may slip out of control as a result of faulty programming and harm people. Third, a remote takeover (through cyber warfare) may occur that will turn the system against its operators or against people who were not its original targets,²³ since even in the event of a remote takeover of autonomous machines or medical robots, serious damage can be caused to human beings.

Modifying Existing Arms Control Tools for Use in Robotics

There are three leading treaties today in the field of arms control and prevention of the proliferation of nonconventional weapons: nuclear weapons (NPT, 1970), chemical weapons (Chemical Weapons Convention, 1993), and biological weapons (Biological Weapons Convention, 1975),²⁴ and these are supplemented with additional treaties. There is also a customary law that has been established in international relations over decades. Although there is no sovereign in the international arena, nations have agreed throughout history to restrict or prevent use of various weapons, whether voluntarily or for purposes of maintaining a balance in the international system, or as a result of economic and other constraints. These longstanding tools were relatively good for the weapons in use until now, but even then, they were highly dependent on cooperation among states. In spite of the long history of these tools, experts in the field acknowledge that the effectiveness is limited even among states, and all the more so in restricting terrorist organizations or criminal elements.²⁵ The field of robotics (and the cyber realm), given that they are based on software, will pose an even greater challenge because of their leakage capabilities and the difficulty in monitoring their development.

Anyone who believes that existing arms control tools – such as treaties, survey committees, and partial commitment by internationally prominent states – are suited to the new era must attempt to answer the following questions: Will states agree to sign on restrictions on autonomous systems and artificial intelligence, which have tremendous economic potential? How can an agency on the model of the IAEA monitor the proliferation of autonomous robots for industrial or medical purposes, which could, with only small modifications, be turned into armed robots? And how is it possible to contend with leakage of such technologies to violent non-state organizations in the context of decreasing costs and the greater availability of technologies generally?

Anyone who believes that it is a positive development for leading countries to restrict themselves, as with the directive of the US Department of Defense, should understand that these are isolated cases, and that their impact in the long term could be negative. This is because they do not achieve a proper solution to the problem, but create the appearance of a solution and allow prominent countries to avoid appropriate confrontation of the problem.

The biological and chemical conventions, together with the NPT, are the leading channels today for restriction of weapons. In spite of the vast

differences among these three fields, the restrictions work similarly. They are based on agreement by states and on monitoring and inspection of military and civilian facilities.²⁶ Although these fields have civilian applications, with some of the biological and chemical components readily available in the civilian market, they are still significantly different from robotics, where the serious risks are in the software, which creates artificial intelligence capabilities.

We can learn a great many lessons from the history of these treaties: on building confidence, on building control mechanisms, and on dependence on the good will of states that are conspicuous for their power in the international arena, such as the United States and Russia. Nevertheless, it is important to understand that aside from the fact that biological, chemical, and even nuclear weapons have a longer history in the battlefield and that the restrictions on them began only after the problematic nature of their use was proven in practice, their economic potential is relatively small compared to that of robots. In the past decade, there has been constant growth in the various markets for robotics, which is a relatively new field.²⁷ Another significant difference is the ability of individuals to do work in this field at home, making monitoring and detection more difficult.

Therefore, an in-depth examination of the subject is warranted, not in connection with committees on human rights, but in order to address broader and deeper aspects. It is prudent to understand the similarities and differences between chemical, biological, and nuclear weapons, while addressing the essential differences between these weapons and robotics, in order to acquire new tools for coping with the new problems that the robotic future is liable to present.

Conclusion

We are in a new era of the battlefield, one in which robotic tools are capable of using lethal force and taking human life autonomously, without human intervention. Unmanned systems, and robotic systems in particular, are playing an increasingly large role in military forces, and they will continue to develop in a variety of fields in which they are active today and spread to others as well.

The trends that enable proliferation of autonomous systems are also part of their inherent risk. The lower cost and greater availability of technologies could enable any person to purchase systems or assemble them using purchased

components, with the potential to inflict serious damage. Furthermore, more than other technologies, these systems have a dual use, civilian and military, and are easily converted from one to the other because they are computer based. This creates a real difficulty in placing restrictions on the technologies, significantly increasing their hazardous potential.

The ethical and moral questions raised by the use of armed autonomous systems grab much attention today, because those leading the campaign to limit or to outlaw the use of such systems are human rights organizations and scholars from the field of human rights who work at the UN. Their focus on harm to civilians diverts the discussion from even greater risks.

Countries that impose restrictions on themselves voluntarily, whether by means of internal directives or by multi-state agreements that lack an enforcement mechanism, perhaps soothe public opinion in the short term, but they adversely affect the chances of preemptive, in-depth treatment of this issue for the benefit of all of humanity. Consequently, it is preferable to stop treating this issue under the umbrella of human rights and the laws of warfare. Leading states and international organizations, and particularly the United Nations, should initiate an in-depth discussion on the future impact of robotic technologies on humanity in order to cope with the risks and enjoy the benefits. To this end, the international community should develop and apply new arms control tools, because the current ones are not suited to the age of robotics, an age that is no longer in the realm of science fiction.

Notes

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