AUTONOMOUS WEAPON SYSTEMS

THE NEED FOR MEANINGFUL HUMAN CONTROL

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Contents

Foreword

In April 2015, the Ministers of Foreign Affairs and Defence asked the Advisory Council on International Affairs (AIV) and the Advisory Committee on Issues of Public International Law (CAVV) to produce an advisory report on autonomous weapon systems (see Annexe I). In its request for advice, the government notes that the future development of fully autonomous weapon systems with artificial intelligence that are capable of selecting targets and applying potentially lethal force without human intervention is no longer a fanciful idea. A debate about the legal, ethical and policy implications of such systems has arisen in the international arena. In this context, the government asks the AIV/CAVV the following questions:

1. What role can autonomous weapon systems (and autonomous functions within weapon systems) fulfil in the context of military action now and in the future?
2. What changes might occur in the accountability mechanism for the use of autonomous or fully autonomous weapon systems in the light of associated ethical issues? What role could the concept of 'meaningful human control' play in this regard, and what other concepts, if any, might be helpful here?
3. In its previous advisory report, the CAVV states that the deployment of any weapon system, whether or not it is wholly or partly autonomous, remains subject to the same legal framework. As far as the CAVV is concerned, there is no reason to assume that the existing international legal framework is inadequate to regulate the deployment of armed drones. Does the debate on autonomous and fully autonomous weapon systems give cause to augment or amend this position?
4. How do the AIV and the CAVV view the UN Special Rapporteur's call for a moratorium on the development of fully autonomous weapon systems?
5. How can the Netherlands best contribute to the international debate on this issue?

In order to be able to respond to current and future threats, the armed forces must continue to innovate. They therefore make use of the latest technologies. As a rule, civilian dual-use technologies are developed before military applications.[1] Emerging technologies such as nanotechnology, cognitive science and artificial intelligence play a key role in the development and use of weapon systems.

For many years, the armed forces have been using systems that can to a large extent operate automatically and possess a certain degree of autonomy, such as the ship-based Goalkeeper close-in weapon system and Patriot surface-to-air missiles. These defensive systems are controlled by operators but can also select and engage targets independently. Given the speed of developments in the fields of robotics and artificial intelligence, in particular, certain observers fear that weapon systems will at some point be able to function and be deployed without any human control.

1 See: Kenneth Anderson, Daniel Reisner and Matthew Waxman, 'Adapting the Law of Armed Conflict to Autonomous Weapon Systems', *International Law Studies*, vol. 90, 2014, p. 391, see: <https://www.usnwc.edu/getattachment/a2ce46e7-1c81-4956-a2f3-c8190837afa4/Adapting-the-Law-of-Armed-Conflict-to-Autonomous-We.aspx> and 'Framing Discussions on the Weaponization of Increasingly Autonomous Technologies', *UNIDIR Resources,* no. 1, 2014. See: <http://www.unidir.org/files/publications/pdfs/framing-discussions-on-the-weaponization-of-increasingly-autonomous-technologies-en-606.pdf>.

This fear has given rise to the above-mentioned international debate on the legal, ethical, technological and policy implications of the possible future development and deployment of autonomous or fully autonomous weapon systems. Since 2013, various non-governmental organisations (NGOs) have joined forces under the banner of the international Campaign to Stop Killer Robots. These NGOs believe that a moral line is crossed when machines are allowed to make life-and-death decisions and that the use of autonomous weapons also has other negative consequences.[2] In the same year, the UN Special Rapporteur on extrajudicial, summary or arbitrary executions, Christof Heyns, presented a report on lethal autonomous robotics to the Human Rights Council.[3] Heyns believes that weapons that autonomously select and engage targets violate human dignity and calls for a moratorium in order to facilitate the adoption of an international agreement on their future. On 28 July 2015, over a thousand scientists and entrepreneurs published an open letter calling for a ban on offensive autonomous weapon systems that are beyond meaningful human control.[4] Many more have since endorsed this call.

In May 2014 and April 2015, a large number of experts met to discuss autonomous weapon systems in the framework of the UN Convention on Certain Conventional Weapons (CCW). During these meetings, it became clear that there is no consensus on key issues, including the definition of what constitutes an autonomous weapon. On the other hand, some important questions were raised, for example concerning the adequacy of the existing international legal framework, accountability, ethical issues and the meaning of the concept of meaningful human control. These questions, which will feature prominently in the ongoing debate on autonomous weapon systems, are also at the centre of the government's request for advice.

Given that this report is about potentially rapid developments in the field of emerging technologies and the international debate on autonomous weapon systems is still in full swing, the AIV/CAVV believes it makes sense to focus chiefly on ***the next 10 years*** *when answering the government's questions. Nevertheless, it will also cast a glance into the more distant future.*

Because definitions are integral to a clear discussion of this complex issue, chapter I of this report starts by examining the concept of autonomous weapon systems. It then describes the military advantages and limitations of such systems and their potential future deployment. This discussion also covers the targeting process, which plays a prominent role in this report. Finally, several potential long-term developments are considered.

Chapter II examines the legal framework governing the admissibility of autonomous weapons and their deployment. It focuses in particular on the legal regimes applicable to deployment and the lawfulness of these weapons.

Chapter III discusses issues relating to accountability. It examines various forms of accountability, including liability of military commanders and state responsibility.

2 See: <http://www.stopkillerrobots.org/the-problem>, (accessed on 6 May 2015).

3 Report of the Special Rapporteur on extrajudicial, summary or arbitrary executions, Christof Heyns, 9 April 2013, UN Doc. A/HRC/23/47.

4 See: <http://futureoflife.org/AI/open_letter_autonomous_weapons>, (accessed on 29 July 2015).

Chapter IV examines the concept of meaningful human control and the role it can play in the debate on autonomous weapons.

Chapter V examines various ethical issues relating to autonomous weapons.

Chapter VI considers whether a moratorium on the development of autonomous weapons would be expedient or feasible.

The report ends with a summary, conclusions and recommendations, which are presented in chapter VII.

The report was prepared by a joint committee of the AIV and the CAVV chaired by Lieutenant General (ret.) M.L.M. Urlings (AIV/Peace and Security Committee). Its other members were: Professor I. Duyvesteyn (AIV/ Peace and Security Committee), Professor T.D. Gill (CAVV), Dr B.T. van Ginkel (AIV/ Peace and Security Committee), Professor L.J. van den Herik (CAVV), Professor J.G. Lammers (CAVV), Professor M.E.H. van Reisen (AIV/Development Cooperation Committee) and Professor W.G. Werner (CAVV). Major General (ret.) C. Homan (AIV/ Peace and Security Committee) served as a corresponding adviser. The executive secretaries were J. Smallenbroek (AIV) and Ms E.M. van Rijssen (CAVV), assisted by Ms E.J.M. Smit and Ms T.J.E. van Rens (trainees). The civil service liaison officers were M. Reubzaet, M. Valstar and Dr J. Gutter (on behalf of the Ministry of Foreign Affairs) and J.M.D. van Leeuwe and Major M. Antzoulatos (on behalf of the Ministry of Defence).

The committee consulted the following experts:
- Professor M.J. van den Hoven, Professor of Ethics and Technology, Delft University of Technology;
- Dr L.J.H.M. Kester, Senior Research Scientist in the Distributed Sensor Systems group, Netherlands Organisation for Applied Scientific Research (TNO);
- Professor M.M. Louwerse, Professor of Cognitive Psychology and Artificial Intelligence, Tilburg University;
- Ms M. Struyk, Programme Director for Security and Disarmament at PAX.

In addition, the committee was able to call on the expertise of two PhD students, Ms M.A.C. Ekelhof, LL.M and D.R. Saxon, LL.M, who attended its meetings as observers.

The AIV and the CAVV are grateful to all of them for sharing their views.

The AIV adopted this report at its meeting on 2 October 2015.

The CAVV adopted this report at its meeting on 12 October 2015.

I Autonomous weapon systems[5]

I.1 What is an autonomous weapon?

The development of weapons with autonomous functions is nothing new. During the Second World War, Germany used an acoustic torpedo, which was able to adjust its course to intercept a moving target. After being launched, the torpedo would travel 400 metres before activating a set of microphones. Following the sound of the ship's propeller, the torpedo would correct its course in order to strike the target with greater accuracy.

The development of autonomous weapons is part of an ongoing process of technological innovation in which humans seem to be playing an increasingly limited role in decisions concerning the selection and engagement of targets. This raises certain legal and ethical questions, for instance whether such weapons are permitted under international humanitarian law and whether they are ethically acceptable.

A weapon can perform certain tasks or functions autonomously, while requiring human involvement for others. In this context, the United Nations Institute for Disarmament Research (UNIDIR), the International Committee of the Red Cross (ICRC) and others distinguish between the critical and non-critical functions of a weapon.[6] Critical functions relate to the use of force and include 'target selection' and 'target engagement'. Autonomous aerial refuelling, for example, is not a critical function. Only weapons whose critical functions are carried out autonomously (i.e. by the weapon itself rather than by humans) are classified as autonomous weapons.

Most publications on autonomous weapons distinguish between three categories of weapons, namely those in relation to which humans are 'in the loop', 'on the loop' or 'out of the loop'.[7] The first category consists of weapons, with a human 'in the loop', for selecting and engaging specific targets. These are weapon systems that autonomously engage individual targets or specific types of targets that have been selected by a human. They include various types of guided munitions that have been in use for decades. Some of them, such as the latest version of the Tomahawk land attack cruise missile, can be retargeted in flight. Other types of guided munitions, such as fire-and-forget weapons, do not have this ability. All the weapons in this category (human in the loop) are semi-autonomous weapons.

5 Other terms that are used include: lethal autonomous weapon systems (LAWS), robot weapons, lethal autonomous weapons (LAWs), lethal autonomous robots (LARs), fully autonomous weapon systems (FAWs), killer robots and weaponised unmanned systems (WUS). This advisory report uses the terms autonomous weapon systems and autonomous weapons interchangeably.

6 UNIDIR, *Framing Discussions on the Weaponization of Increasingly Autonomous Technologies*, UNIDIR Resources no. 1, 2014, pp. 3-4; and ICRC, *Autonomous Weapon Systems: Technical, Military, Legal and Humanitarian Aspects*, Expert Meeting, 26-28 March 2014, Geneva, Part III: Background Paper by the International Committee of the Red Cross, p. 62.

7 See Paul Scharre and Michael C. Horowitz, *An Introduction to Autonomy in Weapon Systems*, Working Paper, Center for a New American Security, February 2015, Appendix A.

The second category consists of weapons, with a human 'on the loop', for selecting and engaging specific targets after the weapon has been activated. These are weapon systems that autonomously select and engage targets that have not been selected by a human. However, humans know what type of target will be engaged and can intervene if necessary. In practice, these human-supervised autonomous weapon systems carry out defensive tasks and are deployed in relatively uncomplicated environments. In most cases, they are mounted (e.g. the Goalkeeper system on frigates) or deployed in a static position (e.g. the Patriot system). Given the short time required for engagements, human controllers may not be able to intervene before any inappropriate engagements occur.[8] However, they can stop the system from functioning altogether after an inappropriate engagement and can also intervene in the event of software malfunctions or cyberattacks. The main difference between weapons with a human in the loop (the first category) and weapons with a human on the loop is that the latter can autonomously select individual targets.

The third category consists of weapons, with a human 'out of the loop', for selecting and engaging specific targets after the weapon has been activated and with no possibility of human intervention to halt an attack. These are weapon systems that autonomously select and engage targets in a pre-programmed geographical area for a specific amount of time according to pre-programmed rules. Human operators do not know which specific targets will be engaged, but the type of target is predefined. Such autonomous weapons therefore only engage targets matching the pre-programmed criteria. At present, there are only a few examples of operational weapon systems that answer to this description, such as the Israeli Harpy unmanned combat aerial vehicle, which targets radar systems. This weapon is able to fly a search pattern over a designated area and is pre-programmed to engage enemy radar installations within that area if the target meets certain criteria. Human operators accordingly do not know which individual targets will be engaged; they only know that the weapon will search for – and potentially engage – a specific type of target within a designated geographical area for a specific amount of time. Other examples of weapon systems that share most of these characteristics include sensor-fused weapons and the Brimstone air-to-surface anti-armour missile.[9] The main difference between weapons with a human on the loop (the second category) and weapons with a human out of the loop is that in the latter case humans cannot intervene to stop an attack after the weapon has been activated.

The AIV/CAVV has two comments concerning these definitions. First, it is important to explain that the 'loop' refers to the decision-making process for selecting and engaging targets. The term can refer to the critical processes (target selection and engagement) that weapons carry out autonomously (the narrow loop) as well as to the wider targeting process in which humans play a decisive role (the wider loop). After all, prior to the process whereby it selects and engages a specific target, a human has decided to deploy the weapon concerned. This decision is part of the targeting process, which also includes such tasks as formulating objectives, target selection, weapon selection and

8 Ibid., p. 13.

9 Article 36, 'Key Areas for Debate on Autonomous Weapons Systems', Briefing Paper, May 2014. See: <http://www.article36.org/wp-content/uploads/2014/05/A36-CCW-May-2014.pdf>, (accessed on 30 June 2015).

implementation planning.[10] Potential consequences for the civilian population are also considered in this context. Within the North Atlantic Treaty Organization (NATO), the targeting process follows a series of fixed procedures. The AIV/CAVV believes that this process should also be considered part of the wider loop.

The AIV/CAVV's second comment concerns human involvement in target selection. A weapon that autonomously carries out critical functions (target selection and engagement) is programmed to attack a specific type of target, such as enemy aircraft, tanks or incoming missiles, and nothing else. When the weapon is deployed, it decides which specific target (belonging to the pre-programmed type of target) to select and engage on the basis of algorithms embedded in its instructions and software. In addition, the weapon is restricted in terms of the duration of its deployment and the size of the relevant geographical area. These restrictions on the target type, time frame and area of deployment are the result of human decisions which can influence the effectiveness, legality and legitimacy of the deployment to a high degree. In reality, the weapon does not make any decisions: it performs certain actions on the basis of human-defined rules and in response to signals picked up by its sensors. In this sense, there actually is human involvement in weapons that leave humans out of the narrow loop after they have been activated. In the wider loop, humans even play a crucial role. If they were to be excluded from the targeting process, they would be 'beyond the wider loop'.[11] Chapter IV explores the role of humans in the deployment of autonomous weapons in greater depth.

Autonomous weapons select and engage individual targets on the basis of pre-programmed criteria. Once it has been activated, humans accordingly have less control over the actions of an autonomous weapon than they do over weapons that require continuous human control, such as those employed by a rifleman or by a fighter pilot during aerial combat. As a result, the crux of the decision whether or not to use force shifts to an earlier stage in the decision-making process. The definitive decision to use force no longer takes place just before the person operating the weapon engages the target but at an earlier stage, namely when the decision is made to deploy and activate the autonomous weapon.

A commander making that decision must therefore have a thorough understanding of the risks associated with deployment. In this context, the emphasis is on determining whether the weapon can operate within the boundaries of international law and relevant ethical principles within the given environment. For example, the commander must know how likely the system is to misinterpret the signals picked up by its sensors and whether the parameters defined by the software leave room for attacks on false targets. This assumes that the actions of autonomous weapons – and the consequences of those actions – are sufficiently foreseeable, which in turn places high demands on such factors

10 Mark Roorda, *NATO's Targeting Process: Ensuring Human Control Over and Lawful Use of 'Autonomous' Weapons,* Amsterdam Law School Research Paper no. 2015-106. See: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2593697>, (accessed on 26 May 2015). This process consists of the following six steps: (1) end state and commander's objectives; (2) target development and prioritisation; (3) capabilities analysis; (4) commander's decision and force assignment; (5) mission planning and force execution; (6) assessment.

11 Sean Welsh, 'Machines with Guns: Debating the Future of Autonomous Weapons Systems', *The Conversation,* 12 April 2015. See: <https://theconversation.com/machines-with-guns-debating-the-future-of-autonomous-weapons-systems-39795>, (accessed on 27 August 2015).

as the system's design, its testing in various deployment scenarios and the training of commanders and operators. A commander should know in what situations or under what conditions there will be uncertainty regarding the actions that a weapon might take after it has been activated. This largely depends on the context in which the weapon is deployed. Uncertainty regarding a weapon's potential actions is less problematic in an environment containing only military targets than in one where there are also civilians present. If an autonomous weapon is not suited to a specific situation, the commander in question should not deploy it. If he does so anyway, he can be held accountable for the consequences. This issue is discussed in greater depth in chapter III.

Definition of an autonomous weapon
For the purpose of this report, an autonomous weapon is defined as:

> A weapon that, without human intervention, selects and engages targets matching certain predefined criteria, following a human decision to deploy the weapon on the understanding that an attack, once launched, cannot be stopped by human intervention.[12]

In other words, autonomous weapons are weapon systems with autonomous functions for the selection and engagement of specific targets without human involvement in the narrow loop. Of the three aforementioned categories of weapons, only the third (weapons with the human out of the loop) is consistent with this definition, which covers autonomous weapons that can be deployed at sea, under water, on land, in the air or in space. The above-mentioned wider targeting process – the wider loop – will be discussed in greater depth in chapter IV on meaningful human control.

I.2 Military advantages and limitations of autonomous functions in weapons[13]

Deploying weapons with autonomous functions can have various advantages. Digital devices can collect and process data faster than humans. In some cases, swiftness of action is essential. A ship cannot defend itself against incoming missiles without an autonomous system that independently detects and destroys enemy missiles, such as the Goalkeeper. In addition, systems with autonomous functions can operate in conditions where it is hard or impossible for humans to do so, or only at great risk of life. This is the case, for example, in space or deep under water, where humans require special equipment to survive the high pressure and lack of oxygen. Autonomous weapons can also operate in environments where it is difficult or impossible to communicate, since they are able to carry out their tasks without receiving further instructions. Moreover, they can partially replace humans in high-risk situations, thus ensuring that friendly troops are exposed to fewer risks. Deploying autonomous weapon systems can also help limit the number of casualties among civilians and friendly military personnel.

The use of precision-guided munitions in conjunction with automatic target recognition radar systems and other autonomous functions has given humans greater control over the

12 Although there is still no internationally agreed definition, the present definition reflects those used by various international organisations and government bodies, including Human Rights Watch, ICRC, the UN Special Rapporteur on extrajudicial, summary or arbitrary executions and the US Department of Defense. See also Scharre and Horowitz, *An Introduction to Autonomy in Weapon Systems,* Appendix A.

13 ICRC, *Autonomous Weapon Systems,* pp. 17-18 and 69-71.

use of force in conflicts (e.g. precision strikes instead of carpet bombing).[14] Human Rights Watch has even suggested that using other, indiscriminate types of munitions in populated areas may amount to a war crime.[15]

On the other hand, humans have skills that autonomous systems do not possess – or at least not yet. It is therefore not always more effective or efficient to delegate tasks to systems with autonomous functions. Although certain systems could be made to operate entirely independently, the consequences of potential malfunctions are simply too great to design them in this way. Bradshaw et al. cite the example of the early Mars rovers.[16] They could have been designed as autonomous systems, but if anything had gone wrong the entire costly mission would have ended in failure. NASA therefore opted for a system that could be corrected by humans.

Bradshaw et al. discuss the limitations of autonomous systems, based in part on experiences with computerised systems. It is often assumed that computerised systems can be deployed without hesitation. However, computerisation, or the introduction of autonomous functions, often has far-reaching implications for an organisation. An autonomous system may function properly in one specific context but not in another. If humans do not fully understand a system's limitations, the effectiveness of its deployment will be suboptimal. Autonomous systems have certain advantages, but so do humans. They have a rich understanding of their surroundings and are able to interpret and predict human behaviour. This difference will continue to exist for the foreseeable future. A well-designed system with autonomous functions combines the advantages of autonomous functions with specific human skills. Adding more autonomous functions is not necessarily better.[17]

Deploying autonomous systems also leads to changes in the tasks performed by humans, requiring different skills. If a commander has to decide whether or not to deploy an autonomous weapon, he needs to know what actions the weapon is capable of performing in the situation in question. In other words, he needs to be well trained and have a good understanding of the system and how it interacts with the environment in which it is deployed. Moreover, autonomous functions do not automatically lead to less work, because new capabilities often create new tasks. In such cases, there is often also a need for people with new or different skills.

Autonomous systems are almost always deployed in conjunction with other systems and humans that are dependent on each other. The actions of all these actors need to be coordinated. Bradshaw et al. therefore conclude that the main challenge is not to improve the autonomous functions of systems but to facilitate cooperation between autonomous

14 David A. Koplow, *Death by Moderation: The U.S. Military's Quest for Useable Weapons*, New York: Cambridge University Press, 2010.

15 Human Rights Watch, *Ukraine: Unguided Rockets Killing Civilians,* 24 July 2014. See: <www.hrw.org/news/2014/07/24/ukraine-unguided-rockets-killing-civilians>.

16 Jeffrey M. Bradshaw, Robert R. Hoffman, Matthew Johnson and David D. Woods, 'The Seven Deadly Myths of "Autonomous Systems"', *IEEE Intelligent Systems,* vol. 28, no. 3, May-June 2013, pp. 54-61.

17 See: e.g., United States Air Force Office of the Chief Scientist, *Autonomous Horizons: System Autonomy in the Air Force – A Path to the Future,* Volume I: Human-Autonomy Teaming, June 2015.

systems, on the one hand, and other systems and humans, on the other. As yet, there is little knowledge or understanding of this issue.

I.3 Potential future deployment of autonomous weapon systems

It is not yet clear what tasks autonomous weapons might be able to perform in the future. However, existing weapon systems with autonomous functions offer an indication of the types of tasks they would most likely be able to perform. The current state of affairs as regards the development of artificial intelligence also hints at the possibilities presented by the introduction of autonomous weapons and the limitations attached to the introduction of new generations of such weapons. However, given the relatively fast pace of technological developments, such predictions are purely speculative and need to be accompanied by a good amount of caution when looking more than 10 years into the future.

It is highly unlikely that autonomous weapon systems will entirely or substantially take over the role of humans on the battlefield. This is because the nature of modern conflicts complicates the deployment of such systems. In practice, we are increasingly confronted by conflicts in which military targets are located in predominantly civilian areas and combatants deliberately do not distinguish themselves clearly from non-combatants. This generally makes it more difficult to deploy autonomous weapons. If the objective is to win the hearts and minds of the local population, such weapons are also likely to play a limited role. Autonomous weapon systems will probably be developed and deployed to perform specific tasks alongside troops, existing weapon systems and other military and civilian technology. This is how previous advances in military technology have played out, and there is no reason to assume that matters will be any different in this particular case. After all, the creation of the air force did not replace the role of ground forces. Likewise, the introduction of unmanned aerial vehicles (drones) has not led to the abolition of manned fighter aircraft and helicopters and seems unlikely to do so for the next few decades.

Various military weapon systems have autonomous functions but are not autonomous weapons. Existing versions of such systems are mainly suited to performing specific, predefined tasks in fairly uncomplicated environments. Systems such as the Dutch Goalkeeper close-in weapon system and the Israeli Iron Dome mobile air defence system are designed to neutralise specific types of threat and are deployed in situations where the risk of unforeseeable developments and undesirable side effects is minimal to almost non-existent. The purpose of these systems is to neutralise enemy projectiles and missiles. Another example is the South Korean Samsung SGR-A1 sentry robot, which is capable of eliminating human targets. This system, which has a fully automatic mode, is deployed in the Demilitarised Zone between North and South Korea, where it seeks out infiltrators. This buffer zone between the two countries is closed to civilians. The system is able to distinguish between animals and humans and recognise when an infiltrator is surrendering (arms raised). In such cases, it does not fire. The system also has a – frequently used – mode in which humans retain full control over the use of force.

Ground-based systems such as the Israeli Guardium autonomous unmanned ground vehicle (UGV) can operate in either automatic or remote-controlled mode. This system, which is equipped with various sensors and armed with lethal and non-lethal weapons, is used by the Israeli armed forces and paramilitary border police for border patrol and perimeter defence purposes. It has been operational for several years. Several countries are developing similar systems for a range of tasks, including land mine and improvised

explosive device (IED) clearance, reconnaissance, logistic support and, in some cases, fire support. All the weapons in these systems, insofar as they are armed, are remotely controlled by humans. They accordingly cannot autonomously select and engage targets.

Various navies are using or developing different types of unmanned and autonomous underwater or surface vehicles for such tasks as reconnaissance, naval mine detection and clearance, submarine detection and oceanographic research. Examples include the Israeli Protector, a remote-controlled armed unmanned surface vehicle (USV) that carries out interception and detection tasks, the Norwegian Pluto Plus autonomous underwater vehicle (AUV) for underwater naval mine detection and clearance and the US Navy's Bluefin/Knifefish AUV, which is able to perform various tasks, including naval mine clearance, reconnaissance, marine research and search and rescue. In addition to these platforms and perimeter defence systems, various types of guided munitions are currently being used or developed. All these munitions are programmed to attack a particular type of target within a designated area or a specific target in a preselected location.

A new generation of unmanned fighter aircraft designed to carry out surveillance tasks and airstrikes is also emerging. Various countries are in the process of developing unmanned combat aerial vehicles (UCAVs).[18] For example, US company Northrop Grumman is working on an unmanned carrier-launched airborne surveillance and strike system called the X-47B. This system, which is still in its test phase, has successfully performed the following tasks: autonomous aerial refuelling, autonomous evasive manoeuvres, autonomous target identification and autonomous take-off from and landing on an aircraft carrier.[19]

Based on these examples, it seems likely that autonomous systems will be used for similar purposes – as well as other tasks – in the near future. Armed autonomous systems keep humans in or on the loop, except for the Harpy and a few comparable systems. Systems designed for perimeter defence perform tasks, such as target selection, that require faster than human response times. However, they cannot autonomously do anything other than perform their selected tasks within a pre-programmed area. The threats that these systems deal with are very specific, and the environments in which they operate are so straightforward that the risk of errors or undesirable or unforeseeable side effects is very small. This does not alter the fact that any weapon can be deployed in a context for which it is not intended, thereby violating international humanitarian law or raising ethical issues. Moreover, as in the case of weapons without autonomous functions, human error is always a possibility.

The fact that existing systems are designed and deployed for specific tasks does not rule out that future systems will perform other tasks. However, the current situation provides a reasonable indication of the type of tasks that autonomous weapons will probably be performing over the next 10 years. The computer systems that provide the 'thinking' capacity of these systems can process information and quantitative data quickly and accurately. They are also increasingly able to perform such tasks as navigation,

18 The United Kingdom has a system called Taranis, the United States has a stealth drone called the X-47B, a European prototype is called nEUROn and similar systems in Russia and China are known, respectively, as MiG Skat and Anjian (Dark Sword).

19 Multinational Capability Development Campaign, *Proceedings Report: Autonomous Systems Focus Area*, 2014, p. 6.

autonomous piloting of ground, marine and aerial vehicles and identifying specific objects and persons. On the other hand, they are far less capable than humans when it comes to contextual and qualitative reasoning. In the long term, these limitations may be partially eliminated, but this is highly unlikely to occur in the short or medium term and full elimination may never happen at all.

One development in the field of autonomous systems that is expected to become operational within the next decade is swarming: the use of swarms of small, relatively inexpensive autonomous systems that can be deployed alone or in conjunction with manned systems. Deploying swarms can significantly increase the number of available sensors and weapons.[20] As a result, their combined capability can exceed that of defence systems even if the capabilities of each individual system are limited. A single autonomous system follows simple rules and is comparatively weak, but a swarm can carry out complex tasks and is much more effective. This development is suited to the operations of modern armies. In the Netherlands, those working in this area include Delft University of Technology's Robotics Institute.[21]

Potential strategic implications

In addition to various legal and ethical issues relating to autonomous and fully autonomous weapon systems, the potential strategic implications of such systems in the context of crisis management also raise certain questions. For example, in the case of simultaneous deployment of several autonomous weapon systems in a dynamic environment, the rapid interactions between those systems could have unexpected consequences. This scenario has occasionally been compared to the 'flash crash' on the US stock market on 6 May 2010.[22] An analogy is sometimes made with potential 'flash wars', in which unplanned interactions between the algorithms controlling autonomous weapons might have unintended consequences. Autonomous weapons could be equipped with a 'fail safe' mechanism to limit the consequences of unintentional behaviour.[23] This mechanism would automatically switch off an autonomous weapon if it were not functioning properly. In contrast, certain autonomous weapon systems, such as autonomous air and missile defence systems, can also have a stabilising effect, because they minimise the advantages of pre-emptive attacks and increase deterrence.

Undesirable strategic or political consequences may arise if military and political decision-makers cannot keep up with the speed of action on the battlefield. Under such conditions, a high degree of computerisation and autonomy in the use of force could result in the eruption of flash wars. This highlights the importance of keeping humans in the wider loop

20 Paul Scharre, *Robotics on the Battlefield Part II: The Coming Swarm,* Center for a New American Security, October 2014.

21 See: <http://robotics.tudelft.nl/?q=content/research-themes-projects>.

22 On 6 May 2010, the Dow Jones Index lost almost 10% of its value in a matter of minutes, although the market swiftly recovered. An investigation into the causes of the rapid drop revealed that a large institutional trader had placed a sell order for an immense number of shares, using an automated algorithm trading strategy. See: <http://www.theguardian.com/business/2015/apr/22/2010-flash-crash-new-york-stock-exchange-unfolded>, (accessed on 2 September 2015).

23 Paul Scharre, Presentation at the United Nations Convention on Certain Conventional Weapons, 13 April 2015.

in crucial decisions concerning the use of force, especially when such decisions are of a potentially escalatory nature.

In the AIV/CAVV's opinion, the question whether or not the development of autonomous weapons will lower the threshold for the use of force has not been adequately studied so far. Conducting hostilities from a distance in order to minimise the vulnerability of friendly forces is not unique to the deployment of autonomous weapons but has been done for as long as there have been wars. This is because limiting the risks to its troops is a key responsibility of any national government. As already noted, however, the deployment of autonomous weapons raises problems in many modern conflicts. It is rarely possible to settle a conflict without deploying large numbers of troops in high-risk situations. Parliaments are therefore presumably no more likely to approve the deployment of armed forces now than they were in the past, regardless of the development of autonomous weapons. In contrast, groups that do not abide by international law may well have a lower threshold for the use of force.

I.4 Potential long-term developments: fully autonomous weapons

Long-term developments regarding autonomous weapons are largely dependent on advances in the field of artificial intelligence. Artificial intelligence is difficult to define and extremely complex,[24] but the following three types are often distinguished from each other: limited artificial intelligence, artificial general intelligence and artificial superintelligence.

Artificial intelligence is widely used, but for the most part only for certain functions in equipment. This is known as *limited artificial intelligence*. Examples include anti-lock braking systems (ABS) in cars, email spam filters, systems that track internet users' preferences in order to deliver targeted advertising, internet search engines and so forth. An advanced form is displayed by Deep Blue, a chess computer that is able to beat the world chess champion but cannot do anything else.[25] The world chess champion, in contrast, is able to perform many other functions. Existing weapons with autonomous functions have limited artificial intelligence: they are capable of autonomous navigation, target selection and target engagement. In order to perform these functions, they contain intelligent components.

Artificial general intelligence is a level of artificial intelligence that is supposedly on a par with human intelligence. In theory, it could be created by linking a large number of computers with limited artificial intelligence, but this has not yet been achieved in practice. Developing systems with artificial general intelligence is a major challenge. While computers can perform very complex calculations quickly and accurately, they have trouble with tasks that humans are able to perform without thinking. Computers have difficulty understanding concepts, whereas humans are much better at interpreting observations

24 P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century*, New York: Penguin Press, 2009, pp. 75-77. See also Marco Visscher, 'Computers zijn nog net zo dom als dertig jaar geleden', Interview with Luc Steels in Vrij Nederland, 25 July 2015.

25 According to Luc Steels, artificial intelligence is treacherous because 'once something exists, we no longer refer to it as artificial intelligence'. Once upon a time, nobody believed that computers would be able to beat chess grandmasters. Now we consider it so normal that we say: that's not so intelligent. See: Visscher, op. cit.

(e.g. sounds and images). For artificial general intelligence to become a reality, computers need much more processing power than they have at present. Greater insight into the workings of the human brain is also required. Estimates concerning the time frame within which artificial general intelligence can be realised vary widely. The average estimate is several decades.

Artificial superintelligence surpasses human intelligence. Humans would thus be unable to comprehend the capabilities of a superintelligent machine or the implications of its actions for humans. The idea that such systems could eventually supplant humans frightens many people, because superintelligent autonomous weapons could pose a threat to humanity itself. The Swedish physicist and philosopher Nick Bostrom argues that it is vital to examine right now how such systems can be kept under human control.[26]

A weapon that is capable of selecting and engaging targets that have not been pre-programmed would need to possess a high level of artificial intelligence as well as an ability to learn (machine learning). Given the opportunity to analyse large numbers of examples, such systems might be able to formulate their own rules of conduct. In the future, as a result of new technologies, weapon systems may therefore be able to adapt themselves to dynamic environments.

A weapon that makes autonomous decisions on the basis of self-learned or self-made rules and selects and engages targets without any human involvement could be characterised as an autonomous weapon that places humans beyond the wider loop.[27] Such a weapon would be entirely outside human control. The AIV/CAVV refers to such systems as *fully* autonomous weapons. Such a development, if even possible, would require significant advances in the field of artificial intelligence. The AIV/CAVV considers it unlikely that fully autonomous weapons that are *designed* to function without any human intervention will be developed within the next few decades. If this were to happen, these weapons would be programmed to carry out the entire targeting process autonomously, from formulating the intended military objective to determining the time and place of deployment. Humans would thus no longer have any control over the deployment of such weapons. Setting aside the question of technological feasibility, the AIV/CAVV considers it unlikely that a state would want to develop or commission such an autonomous weapon.

Nevertheless, the increasing complexity of autonomous systems may ultimately lead to a partial or near-complete loss of human control. Because this possibility cannot be ruled out, the AIV/CAVV believes that it must be taken seriously. It is therefore important that states closely monitor developments in the fields of artificial intelligence and robotics.

26 Maarten Keulemans, 'Kan de mens worden uitgeroeid door machines?', Interview with Nick Bostrom in *de Volkskrant,* 8 May 2015. See: <http://www.volkskrant.nl/wetenschap/kan-de-mens-worden-uitgeroeid-door-machines~a4009311>, (accessed on 28 August 2015).

27 Welsh, op. cit.

II Legal framework governing the admissibility of autonomous weapons and their deployment

This chapter examines whether the current international legal framework permits autonomous weapons and what restrictions it imposes on their deployment. The first section discusses the circumstances under which states are entitled to use force and examines whether the deployment of autonomous weapons makes any difference in that regard. The second section looks at international legal regimes that impose restrictions on the use of force by states. For example, international law prohibits certain types of weapons. The third section examines whether autonomous weapons fall under any of the existing categories of banned weapons. The fourth section considers what types of targets may be attacked. The fifth section, finally, discusses whether the deployment of autonomous weapons can comply with the requirements of international law.

II.1 Legal bases for the use of force between states and autonomous weapons

The AIV/CAVV has discussed the international legal framework for the use of force between states (*jus ad bellum* or *jus contra bellum*) in previous advisory reports.[28] In a nutshell, this framework provides as follows. The use of force in international relations is prohibited, unless a state is able to invoke one or more of the recognised exceptions to this rule, namely: (1) a UN Security Council mandate authorising the use of force to maintain or restore international peace and security; (2) individual or collective self-defence of one or more states against an armed attack; or (3) the valid consent of another state to use force within its territory. All three exceptions are subject to further conditions. For example, the right of self-defence can only be invoked in the case of an actual or imminent armed attack. The use of force on the basis of a Security Council mandate must be consistent with the conditions and objectives of the mandate in question. The principles of necessity, proportionality and immediacy apply to every use of force between states. In the case of self-defence, the force must be necessary to repel the actual or imminent attack as well as proportionate.[29]

These rules on the use of force between states apply to every use of force in international relations, regardless of the type of weapons being deployed. They therefore also apply to weapon systems incorporating a greater or lesser degree of autonomy.

When one of the internationally recognised legal bases for the use of force is invoked, the legality of that use of force depends on the particular circumstances of the case. In principle, the nature of the weapon system being deployed is irrelevant. If the UN Security Council issues a mandate to take all necessary measures to counter a threat to the peace, a breach of the peace or an act of aggression, the deployment of a specific weapon system – autonomous or otherwise – will be examined for compatibility with the mandate. The decision to deploy a particular weapon only influences the legality of the use of force in exceptional cases. For example, deploying nuclear weapons in response to a less than

28 CAVV, *Advisory Report on Armed Drones,* CAVV advisory report no. 23, The Hague, July 2013. AIV/CAVV, *Cyber Warfare,* AIV advisory report no. 77/CAVV advisory report no. 22, The Hague, December 2011.

29 AIV/CAVV, *Cyber Warfare,* AIV advisory report no. 77/CAVV advisory report no. 22, The Hague, December 2011, pp. 20-21.

massive conventional attack would almost always be regarded as disproportionate and therefore unlawful. In addition, certain weapons fall under an arms control regime that totally bans specific weapons (e.g. chemical and biological weapons) or subjects them to specific restrictions. In such cases, possession or deployment may constitute a violation of the regime in question. As a rule, however, the legality of deploying a specific weapon is not regulated by *jus ad bellum*. In conclusion, every use of force is subject to the same rules, regardless of the type of weapon that is being deployed.

II.2 Legal regimes governing the use of force and autonomous weapons

In addition to a valid legal basis, every use of force requires those involved to act in accordance with the relevant legal regime. The legal basis determines whether or not force may be used, while the legal regime regulates how, where and against whom force may be used, as well as what form such force may take. Apart from certain specific arms control treaties, there are two legal regimes that regulate the use of force: international humanitarian law (IHL) and international human rights law (IHRL).

The IHL regime only applies to armed conflict situations and regulates such matters as the conduct of hostilities. This includes the use of means and methods of warfare (combat actions) in situations where there is no authority or effective control over people or territory and actual hostilities are taking place or are required in order to eliminate or neutralise a legitimate military target. IHL comprises an extensive system of rules and principles and is specifically designed to regulate these types of situations.

The AIV/CAVV has elaborated on the material, geographical, temporal and personal scope of IHL in previous advisory reports.[30] It has also previously examined different types of armed conflict: international (between two or more states) and non-international (between a government and one or more organised armed groups or between two or more such groups within a state).[31]

The IHRL regime regulates law enforcement both within and outside the framework of armed conflict. It concerns the exercise of authority over territory or persons for the purpose of maintaining or restoring public order, fighting crime and preventing other unlawful activities outside the context of hostilities during an armed conflict. If law enforcement takes place in the context of an armed conflict, IHRL applies alongside IHL. An example of this is the maintenance of public order in occupied territory. In the absence of an armed conflict, IHRL constitutes the only applicable international legal regime regulating the use of force. Both situations are discussed below in so far as they relate to the deployment of autonomous weapon systems.[32]

30 Ibid.

31 See, for instance: CAVV, *Advisory Report on Armed Drones,* CAVV advisory report no. 23, The Hague, July 2013, section 4.1.

32 See: Gloria Gaggioli (ed.), *The Use of Force in Armed Conflicts: Interplay between the Conduct of Hostilities and Law Enforcement Paradigms*, ICRC Expert Meeting Report, November 2013. See also: Nils Melzer, 'Conceptual Distinctions and Overlaps Between Law Enforcement and The Conduct of Hostilities', in Terry D. Gill and Dieter Fleck (eds.), *The Handbook of the International Law of Military Operations*, Oxford University Press, 2011, p. 33ff.

In theory, the two regimes complement each other in situations where they both apply. If there is a conflict between two provisions, the more specific provision applies. This follows from the principle of *lex specialis derogat legi generali* (hereinafter *lex specialis*). Incidentally, this principle does not imply that the other regime is rendered entirely inoperative.

The principle of *lex specialis* is a widely recognised interpretation doctrine for resolving inconsistencies between specific rules in two legal regimes or areas of law. The interconnection between IHL and IHRL has also been discussed in previous advisory reports.[33]

As regards the use of autonomous weapon systems for the purpose of law enforcement both within and outside the framework of an armed conflict, it is sufficient to note that the deployment of such systems to eliminate specific individuals outside the context of actual hostilities, for example as part of police action to maintain public order, will almost always conflict with IHRL. Under this regime, the use of lethal force is only permitted in precisely defined situations and subject to far-reaching restrictions.[34] The deployment of autonomous weapons to use lethal force in such contexts is highly problematic and provides little to no benefit, in contrast to certain combat situations (e.g. interception of incoming projectiles). This is because there are numerous alternatives to lethal force applied by an autonomous weapon system in such situations, such as arrest. There is accordingly no need to deploy autonomous weapons in this context. In contrast, specially designed autonomous systems could be (very) beneficial for the performance of certain law enforcement support tasks, such as surveillance of remote areas and monitoring of vulnerable objects including critical infrastructure. However, if the use of lethal force in a law enforcement context is absolutely necessary and unavoidable, it should always remain under human control. This is due to the fact that IHRL imposes even tighter constraints on the use of lethal force than IHL and the fact that the application of these criteria is very context-specific. It is highly unlikely that, within the next few decades, an autonomous weapon system will be able to consider all these variables in accordance with the legal constraints on the use of lethal force arising from IHRL.

II.3 Are autonomous weapons unlawful per se under international humanitarian law?

In general, there are three reasons for banning certain weapons under IHL. First, IHL prohibits the use of weapons if, when deploying those weapons, it is impossible to distinguish between military targets (individuals and objects), on the one hand, and civilians and civilian objects, on the other. Examples include bacteriological weapons, which will inevitably spread and infect the civilian population, and certain types of mines and booby traps.

Second, IHL prohibits weapons that cause unnecessary suffering or excessive injury to enemy combatants. Examples include bullets that explode on contact with the human body and laser weapons that cause permanent blindness.

33 CAVV, *Advisory Report on Armed Drones,* CAVV advisory report no. 23, The Hague, July 2013, section 4.1.

34 Article 6(1) of the International Covenant on Civil and Political Rights; article 2 of the European Convention on Human Rights. See also Melzer, op. cit., note 32, pp. 36-37.

Third, IHL prohibits weapons and methods of warfare if their effects cannot be controlled in a manner prescribed by IHL, resulting in indiscriminate harm to soldiers and civilians. For example, if a computer virus that is deployed to knock out an opponent's military communication system also knocks out the communication system of the emergency services, it is a prohibited weapon because the effects of its deployment cannot be controlled. Likewise, it is forbidden to set fire to a building in a populated area to force out enemy combatants, as the fire could spread to other buildings. This is accordingly a prohibited method of warfare.

The rules of IHL are part of customary international law[35] and form the basis of the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects (Convention on Certain Conventional Weapons, CCW). The Convention only contains general provisions on such matters as ratification, accession and entry into force but serves as an umbrella for protocols concerning specific weapons. There are currently five protocols:

– Protocol I on Non-Detectable Fragments;
– Protocol II on Prohibitions or Restrictions on the Use of Mines, Booby Traps and Other Devices;
– Protocol III on Prohibitions or Restrictions on the Use of Incendiary Weapons;
– Protocol IV on Blinding Laser Weapons;
– Protocol V on Explosive Remnants of War.

In May 2014 and April 2015, the states parties to the CCW held two informal meetings on autonomous weapons. The next annual meeting of the states parties will take place in November 2015, at which time they will decide whether, and if so how, these informal meetings will be continued.

There are also other conventions that prohibit certain types of weapons, such as the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction,[36] the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction[37] and the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction.[38]

There is no reason to assume that autonomous weapons would by definition fall under one of these prohibited categories of weapons. The term autonomous weapon covers a wide range of systems. The only thing they have in common is that they all possess autonomous critical functions. Obviously, a weapon that is not prohibited can still be

35 Jean-Marie Henckaerts and Louise Doswald-Beck, *Customary International Humanitarian Law Study,* Volume I: Rules, ICRC, Cambridge University Press, 2005, rule 12.

36 See: <https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVI-5&chapter=26&lang=en>.

37 See: <http://disarmament.un.org/treaties/t/bwc/text>.

38 See: <https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVI-3&chapter=26&lang=en> and <https://www.opcw.org/chemical-weapons-convention/download-the-cwc>.

deployed in a manner that conflicts with IHL. This renders the specific use of the weapon unlawful, rather than the weapon itself. It is also possible that a state might develop an autonomous weapon that falls under one of the prohibited categories, just as it might develop a non-autonomous weapon that does so. In practice, however, it appears that almost all states comply with the prohibitions and restrictions.[39] In conclusion, the AIV/CAVV notes that autonomous weapons as such do not automatically fall under any of the categories of prohibited weapons defined by IHL or the existing conventions banning certain weapons. The question of whether a specific autonomous weapon falls under one of these categories therefore needs to be assessed on a case-by-case basis.

Article 36 of the First Additional Protocol to the Geneva Conventions obliges states involved in the development or acquisition of new weapons to determine whether those weapons are permitted under international law. For the purpose of implementing this article, the Netherlands has established a committee to advise the Minister of Defence on the compatibility of the procurement, possession and any use of conventional weapons and munitions, i.e. all non-nuclear weapons and munitions, as well as the compatibility of methods of warfare, with existing and emerging rules of international law and, in particular, IHL. The committee comprises members of the armed forces and officials from the Ministry of Defence.[40]

The principle of humanity

In addition to the rules defined by treaties and customary law prohibiting certain categories of weapons or subjecting them to restrictions, the question is whether the use of lethal force by autonomous weapons is inherently incompatible with the principle of humanity. This is one of the core principles of IHL (along with military necessity, the obligation to distinguish between military and civilian persons and objects, and the principle of proportionality, which is discussed below). The Martens Clause is one of several expressions of this principle and dates back to the Hague peace conferences that codified IHL for the first time.[41] It also appears in the First Additional Protocol to the Geneva Conventions, where it provides that, in situations not covered by international agreements, civilians and combatants remain under the protection and authority of the principles of international law derived from established custom, from the principles of

39 Compliance with the prohibitions and restrictions on specific types of weapons is generally good. There has been no documented use of biological weapons since they were banned. Iraq and Syria have both used chemical weapons in the past – the recent past in Syria's case – but these attacks led to general condemnation by the international community and, ultimately, to the decommissioning of their chemical weapons stockpiles under international supervision. The mechanisms for monitoring compliance with the conventions on chemical and biological weapons and the monitoring mechanism of the CCW are described in detail in William H. Boothby, Weapons and the Law of Armed Conflict, Oxford University Press, 2009, ch. 19, p. 332ff.

40 Decision establishing the Advisory Committee on International Law and the Use of Conventional Weapons of 5 June 2014, no. BS2014011603, Government Gazette, no. 16746, 18 June 2014. The committee is authorised to consult with and commission studies from governmental and non-governmental bodies, such as the Netherlands Organisation for Applied Scientific Research (TNO), the arms industry, other ministries and NGOs.

41 See, inter alia, the reference to this clause in: 'Report of the Special Rapporteur' op. cit., pp. 16-17.

humanity and from the dictates of public conscience.[42] This provision originally concerned the status of civilians who took up arms against an occupier but is nowadays regarded as a general reminder that, in the absence of specific treaty rules, the actions of the parties to an armed conflict remain subject to the principles of IHL and customary international law. This is logical given that the entire system of rules that makes up IHL represents a balance between considerations of humanity and military necessity.[43] However, there is no customary rule, nor any rule derivable from one of the founding principles of IHL, that prohibits the use of lethal force by computerised or autonomous weapon systems or stipulates that it may only be used in face-to-face encounters. Conducting hostilities from a distance has been an integral part of warfare for as long as war has existed (from the ballista of classical antiquity to modern 'over the horizon' ballistic missiles and railguns that are able to fire projectiles over great distances with little to no direct interaction between the protagonists).

II.4 Legitimate targets: distinction, proportionality and precaution

IHL imposes certain constraints on the conduct of hostilities and the deployment of weapons. These constraints apply in full to the potential deployment of autonomous weapons. IHL does not specifically define the conduct of hostilities, which encompasses various activities, including manoeuvring, reconnaissance, intelligence gathering and analysis, command and control, communication, target engagement and direct logistic support for these activities. IHL regulates several of these activities with a view to regulating the use of force and protecting specific categories of persons and objects that may not be attacked – or only under strict conditions. An attack is a use of force (offensive or defensive) against an opponent, with the intention or the effect of killing, wounding or fully or partially incapacitating persons or destroying objects.

The distinction between military targets, on the one hand, and civilians and civilian objects, on the other, lies at the heart of the regulation of hostilities. Persons that qualify as military targets include members of enemy armed forces (with the exception of medical and pastoral personnel), members of organised armed groups with a continuous combat function and civilians participating directly in hostilities on a temporary basis. Enemy combatants who have been placed *hors de combat* as a result of injury, illness, shipwreck, emergency evacuation of an aircraft or surrender must not be made the object of attack. They must be protected and treated humanely when captured. Certain persons and objects benefit from an enhanced level of protection and may only be attacked in exceptional circumstances, if at all. They include civilian and military medical personnel, humanitarian aid workers and civil defence personnel, provided they are not engaged in actions that are incompatible with their medical or humanitarian duties and harmful to the enemy. Journalists carrying out their professional duties are also protected, unless they are participating directly in hostilities. Military personnel participating in UN peace missions are protected as long as they do not become a party to the conflict within the meaning of international law.

42 Art. 1(2) of the First Additional Protocol to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol I), 8 June 1977.

43 See: inter alia, Mary Ellen O'Connell, 'Historical Development and Legal Basis', in Dieter Fleck (ed.), *The Handbook of International Humanitarian Law,* 3rd ed., Oxford University Press, 2013, pp. 33-34.

An object can be a military target on the basis of its nature, location or current or future function or use. Specially protected objects include medical facilities and vehicles, cultural property, and commodities and facilities that are vital to the welfare and survival of the civilian population. Examples include water purification plants, dams and dykes, aid convoys and facilities containing highly hazardous substances (such as nuclear power plants), as well as the equipment, vehicles and facilities of UN peace missions. All the above-mentioned objects only lose their special protection status in exceptional circumstances. Finally, the natural environment is also a civilian object and may not be directly attacked or damaged by reckless action. Means and methods of warfare that cause long-term, widespread and serious harm to the environment as a side-effect of attacking military targets are prohibited.

All persons and objects not covered by the above description of a military target are civilians or civilian objects. Attacks may only be directed at military targets; civilians and civilian objects may not be attacked. If there are serious doubts concerning the status of a person or object, that person or object may not be attacked.

The principle of distinction must always be applied in the planning and execution of an attack. This means, for example, that attacks must be directed against military targets. Attackers may only use a means (weapon) or method of warfare that allows them to distinguish between military targets, on the one hand, and civilians and civilian objects, on the other. They are similarly prohibited from deploying weapons or using methods of warfare whose effects cannot be controlled, as this would not allow them to make such a distinction.

The above-mentioned distinction also implies that disproportionate attacks are prohibited. IHL defines a disproportionate attack as an attack on a military target which may be expected to cause loss of civilian life, injury to civilians and/or damage to civilian objects that would be excessive in relation to the concrete and direct military advantage afforded by the attack. The relevant standard is that of a reasonable commander or combatant who weighs the expected collateral damage against the anticipated military advantage in good faith, based on information available at the time of the attack. A series of directly related attacks is regarded as a single attack in this context. However, it is prohibited to treat an area as a single military target if it only contains a few scattered military targets located within a concentration of civilians and civilian objects.

Attacks must always be planned and executed with the necessary continuous precaution in order to protect the civilian population, individual civilians and civilian objects as much as possible from damage and injury. This means that attackers must do their utmost to ensure that the person or object selected for attack actually constitutes a military target. Attacks must be executed in such a way that collateral damage and collateral casualties are kept to a minimum. Moreover, attackers must warn the civilian population prior to an attack, unless doing so would significantly undermine its success. Finally, attacks must be suspended or cancelled if they are likely to cause excessive collateral damage or collateral casualties.

II.5 Deployment of autonomous weapons for target selection and engagement in the context of international humanitarian law

One of the key questions in this advisory report concerns the ability of autonomous weapons to independently select and engage targets in accordance with IHL. Much of the debate concerning these weapons focuses on the question whether their deployment can comply with the IHL requirements of distinction, proportionality and precaution.

Distinction

As explained in section II.4, many factors are involved in deciding whether or not a person or object constitutes a legitimate target. In the foreseeable future, no weapon will be able to distinguish between a member of an organised armed group with a combat function, a non-fighting member and an ordinary civilian in a non-international armed conflict; or between a member of the armed forces participating in combat and a person who has been placed *hors de combat* as a result of injury, illness or surrender; or between a civilian participating directly in hostilities and a civilian firing a gun in the air during a wedding celebration. In the foreseeable future, autonomous weapons will almost certainly not be able to correctly apply the three criteria of direct participation in hostilities (a threshold of harm, a causal link between the act and the harm and a connection to one of the parties to an armed conflict) or determine how long a person who meets these criteria continues to constitute a legitimate target.[44] Likewise, many factors are involved in deciding whether or not an object constitutes a legitimate target. As noted in chapter I, however, existing autonomous weapons are able to distinguish between military targets and civilian objects under certain circumstances. This is because they are only able to select and engage certain types of enemy targets based on specific criteria.

Proportionality

The planning and execution of an attack against a military target in an environment where civilians are present always requires a proportionality assessment. The same applies to attacks that can reasonably be expected to affect civilians and civilian objects. A proportionality assessment comprises not only a quantitative estimate of the expected number of military and civilian casualties as a result of deploying a particular weapon but also an assessment as to whether this number is commensurate with the anticipated military advantage under the prevailing conditions. It is highly unlikely that autonomous weapons will be able to independently weigh military advantage against collateral damage within the next 10 years, at least not in most situations. This is because the act of assessing an anticipated military advantage is partly subjective and because each assessment is heavily dependent on the context in which the attack is carried out as well as on a whole range of factors that are liable to change rapidly. These are the kinds of situations in which human reasoning is more reliable than artificial intelligence.

Precaution

During the planning and execution of an attack, precautionary measures must be taken at all times to minimise – and if possible nullify – the effects of the attack on civilians and civilian objects. These measures include continuous verification of the target, the choice of weapon and the timing and method of the attack. Attacks must be suspended or cancelled if it becomes clear that they will have a disproportionate impact or if the target is not (or no longer) legitimate. Finally, where possible, civilian populations must be issued a warning prior to an attack. Within the next 10 years, autonomous weapons will not be able to perform such assessments independently (i.e. without human intervention) in the vast majority of cases, given that each assessment is highly context-dependent and susceptible to rapid and unpredictable change.

44 See: ICRC, *Interpretive Guidance on the Notion of Direct Participation in Hostilities under International Humanitarian Law,* ICRC, 2009, Section V: Constitutive Elements of Direct Participation in Hostilities, which sets down and explains these three criteria. Although some elements of this study have caused a certain amount of controversy, these three basic criteria are generally regarded as the starting point for assessing whether a specific act can be classified as direct participation. The criteria are context-specific and require a significant amount of insight into a range of factors that are difficult, or even impossible, to program in advance.

This proves that, as in the case of all other weapons, the potential deployment of autonomous weapons is subject to certain constraints. For example, there needs to be sufficient certainty that the intended target is of a military nature and that any attack in an area in which civilians are or may be present will not have a disproportionate impact on them. Likewise, the deployment of autonomous weapons cannot be justified if the impact on the civilian population cannot be quantified in advance. Finally, it can be risky to deploy autonomous weapons in unpredictable or rapidly changing situations, as this makes it difficult to comply with the requirements of IHL. At present, existing weapons with autonomous functions are therefore primarily deployed against military platforms such as military aircraft, warships and military vehicles in environments or situations in which there is little to no risk of collateral damage to civilians or civilian objects or inaccurate assessments. The deployment of defensive weapons with autonomous functions against enemy projectiles or missiles also raises few if any problems under IHL. The use of autonomous systems for the purpose of electronic warfare, reconnaissance, navigation, explosive ordnance disposal and other non-lethal tasks likewise raises no problems in this area. The same applies to weapon systems with a high degree of autonomy in non-lethal functions, such as take-off and landing.

The nature of modern conflicts also makes it harder to comply with the requirements of IHL. In practice, we are increasingly confronted by non-international conflicts without clearly defined geographical front lines, in which military targets are located in predominantly civilian areas and combatants deliberately do not distinguish themselves clearly from non-combatants.

It is clear from the above that humans will remain responsible for making assessments regarding distinction, proportionality and precaution for at least the next 10 years. The deployment of autonomous weapons will only be permitted in cases where it is almost certain that IHL will not be violated. Such weapons will not be able to independently apply IHL for at least the next 10 years. The AIV/CAVV believes that discussing whether autonomous weapons might be able to perform this task themselves one day is a hypothetical exercise. From a legal perspective, it makes no difference whether a target is selected and engaged by a human or an autonomous weapon; in both cases, this process must adhere to IHL rules. Even if autonomous weapons that are capable of independently applying IHL are developed in the future, the same legal requirements will continue to apply to their deployment. Fortunately, the targeting process – the wider loop – enables humans to perform the necessary assessments regarding IHL. This process, in which humans play a crucial role, consists of the following six steps: (1) end state and commander's objectives; (2) target development and prioritisation, (3) capabilities analysis; (4) commander's decision and force assignment; (5) mission planning and force execution; and (6) assessment. Annexe II indicates which requirements of IHL apply to the various steps of the process (the wider loop).

The involvement of humans in the deployment of autonomous weapons and anticipated long-term developments in this area are discussed in greater depth in chapter IV on meaningful human control.

III Accountability

III.1 Introduction

In its request for advice, the government asks whether the AIV/CAVV foresees any changes in the accountability mechanism for the use of autonomous or fully autonomous weapons in light of the associated ethical issues. Accountability can refer to political accountability or legal liability. The way in which political accountability for the use of force is enforced depends on the political system of the country in question and is unlikely to change as a result of the use of autonomous or fully autonomous weapons. This advisory report therefore does not address the issue of political accountability for the acquisition or deployment of such weapons.

This chapter examines the issue of accountability in connection with the development, deployment and decision-making concerning the use of weapons with critical autonomous functions. Section III.2 examines the potential accountability gap and argues that the deployment of autonomous weapon systems over the next 10 years will not necessarily lead to gaps in accountability mechanisms but rather to a shift in the attribution of accountability. Section III.3 then briefly discusses various concepts of liability under criminal law, while section III.4 examines the issue of state responsibility under national and international law.

III.2 A shift in accountability instead of an accountability gap

The claim that the deployment of autonomous weapon systems leads to an accountability gap is one of the reasons why NGOs such as the International Committee for Robot Arms Control (ICRAC) and Human Rights Watch advocate a total ban on the development, production and use of fully autonomous weapons.[45] These organisations argue that, if weapon systems autonomously select and engage targets, individuals can no longer be held responsible for potential mistakes or violations of IHL. As noted in chapter I of this advisory report, humans will remain in the wider loop for at least the next decade and will therefore continue to decide whether or not to deploy autonomous weapons in specific environments, where those weapons select and engage targets on the basis of pre-programmed criteria. Accountability can thus always be traced back to a human action, namely the decision to deploy. Chapter II points out that deploying autonomous weapons is unlawful under IHL if there is insufficient certainty that the core principles of distinction, proportionality and precaution will be satisfied. If the deployment of such weapons constitutes a violation of IHL, it follows that accountability does exist and that in the case of autonomous weapons the decision whether or not to use force has simply shifted to an earlier stage in the wider loop. In practice, accountability has been transferred to the commander who decides to deploy an autonomous weapon and – potentially – to the person who activates it.

This shift in accountability is therefore a reflection of the transition from autonomous weapon systems with a human in/on the loop to systems with a human out of the loop (the narrow loop). Since humans will remain in the wider loop during the 10-year period on which this report focuses, the AIV/CAVV believes we are seeing a shift in the attribution of accountability rather than an accountability gap.

45 Human Rights Watch, *Mind the Gap: The Lack of Accountability for Killer Robots,* April 2015.

Even after this 10-year period, a true accountability gap could only emerge in the case of weapon systems that place humans beyond the wider loop, i.e. systems that can autonomously adapt to dynamic environments and attack targets that have not been pre-programmed or anticipated by humans. As noted in chapter I, such systems are unlikely to be developed in the next few decades.

This is confirmed by the conclusion of chapter II, which states that humans must comply with IHL when deciding whether or not to deploy autonomous weapon systems. The basic norms of IHL strictly regulate the deployment of such systems, and any deployment that does not adhere to these norms is therefore unlawful.

As explained in greater depth in section III.3, a commander can therefore actually be held accountable for the reckless deployment of autonomous weapon systems resulting in violations of IHL. Factors such as the interval between the weapon's activation (i.e. the last moment at which distinction, proportionality and precaution can be considered) and the actual attack on a target, as well as the complex nature of autonomous weapons, give rise to a need for greater restraint in their deployment. In other words, these factors cannot be invoked to evade accountability by arguing that certain consequences were unforeseeable.

III.3 Forms of liability under criminal law

Discussing various scenarios, this section builds on the proposition advanced in the previous section that humans will remain ultimately responsible for deciding whether or not to deploy weapons for at least the next few decades, as well as on the above-mentioned shift in accountability within the wider loop.

Deliberate unlawful deployment of autonomous weapons
In situations where autonomous weapons are deployed for the specific purpose of violating the rules of IHL and committing international crimes, the political and military leaders involved can be held liable on the grounds of regular forms of accountability under national and international criminal law. In such situations, the specific programming of an autonomous weapon can be an important factor in proving intent. This scenario also covers situations in which autonomous weapons have been hacked, which may lead to the hackers being held liable under criminal law. However, it may not always be easy to prove such liability in practice.

Reckless deployment of autonomous weapons
A commander who decides to deploy autonomous weapons when he or she knows, or should have known, that doing so could result in the commission of war crimes can also be held individually liable under criminal law.

The scope of the standards of *dolus eventualis* (recklessness) and knowledge differs for each international crime, and every national criminal justice system has its own standards and interpretations. Dutch criminal law interprets the concept of recklessness as meaning that a commander can be held liable for a particular war crime if he or she knowingly accepts the substantial risk that his or her actions, in this case the deployment of a specific weapon in a particular environment, would result in said crime.

In this context, it is also worth referring to article 30 of the Rome Statute of the International Criminal Court, which reads as follows:

1. Unless otherwise provided, a person shall be criminally responsible and liable for punishment for a crime within the jurisdiction of the Court only if the material elements are committed with intent and knowledge.
2. For the purposes of this article, a person has intent where:
   (a) In relation to conduct, that person means to engage in the conduct;
   (b) In relation to a consequence, that person means to cause that consequence or is aware that it will occur in the ordinary course of events.
3. For the purposes of this article, 'knowledge' means awareness that a circumstance exists or a consequence will occur in the ordinary course of events. 'Know' and 'knowingly' shall be construed accordingly.

The key question is whether this article can be interpreted in such a way as to include *dolus eventualis* (recklessness), i.e. situations in which a commander does not deliberately set out to commit war crimes but nevertheless accepts the risk that his or her actions might have this outcome. The literature is divided on this issue, and the case law of the International Criminal Court (ICC) is also ambiguous.[46] However, according to prevailing scholarly opinion and the general orientation of the Court's case law, article 30 excludes *dolus eventualis*. If this were true, there would be an accountability gap.

However, this is a matter of interpretation, and it is possible in principle to explicitly accept the concept of *dolus eventualis* in the context of the ICC, following the example set by all national legal systems. In any case, it is worth noting that there is no such accountability gap at national level, as every national legal system has a version of *dolus eventualis* that establishes accountability in cases where intent is lacking but the crime itself was foreseeable. Here, too, the AIV/CAVV would point out that the intention to commit criminal acts (as described above in the section on the reckless deployment of autonomous weapons) is difficult to prove in practice but that the awareness that particular actions may give rise to certain consequences is easier to prove.

In practice, the criterion of foreseeability or acceptance of a substantial risk would be met, for example, if a commander were to deploy a particular autonomous weapon system in a situation other than the type of situation for which it was originally developed. In addition, a commander may be deemed to have accepted a substantial risk that the deployment of autonomous weapon systems might result in the commission of war crimes if they are operated by inadequately trained operators.[47]

In light of this logic and, more specifically, the application of the concept of recklessness, commanders are likely to act with restraint when using highly complex autonomous weapons. This is because it may be impossible to foresee how the weapon will respond

46 For an overview, see Elies van Sliedregt, *Individual Criminal Responsibility in International Law,* Oxford University Press, 2012, pp. 45-48. See also Concurring Opinion of Judge Christine Van den Wyngaert to the Ngudjolo Chui Judgment, Case no. ICC-01/04-02/12, 18 December 2012, paras. 36-38, which describes the conflicting interpretations of various ICC chambers on this issue.

47 This is similar to a finding of the Ethiopia-Eritrea Claims Commission (EECC), which held the state of Eritrea responsible for bombing Mekele airport in violation of article 57(2)(a)(ii) of the First Additional Protocol to the Geneva Conventions, on account of the use of 'utterly inexperienced' pilots. See EECC, Partial Award, Central Front, Ethiopia's Claim 2, 28 April 2004, RIAA, vol. XXVI, part V, as cited by Marco Roscini, *Cyber Operations and the Use of Force in International Law,* Oxford University Press, 2014, p. 235.

to the situation and circumstances in which it is deployed, which in turn may lead to accountability on the commander's part.[48]

Command responsibility

Studies on accountability and autonomous weapon systems often cite the doctrine of command responsibility as a basis for the accountability of military commanders and other superiors.

A military commander can be held responsible for crimes committed by subordinates (i) under his or her command or authority, if (ii) that military commander either knew or, owing to the circumstances at the time, should have known that the forces were committing or about to commit such crimes and (iii) that military commander or person failed to take all necessary and reasonable measures within his or her power to prevent or repress their commission or to submit the matter to the competent authorities for investigation and prosecution.

Accountability on the part of other individuals in a position of (civilian and political) responsibility may also arise in such circumstances, albeit under stricter conditions. This follows from article 28 of the Rome Statute of the International Criminal Court, as implemented in the International Crimes Act (*Wet internationale misdrijven,* WIM). A weapon system with autonomous critical functions cannot be regarded as a subordinate and a commander cannot be held responsible for actual attacks carried out by such systems on the basis of this construct.[49] The command responsibility doctrine is a mechanism that was developed to punish senior officers for failing to prevent or punish crimes committed by their subordinates. It is clearly designed for human-to-human relationships, given that, in a human-to-machine relationship, a 'superior' cannot be held responsible for failing to punish the machine.

However, in a situation in which a commander knew or should have known that a human under his or her command was using an autonomous weapon system to commit international crimes, the commander can be held responsible. Problems might arise in situations where the expertise of the operator(s) of the weapon significantly exceeds that of the commander. Here, too, it is important that the article 36 procedure be designed in such a way that commanders are able to accept and carry out their responsibilities in a proper and effective manner.

Unforeseeable unlawful action involving autonomous weapons

The final scenario concerns autonomous weapons that are programmed and deployed in accordance with existing rules of IHL but subsequently violate those rules, for example because the weapons have been hacked or because of technical failure. In fact, this scenario does not differ fundamentally from similar situations involving weapons without autonomous critical functions, although the risk of failure obviously increases with the development of increasingly complex weapon systems. That risk also increases as more systems are linked together, as this makes it impossible to verify whether operational certainty and foreseeability can be obtained through mathematical calculations. If there is a significant risk of technical failure, deployment of an autonomous weapon may qualify as an act of recklessness in the sense that the commander concerned

48 Roorda, op. cit., p. 14.

49 Human Rights Watch, op. cit., pp. 20-25.

has accepted a substantial risk that the weapon system will malfunction, resulting in a serious violation of IHL.

III.4 State responsibility

Accountability does not only relate to the possible commission of criminal acts by political or military leaders. States, too, can be held legally liable when autonomous weapons are deployed in an unlawful manner by state organs or individuals whose actions can be attributed to the state. At international level, such matters are governed by the doctrine of state responsibility.[50] At national level, states can be held liable in civil court under the wrongful act doctrine.

State responsibility under international law

State responsibility traditionally applies to relations between states. An affected state can invoke the responsibility of another state through diplomatic channels or, where available, a judicial process.

The duty of care plays a key role in state responsibility. States are obliged to take adequate steps to ensure that the deployment of autonomous weapons does not lead to potential or actual violations of international law. For example, they are obliged to make sure that such weapons are procured from reliable producers, that they are adequately tested prior to use and that commanders receive sufficient training and information on the functioning and risks of autonomous weapons. In fact, states must ensure that commanders have such a good understanding of a weapon's functioning that they are able to make judicious decisions concerning its deployment and correctly anticipate the implications of doing so. When states evade these obligations to make their best efforts, they can be held accountable under international law. In this regard, reference may be made, in particular, to article 36 of the First Additional Protocol to the Geneva Conventions, as previously discussed in chapter II.

Civil liability under national law

In practice, it will often be difficult for individual victims to legally challenge states. Civil proceedings at national level do not always provide relief for individual victims of state action. However, this is a general problem that goes beyond the potential deployment of autonomous weapons. Various questions arise, such as: What court has jurisdiction to examine claims for damages? Can states invoke immunity? How can a judicial decision in favour of a claimant be enforced? It is very difficult to answer such questions if the claimant and the defendant fall under different legal systems, which is likely to be the case in situations involving autonomous weapons.

50 Rule 149 of the ICRC's study on customary international law states the following: 'A State is responsible for violations of international humanitarian law attributable to it, including:
(a) violations committed by its organs, including its armed forces;
(b) violations committed by persons or entities it empowered to exercise elements of governmental authority;
(c) violations committed by persons or groups acting in fact on its instructions, or under its direction or control; and
(d) violations committed by private persons or groups which it acknowledges and adopts as its own conduct.'

IV Meaningful human control

IV.1 Definition

The concept of *meaningful human control* over weapons plays a key role in the debate on the acceptability of autonomous weapons. Despite the lack of an internationally agreed definition of the concept, supporters and opponents of increasing autonomy recognise that a certain degree of human control is instrumental to the public acceptance of weapon systems that autonomously select and engage targets. Under current practices regarding the use of force, humans are generally expected to exercise a certain amount of control over who or what is attacked (persons or objects) and when (timing and duration of the attack), where (location), why (reason for selection or attack) and how (process).[51] Human control can serve as a guarantee for the inclusion of ethical and legal considerations in the decision-making processes that precede the use of potentially lethal force. Moreover, it is only possible to attribute responsibility and accountability to individuals if humans have control over autonomous weapons. The concept of meaningful human control accordingly has implications for accountability, moral responsibility and controllability.[52] The issue of accountability was discussed in the previous chapter, and ethical and moral questions are examined in the next one. The present chapter aims to contribute to the international debate on the definition of the concept of meaningful human control.

Not all forms of human control are meaningful, effective or adequate. If such control merely implies that the operator of a weapon system has to press a button when it lights up, without receiving any other information, this definitely does not constitute meaningful human control.

This does not mean that humans always have access to all the necessary information. That would fly in the face of the long-accepted realities of warfare and the use of weapons. According to the International Committee for Robot Arms Control (ICRAC), a commander should nevertheless have 'full contextual and situational awareness of the target area and be able to perceive and react to any change or unanticipated situations that may have arisen since planning the attack.' In addition, 'there must be a means for the rapid suspension or abortion of the attack.'[53] Yet humans have been using weapons without having perfect, real-time situational awareness of the target or the target area since the invention of the catapult. The ability to adjust the flight path of a projectile or abort an attack has only existed since the introduction of modern, advanced weapons.[54]

51 Maya Brehm, Meaningful Human Control, presentation to the informal meeting of experts on lethal autonomous weapons systems of the Convention on Certain Conventional Weapons (CCW), Geneva, 14 April 2015.

52 Michael C. Horowitz and Paul Scharre, *Meaningful Human Control in Weapon Systems: A Primer,* Working Paper, Center for a New American Security, March 2015, p. 8.

53 Frank Sauer, ICRAC Statement on technical issues to the 2014 UN CCW Expert Meeting, 14 May 2014. See: <http://icrac.net/2014/05/icrac-statement-on-technical-issues-to-the-un-ccw-expert-meeting>.

54 Horowitz and Scharre, op. cit., p. 9.

With this in mind, should humans have control over all the functions of a weapon system or just the critical ones? Should they be required to authorise each individual attack? For Article 36, a British NGO and leading advocate of the concept of meaningful human control, what matters is human control over individual attacks.[55] The AIV/CAVV believes that any evaluation of meaningful human control should focus on the entire targeting process (the wider loop), since the human intent to use lethal force plays a vital role in this context.

In addition to *meaningful human control*, there are other concepts that can serve as a starting point for examining the legal and ethical aspects of deploying autonomous weapons, such as *judgment* and *predictability*.[56] Decisions and judgments are made at various stages during the design and procurement of autonomous weapons as well as during the targeting process. Judgment is therefore an essential element of meaningful human control. After all, what matters is that a human is responsible for judging whether or not the task of selecting and engaging targets can be delegated to an autonomous weapon in a given context. When a commander decides whether or not to deploy an autonomous weapon, it implies that he or she is judging whether or not to relinquish further direct control over the critical functions of target selection and engagement. Meaningful human control therefore always includes judgment, but the reverse is not true. Moreover, judgment implies supervision rather than control.

Predictability is another aspect of the concept of meaningful human control that manifests itself in various ways. The predictability of the behaviour of an autonomous weapon is very important for the commander who has to decide on its deployment and the soldier who must activate it, in the sense that they are able to foresee what *might* happen without being able to predict *precisely* what will happen. The predictability of the context in which the weapon is deployed is also an important factor. In environments where there are large numbers of civilians or civilian objects, there is a greater risk that they will suffer harm as a result of the expected or unexpected consequences of the weapon's deployment. The more predictable the weapon and the environment, the easier it becomes to accurately assess the potential advantages and disadvantages of deployment and activation. However, like *judgment*, the concept of *predictability* is more limited than *meaningful human control*.

The AIV/CAVV thus prefers the concept of meaningful human control to the concepts of judgment and predictability. International consensus also seems to be emerging on the usefulness of this concept as a criterion for distinguishing between acceptable and unacceptable types of autonomous weapons.[57] This is another reason to devote significant attention to this concept in the present advisory report.

55 Article 36, op. cit.

56 UNIDIR, 'The Weaponization of Increasingly Autonomous Technologies: Considering how Meaningful Human Control might move the discussion forward', *UNIDIR Resources*, no. 2, 2014, pp. 7-8.

57 Christof Heyns, Comments to the Informal Meeting of Experts on Lethal Autonomous Weapons: Convention on Conventional Weapons, 16 April 2015. See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/1869331AFF45728BC1257E2D0050EFE0/$file/2015_LAWS_MX_Heyns_Transcript.pdf>, (accessed on 10 July 2015).

International law and ethical considerations impose limits on the use of force. Humans are responsible for respecting those limits when deploying any type of weapons. Meaningful human control is meant to facilitate compliance with the requirements of distinction, proportionality and precaution. Whether or not these requirements are actually satisfied depends on those who are responsible for deciding whether to deploy an autonomous weapon.

IV.2 Components of meaningful human control

At the very least, meaningful human control comprises the following three components:[58]

- Humans make informed, conscious decisions about the use of weapons;
- Humans have sufficient information to ensure that force is used in accordance with the requirements of international law, given what they know about the target, the weapon, and the context in which the weapon is deployed;
- The weapon is designed and tested in a realistic operational environment, and humans are properly trained, to ensure that the weapon is deployed in a judicious manner.

The components are discussed in greater detail in the following sections. The AIV/CAVV endorses this approach.

Informed, conscious decisions
The decision to deploy an autonomous weapon must be made judiciously and on the basis of all necessary and relevant information. It may not be arbitrary, although in practice the person making the decision will rarely have access to all the information. Informed, conscious decisions do not require commanders or weapons operators to collect this information themselves. In practice, military personnel often rely on information provided by others. Moreover, the information used by commanders and operators of modern weapons when deciding whether or not to use force is often collected by sensors and processed by computers. In many cases, a pilot who fires a missile at an enemy aircraft does not actually see the aircraft. However, his instruments provide him or her with sufficient information to make a decision that complies with international law and ethical principles.

As explained in previous chapters, it is always necessary to consider whether deploying a weapon is justified in a given context. This applies to all types of weapons, not just the autonomous kind. However, because autonomous weapons are able to independently select and engage targets on the basis of pre-programmed criteria, this changes the nature of the interaction between human and machine. Commanders are not able to monitor attacks on individual targets as closely and are therefore required to determine in advance whether the actions of an autonomous weapon will remain within the boundaries of international law in a given situation.

Sufficient information: target, weapon and context
In order to determine whether the deployment of autonomous weapon is in accordance with the requirements of international law, information on the target, the weapon and the context is required. Chapter II discussed the legal regimes that determine what constitutes a legitimate military target. Prior to the decision to deploy an autonomous

58 Horowitz and Scharre, op. cit., p. 4.

weapon, it must be clear that the attack will focus on legitimate military targets and that any collateral damage will be proportionate. Observation in the field by military personnel is an important tool in this regard. Military personnel must know how predictable and reliable a weapon is in the specific situation they are faced with, what technical and other limitations it has, what environments it is suited to, and so forth. This is because it is up to them to determine whether deployment in a given situation will comply with the requirements of distinction, proportionality and precaution. In addition, they must be familiar with the context, in particular whether there are civilians or civilian objects in the deployment area. They must understand how an autonomous weapon might affect the specific environment in which it is to be deployed in order to assess its potential impact. Compared to weapons without autonomous critical functions, this requires more detailed information and knowledge.

All this is very important for commanders who are responsible for deciding whether or not to deploy autonomous weapons. Not only must they know whether deployment will comply with the requirements of IHL (see chapter II) and relevant ethical standards, but they are also personally accountable (see section III.3).

When deploying autonomous weapons, the risk of civilian casualties must be kept as low as possible. According to the NGO Article 36, that risk increases and human control over the consequences of deployment decreases when an autonomous weapon: (1) operates for a longer period; (2) operates in a wider geographical area; (3) uses broader target parameters; and (4) is used in an area where there are a greater number of persons and objects that potentially match those parameters. The weapon system's target parameters and algorithms are meant to ensure that only the correct target is attacked. However, if a weapon system that targets vehicles on the basis of infrared emissions and shape is deployed in a populated area, it might also attack a civilian object, such as a school bus.[59]

Weapon design, testing and training

The design of autonomous weapons must take account of all interactions between humans and machines. Man and machine together constitute a system. In part on ethical grounds, it is important to consider during the design phase which of the system's functions will be autonomous. The key issue here is the division of responsibility between man and machine. Professor Jeroen van den Hoven, Dr Phil Robichaud and Dr Filippo Santoni de Sio of the Delft University of Technology highlight the importance of morally responsible engineering and note that allocating responsibility is an important aspect of the design process.[60] After all, if a prolonged, complex mission involving several different people produces an undesirable outcome, such as a violation of IHL, it can be difficult to retroactively ascertain who was responsible. The Canadian engineer and philosopher Jason Millar refers to research indicating that seemingly unimportant situational factors, such as ambient noise or the cleanliness of the work environment, can significantly impair the ability of humans to make consistent ethical decisions. He advocates further research into whether and how the design of autonomous weapons (in particular the interface

59 Article 36, *Killing By Machine: Key Issues for Understanding Meaningful Human Control,* April 2015.

60 Jeroen van den Hoven, Phil Robichaud and Filippo Santoni de Sio, *Why the Future Needs Us Today: Moral Responsibility and Engineering Autonomous Weapon Systems,* presentation to the CCW Meeting of Experts on Lethal Autonomous Weapon Systems, 2015. See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/89116E298AE593C2C1257E2A00413D61/$file/2015_LAWS_MX_VanDenHoven.pdf>, (accessed on 19 June 2015).

between man and machine) can help strengthen or undermine ethical decision-making by humans.[61]

A weapon system must be designed in such a way that humans are presented with relevant information in a prompt and organised manner during those stages of the targeting process in which they are obliged to make decisions. The philosopher Peter Asaro regards this as the essence of meaningful human control. He argues that it is not enough for humans to be involved in decision-making concerning the use of lethal force. They must also be allowed enough time to think, be well trained and informed and be accountable.[62]

Procedures for assessing the compatibility of autonomous weapons with article 36 of the First Additional Protocol to the Geneva Conventions should also examine whether the degree to which human control has been incorporated into the design of a weapon offers adequate guarantees of compliance with international law. Autonomous weapons need to be thoroughly tested in realistic environments. Tests carried out by manufacturers and potential buyers must indicate how the weapon behaves under various conditions and what risks are associated with its deployment. These tests can produce valuable information for commanders who are responsible for deciding whether or not to deploy autonomous weapons.

If international law is violated as a result of the deployment of an autonomous weapon, somebody will be deemed accountable. This makes sense, because humans make decisions during the targeting process, for example concerning the parameters for deployment or the actual deployment itself. The question is whether these individuals have committed culpable acts. Research on this issue presupposes that it is clear who made each decision. However, Professor Philip Alston, who was UN Special Rapporteur on extrajudicial, summary or arbitrary executions from 2004 until 2010, notes that existing unmanned weapons are not designed to support the retroactive investigation of unlawful acts, since they do not store information. To ensure states can be held to account for the use of lethal force, every unmanned system, regardless of its degree of autonomy, should be designed to facilitate the investigation of unlawful acts. Autonomous weapons can be fitted with an instrument that records data and sends it to a database, thus facilitating the retroactive investigation of the causes of any failures and violations of international law.[63]

Commanders and operators must be sufficiently well trained to be able to determine whether the deployment of an autonomous weapon complies with the requirements of distinction, proportionality and precaution. When new weapons are procured, military personnel not only have to be trained in their use but also need to gain an understanding

61 Jason Millar, Expert testimony to the Informal Meeting of Experts on Lethal Autonomous Weapon Systems, Geneva, 15 April 2015. See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/F483D421E67D230FC1257E2F0033E690/$file/Jason+Millar+-+Meaningful+Human+Control+and+Dual-Use+Technology.pdf>, (accessed on 26 June 2015).

62 Peter Asaro, 'On banning autonomous weapon systems: human rights, automation, and the dehumanization of lethal decision-making', *International Review of the Red Cross,* vol. 94, no. 886, Summer 2012, p. 695.

63 Philip Alston, 'Lethal Robotic Technologies: The Implications for Human Rights and International Humanitarian Law', *Journal of Law, Information & Science,* vol. 21, issue 2, 2012, p. 52.

of how they function and in what situations and under what conditions they can be deployed within the boundaries set by international law. Ethical instruction is an essential aspect of the training of military personnel at all levels.

IV.3 Meaningful human control during the targeting process

Meaningful human control becomes significant at various stages of the targeting process (see also the table on the targeting process and IHL in annexe II). This is because there are various moments at which humans make decisions concerning the use of force and the relevant parameters, for example when adopting rules of engagement, deciding to deploy an autonomous weapon or programming target categories. When an autonomous weapon is deployed, it is given the task of selecting and engaging targets according to pre-programmed criteria. The fact that decisions concerning the use of force are made at various moments implies that several people can usually be held accountable for those decisions. For example, as noted in chapter III, a commander who decides to deploy an autonomous weapon and the operator who activates it can both be held accountable. Commanders can also be held accountable for violations of IHL by their subordinates if it can be demonstrated that they failed to properly supervise them.

Various decisions that are made during the targeting process can reduce the risks associated with the deployment of an autonomous weapon,[64] in particular decisions concerning the weapon's specific autonomous tasks, its operational environment, the duration of its deployment and its geographical range and mobility. For instance, the weapon's tasks may be offensive or defensive, and the category of potential targets may be more or less strictly defined. The environment may be predictable or dynamic and complex, as in the case of a city. It also makes a difference whether the weapon is mounted in a fixed location, for example on a ship, or capable of independent movement. In the latter case, the weapon's geographical range may be limited or extensive. The more limited a weapon's tasks, the less dynamic its operational environment, the shorter the duration of its deployment and the more restricted its mobility, the more predictable the effects of its deployment are likely to be. In such situations, human control is more pronounced. In contrast, a more complex weapon that travels through rapidly changing environments for longer periods of time carries with it a greater risk of unexpected or unpredictable outcomes. In such situations, it is harder to exercise human control.

After an attack has been carried out, it is important to establish its effect. Has the objective been achieved? This is the final stage of the targeting process. Providing this kind of feedback to a command centre where people track the performance of autonomous weapons is instrumental to strengthening meaningful human control.

IV.4 The (distant) future

As noted in chapter I, technological developments may give rise in the long term to artificial general intelligence (which is on a par with human intelligence) and artificial superintelligence (which surpasses human intelligence). Humans are unable to comprehend the capabilities of a superintelligent machine or the implications of its actions for humans. The field of artificial intelligence is advancing rapidly, and it is conceivable

64 Neil Davison, *Characteristics of Autonomous Weapon Systems*, CCW Meeting of Experts, 14 April 2015. See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/37D5012BBF52C7BBC1257E2700599465/$file/Characteristics+of+AWS+ICRC+speaking+points+14+Apr+2015.pdf>, (accessed on 19 May 2015).

that in the future autonomous weapons will be able to learn independently and modify their own rules of conduct based on their 'experiences'.[65] If humans can no longer predict how an autonomous weapon will behave, meaningful human control will cease to exist. After all, such control can only exist if humans are able to anticipate how an autonomous weapon will behave in a particular situation and if they are able to retroactively explain its behaviour based on their knowledge of how it functions. If it becomes impossible to predict how an autonomous weapon will behave, it is debatable whether a commander can still make a judicious decision concerning its deployment, as he or she cannot be certain that IHL will not be violated.

Experts such as Armin Krishnan (Assistant Professor for Security Studies at East Carolina University),[66] Kenneth Anderson (Professor of Law at American University's Washington College of Law) and Matthew Waxman (Professor of Law at Columbia Law School) note that technological developments in the field of autonomous systems are incremental. They also consider it likely that human involvement in the selection and engagement of targets will gradually erode as a result of developments in weapons technology.[67] The AIV/CAVV does not rule out the possibility that, in the long term, meaningful human control will be partially or largely wiped out by technological advances (particularly in the field of artificial intelligence). This could happen if autonomous weapons acquire the capacity to learn and independently modify pre-programmed rules of conduct, for example in response to experiences or changes in their environment. Another scenario involves the full or partial transfer of the command-and-control function to computers, which could *accidentally* activate autonomous weapons. Finally, the increasing complexity of autonomous systems could ultimately lead to a partial or near-complete loss of human control. If this happens, it is impossible to predict whether technology will find ways to guarantee that autonomous weapons continue to function in accordance with international legal norms and ethical principles.

As noted in chapter I, the AIV/CAVV considers it unlikely that fully autonomous weapons that are *designed* to function without any human control will be developed within the next few decades. If that were to happen, these weapons would be programmed to perform the entire targeting process autonomously, from formulating the military objective to determining the time and place of deployment. Setting aside the question of technological feasibility, the AIV/CAVV considers it unlikely that any state would want to develop or commission such a weapon.

Legislation?

The AIV/CAVV believes that there is currently no need for new or supplementary legislation on meaningful human control. The concept, which should be regarded as a standard deriving from existing legislation and practices (such as the targeting process), does not need to become a new norm within international law. However, it can serve as a

65 'Rise of the machines', in The Economist, 9 May 2015, pp. 17-20.

66 Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons,* 2009. See: also Alex Leveringhaus and Gianni Giacca, *Robo-Wars: The Regulation of Robotic Weapons,* Oxford Martin Policy Paper, 2014.

67 Kenneth Anderson and Matthew Waxman, *Law and Ethics for Autonomous Weapon Systems: Why a Ban Won't Work and How the Laws of War Can,* 2013, p. 19. See: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2250126>, (accessed on 19 June 2015).

benchmark for assessing compatibility with article 36 of the First Additional Protocol to the Geneva Conventions. In addition, as previously noted, it can serve as a point of reference for the design of autonomous weapon systems and plays a crucial role in their actual deployment.

An interpretative guide could clarify the current legal landscape with regard to the deployment of autonomous weapons. The publication of such a document might also promote consensus on the concept of meaningful human control. For example, it could list best practices – classification levels of national systems and procedures permitting – on such issues as the role of meaningful human control in the article 36 procedure and in relation to the deployment of autonomous weapons. Such a guide, which would be informative and educational, could conceivably be produced within the framework of the Convention on Certain Conventional Weapons (CCW).

V Ethics and autonomous weapons

National and international law are based on ethical principles, which are broader in scope than the law. Just because the law permits a certain act does not mean that it is appropriate in every case. Moreover, the law does not provide for every conceivable situation. Where there are gaps in the law, it is possible to fall back on ethical principles in order to reach a decision.

Human dignity is an ethical principle that features in the debate on autonomous weapons, as it forms the cornerstone of human rights and IHL. It is mentioned in the preambles of the UN Charter, the Universal Declaration of Human Rights, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights. The last two identify human dignity as the source of human rights. It is also mentioned in the constitutions of various countries. For example, article 1, paragraph 1 of the German Constitution (Basic Law for the Federal Republic of Germany) states that human dignity is inviolable and instructs the state to protect it.[68] The principle is also reflected in IHL, which aims to balance military necessity against the protection of human dignity.

In his report to the Human Rights Council of 9 April 2013, the UN Special Rapporteur on extrajudicial, summary or arbitrary executions, Professor Christof Heyns, asks whether human dignity is violated when people are killed by machines. Various NGOs, such as those united in the Campaign to Stop Killer Robots, believe that a moral line is crossed when machines are allowed to make life-and-death decisions. Heyns asks whether it is not inherently wrong to let autonomous machines decide who and when to kill, even if they operate within the boundaries of international law and are proven to produce fewer casualties than humans. If it is inherently wrong, he argues, no other consideration can justify the deployment of autonomous weapons.[69] In the same report, Heyns also calls for a moratorium and advises the UN High Commissioner for Human Rights to convene a multidisciplinary panel to take stock of technological advances in the field of autonomous weapons and evaluate the relevant legal, ethical and policy issues, among other tasks.[70] The Human Rights Council welcomed the report.[71] Since then, the debate on autonomous weapons at the UN has mainly been conducted within the framework of the CCW. NATO is also devoting attention to this issue.[72]

68 Article 1, paragraph 1 reads: *'Die Würde des Menschen ist unantastbar. Sie zu achten und zu schützen ist Verpflichtung aller staatlichen Gewalt.'* [Human dignity shall be inviolable. To respect and protect it shall be the duty of all state authority. Translation from <https://www.bundestag.de/blob/284870/ce0d03414872b427e57fccb703634dcd/basic_law-data.pdf>.

69 Report of the Special Rapporteur, op. cit., paras. 92-93.

70 Ibid., para. 114.

71 Mandate of the Special Rapporteur on extrajudicial, summary or arbitrary executions, A/HRC/RES/26/12, 11 July 2014, para. 5.

72 See, for example: Andrew P. Williams and Paul D. Scharre, eds., *Autonomous Systems: Issues for Defence Policymakers,* NATO Headquarters Supreme Allied Commander Transformation, Norfolk, VA, United States, October 2015.

Heyns believes that human dignity is at risk when there is no meaningful human control over the use of force. During the CCW's informal meeting of experts on lethal autonomous weapon in April 2015, he highlighted the importance of meaningful human control over the use of lethal and non-lethal force in armed conflict and law enforcement.[73] IHL determines whether or not an attack is lawful, but according to Heyns the law relies on the assumption that it is a human making the decision whether or not to carry out a legitimate attack. In his opinion, the possibility that machines may one day be able to comply with the standards of IHL better than humans is not a sufficient reason to surrender decision-making to them (without human intervention). He further believes that the issue of human dignity arises when humans are no longer involved in making life-and-death decisions. Heyns is therefore opposed to fully autonomous weapons – weapons lacking meaningful human control – even if their deployment could save lives.[74] In addition, he notes that it is difficult to assign accountability in the absence of meaningful human control and that this constitutes a further violation of the right to life. He also refers to the argument that, when an autonomous weapon is deployed in a clearly defined and pre-programmed geographical area (for a limited period of time), the assessment of military necessity and proportionality has been carried out by the person who programmed the weapon and that this constitutes a form of human control. Heyns sees this as a potentially useful interpretation of the concept of meaningful human control. He therefore believes that it is important to develop the concept further and that the ongoing debate on this issue within the CCW can play a key role in this regard.[75]

Chapter II discussed the Martens Clause, which refers to principles of international law deriving from established custom, the principles of humanity and the dictates of public conscience in situations not covered by international agreements. Although there is no generally accepted interpretation of the clause,[76] it was referred to in the formulation of the prohibitions on poison gas, blinding laser weapons and anti-personnel mines. One way of interpreting the clause is that the absence of a legal prohibition does not imply that something is permitted.[77] After all, ethical principles that are not – or not yet – reflected in the law still carry a certain amount of weight. However, the notion of public conscience referred to in the clause is difficult to define, since it depends in part on the cultural and legal context and the relevant value systems.[78] It may be possible to deduce certain aspects of public conscience from public opinion, the concerns of international movements or the articulation of specific principles, such as meaningful human control.[79]

73 Heyns, op. cit., p. 2.

74 Ibid., p. 9.

75 Ibid., p. 2.

76 Rupert Ticehurst, 'The Martens Clause and the Laws of Armed Conflict', *International Review of the Red Cross*, no. 317, April 1997.

77 UNIDIR, 'The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values', *UNIDIR Resources*, no. 3, Geneva, 2015, p. 6.

78 In animistic cultures, such as Japan, inanimate objects are also regarded as having a soul.

79 UNIDIR, 'The Weaponization of Increasingly Autonomous Technologies: Considering Ethics and Social Values', pp. 6-7.

During the CCW's informal meeting of experts in April 2015, several speakers referred to the problem of measuring public opinion in a reliable manner.[80] Given the lack of agreement on its interpretation, it is difficult to apply the Martens Clause to the debate on autonomous weapons.

In the context of the debate on ethics and autonomous weapons, Professor Ronald Arkin of the Georgia Institute of Technology's College of Computing argues that in the future it will be possible to imbue autonomous weapons with an ethical awareness that enables them to function in accordance with international law and ethical principles. In this scenario, a built-in 'ethical governor' could prevent autonomous weapon systems from executing human decisions if doing so would result in a violation of IHL.[81] Arkin acknowledges that ethically programmed fully autonomous weapons will not be perfectly ethical on the battlefield but still believes that they can perform more ethically than humans.[82] He even believes that in the future autonomous weapons can be expected to comply with IHL more effectively than humans. He presents several arguments in support of this position, including that autonomous weapons do not need to kill or injure enemy combatants in self-defence, that they can be equipped with sensors that function better than human senses, that they do not experience emotions (such as vengeance or anger) and that they are able to process more information at a faster pace than humans. Moreover, it appears that human soldiers do not always adhere to the norms of international law in practice.

Human Rights Watch notes that, in contrast to machines, humans possess positive emotions, such as compassion and empathy, as well as negative ones. Rosa Brooks, a professor at the Georgetown University Law Center, subscribes to this view but also points to mankind's remarkable propensity for violence and cruelty. 'Every year, more than half a million people around the globe die as a result of intentional violence. […] In the United States alone, more than 16,000 are murdered each year, and another million-plus are the victims of other violent crimes.' According to Brooks, 'Humans, not robots, came up with such ingenious ideas as torture and death by crucifixion. Humans, not robots, came up with the bright idea of firebombing Dresden and Tokyo; humans, not robots, planned the Holocaust and the Rwandan genocide.' She also notes that well-programmed armed robots may be capable of behaving more humanely than humans.[83]

The AIV/CAVV believes that society will have to come to decisions on ethical issues relating to autonomous civilian systems before autonomous weapons are widely adopted. As a rule, civilian technologies develop much more rapidly than military applications.

80 See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/75FA2FB4CB45C2BAC1257E290054DF92/$file/Horowitz+CCW+Presentation+Public+Final.pdf> and <http://www.unog.ch/80256EDD006B8954/(httpAssets)/2B52D16262272AE2C1257E2900419C50/$file/24+Patrick+Lin_Patrick+SS.pdf>.

81 Ronald C. Arkin, 'The Case for Ethical Autonomy in Unmanned Systems', *Journal of Military Ethics,* vol. 9, issue 4, 2010, pp. 332-341.

82 Ronald C. Arkin, Governing Lethal Behavior: Embedding Ethics in *a Hybrid Deliberative/Reactive Robot Architecture,* 2011, pp. 6-9. See: <http://www.cc.gatech.edu/ai/robot-lab/online-publications/formalizationv35.pdf>, (accessed on 26 June 2015).

83 Rosa Brooks, 'In Defense of Killer Robots', *Foreign Policy*, 18 May 2015.

Experiments involving driverless cars and care robots are already taking place. At some point in the future, traffic accidents involving driverless cars are likely to result in fatalities. Will society accept that driverless cars cause accidents and fatalities, just like humans, or will they not be allowed to make mistakes? What action should a driverless car take if all options will result in casualties? What ethical choices need to be programmed into the system? Spelling out these choices is likely to provoke a lot of discussion. Over the next few years, the public debate on such ethical issues will therefore be driven mainly by the roll-out of autonomous civilian systems. The AIV/CAVV believes that a discussion on the ethical aspects of incorporating autonomy in both civilian and military applications is urgently needed.

The AIV/CAVV believes that as long as the deployment of autonomous weapons is subject to meaningful human control, ethical issues will not give rise to any serious problems. Within the wider loop, humans are responsible for making a balanced decision to deploy autonomous weapons for the purpose of eliminating enemy units and objects. The use of potentially lethal force is intentional in such cases, even if the targets are selected and attacked by autonomous weapons. Deploying autonomous weapons with meaningful human control can even help prevent or limit civilian casualties. The AIV/CAVV believes that such weapons should not be used if humans no longer have meaningful control over them.

VI A moratorium?

The position of the UN Special Rapporteur on extrajudicial, summary or arbitrary executions, Christof Heyns, was discussed at length in the previous chapter. In April 2013, he called for a moratorium on 'at least the testing, production, assembly, transfer, acquisition, deployment and use of LARs [lethal autonomous robots] until such time as an internationally agreed upon framework on the future of LARs has been established'.[84] During the CCW's informal meeting of experts in April 2015, he highlighted the importance of meaningful human control: 'Especially significant is what appears to be an emerging consensus that the notion of meaningful human control presents a guide to distinguish acceptable forms of autonomous force release.' In the conclusion of his statement, Heyns also focused on meaningful human control: '[I]t seems to me that we are getting closer to an answer to the question how to deal with AWS [autonomous weapon systems]: As long as they are good tools, in the sense that humans exercise meaningful control over them, they can and should be used in an armed conflict situation. There is significantly less room for their use in law enforcement, where it will be difficult to outperform human beings. If they are no longer tools in the hands of humans, they should not be used.'[85]

Several NGOs, such as the Campaign to Stop Killer Robots, support Heyns' call for a moratorium but favour a preventive ban on autonomous weapons.[86] In an open letter published on 28 July 2015, over a thousand scientists and entrepreneurs called for a ban on offensive autonomous weapon systems that are beyond meaningful human control: 'In summary, we believe that AI has great potential to benefit humanity in many ways, and that the goal of the field should be to do so. Starting a military AI arms race is a bad idea, and should be prevented by a ban on offensive autonomous weapons beyond meaningful human control.'[87]

In its statement to the CCW's informal meeting of experts on 13 April 2015, the International Committee of the Red Cross (ICRC) noted as follows: 'We first wish to recall that the ICRC is not at this time calling for a ban, nor a moratorium on "autonomous weapon systems".' However, it did urge states to 'consider the fundamental legal and ethical issues raised by autonomy in the "critical functions" of weapon systems before these weapons are further developed or deployed in armed conflicts'. In addition, it emphasised that its 'thinking about this complex subject continues to evolve as [it gains] a better understanding of current and potential technological capabilities, of the military purposes of autonomy in weapons, and of the resulting legal and ethical issues raised'.[88] The government's question concerning the

84 Report of the Special Rapporteur, op. cit., paras. 109 and 113.

85 Heyns, op. cit.

86 ICRAC Closing Statement to the CCW Informal Meeting of Experts at the United Nations in Geneva. See: <http://www.unog.ch/80256EDD006B8954/(httpAssets)/62045282E84824EFC1257E2D004BF2B7/$file/2015_LAWS_MX_ICRAC_WA.pdf>.

87 See: <http://futureoflife.org/AI/open_letter_autonomous_weapons>.

88 Statement of the International Committee of the Red Cross (ICRC), CCW Meeting of Experts on Lethal Autonomous Weapon Systems, 13 April 2015.

AIV/CAVV's views on the UN Special Rapporteur's call for a moratorium touches on two key issues – the expediency and feasibility of a moratorium – which are discussed in detail in the following sections.

VI.1 Is a moratorium expedient?

Chapter II discussed the current legal framework for the use of weapons. Any deployment of autonomous weapons must comply with the conditions stipulated by this framework, including the grounds on which a weapon may be banned and the requirements that its deployment must satisfy. Chapter II also explained that autonomous weapons do not by definition fall under any of the existing categories of prohibited weapons: those that are inherently unable to distinguish between military and other targets, those that cause unnecessary suffering or excessive injury and those whose effects cannot be controlled. Every type of autonomous weapon must be assessed to determine whether it falls into one of these categories. In contrast, in the case of future autonomous weapons, it may only become apparent from certain tests, such as the article 36 procedure, whether they should be prohibited or their use regulated. This procedure can also shed light on the circumstances under which autonomous weapons can be deployed in accordance with the requirements of IHL (distinction, proportionality and precaution).

Over the next 10 years and, in all likelihood, the next few decades, autonomous weapons will be designed that require humans to remain responsible for making decisions within the wider loop, in order to ensure that the deployment of those weapons does not violate existing legislation. These weapons are likely to be designed in a way that allows such human-machine interaction, and therefore meaningful human control, ensuring that they can be deployed in a lawful and legitimate manner.

One of the arguments in favour of a moratorium or ban on autonomous or fully autonomous weapons is that they may not be able to comply with IHL without human intervention.[89] In fact, it is unlikely that any weapon developed over the next 10 years, or even the next few decades, will have this capability. The key issue is therefore that those responsible for deploying or activating such a weapon – that is to say, humans – must assess whether its use is justified in the relevant circumstances, as in the case of all other weapons. Commanders and operators of autonomous weapons must decide whether deployment is proportionate and whether adequate precautions have been taken. The wider loop provides sufficient opportunity to exercise human control, thus facilitating compliance with IHL. This human control can be translated into liability under criminal law, which ensures that there is no accountability gap.

Over the next 10 years, autonomous weapons will probably not fall under any of the existing categories of prohibited weapons simply because of their autonomous nature, which means their use can and must comply with the existing legal framework and the relevant ethical principles (as recognised and enshrined in the applicable law and rules of engagement). There is no reason to assume that current or future technologies will be unlawful or unethical at any point during the next decade. Their use could obviously be either, but this applies to all weapons. Nevertheless, as noted in previous chapters, the possibility cannot be ruled out that, in the long term, meaningful human control will be partially or largely wiped out by technological advances (particularly in the field of artificial intelligence and as a result of increasing complexity). This also depends on the possibility

89 Report of the Special Rapporteur, op. cit., para. 109.

of increasing human control over autonomous weapons through technological or other means, for example by introducing fail-safe mechanisms to limit the effects of unintended actions of autonomous weapons.

Technological development is a process that constantly advances by small steps or large leaps. Heyns cites Anderson and Waxman, who argue that the incremental nature of the process makes regulation difficult.[90] It is hard to draw a clear distinction between permitted and prohibited technologies. On the other hand, Heyns notes that 'technology creep' may imperceptibly lead to a situation that endangers human values and international security. He therefore concludes that it is 'essential for the international community to take stock of the current state of affairs, […] establish a responsible process to address the situation and where necessary regulate the technology as it develops'.[91]

Max Louwerse (Professor of Cognitive Psychology and Artificial Intelligence at Tilburg University) believes that it is important to continue investing in research in the field of autonomous weapons. In order to keep track of all the ethical, legal, technological and policy issues associated with autonomous weapon systems, a thorough understanding of these systems and their development is crucial.[92] The AIV/CAVV agrees with this position. Moreover, research into dual-use technologies has many important civilian applications as well as legitimate military ones, as noted in previous chapters.

VI.2 Is a moratorium feasible?

The AIV/CAVV believes that there are various practical objections to a moratorium or a ban. Much of the relevant technology is being developed in the civilian sector and has both civilian and military (dual-use) applications. It is difficult to assess the lawfulness of these developments when the software for autonomous systems is still in development and the technology in question still has dual-use applications (rather than focusing exclusively on autonomous weapons). Ultimately, it is about combining dual-use software with certain hardware components for the purpose of creating autonomous weapons. In addition, as noted in the foreword to this report, there is no international consensus on the definition of the relevant concepts. The question thus becomes: a moratorium on what?

Michael Schmitt (Professor of International Law at the United States Naval War College) believes that until their military capabilities and potential humanitarian consequences are better understood, states will not be willing to ban autonomous weapons.[93] During the CCW's informal meeting of experts in April 2015, it actually became apparent that there was no support among states for a moratorium or a ban. As far as is known, only five countries (Cuba, Ecuador, Egypt, the Holy See and Pakistan) indicated that they would

90 Ibid., para. 48.

91 Ibid., para. 49.

92 Interview with Max Louwerse, Professor of Cognitive Psychology and Artificial Intelligence, Tilburg University, 6 July 2015.

93 Michael N. Schmitt, *Autonomous Weapon Systems and International Humanitarian Law: A Reply to the Critics,* 2012, p. 36. See: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2184826>, (accessed on 13 July 2015).

support such an initiative.[94] A treaty establishing a moratorium or a ban is not viable without widespread support. Another complicating factor is that autonomous systems consist of software and hardware. The proliferation of these two technologies is almost impossible to prevent, because they are freely available for civilian applications. A non-proliferation regime would therefore be unfeasible, as is clear from the existing nuclear non-proliferation regime.

The current nuclear non-proliferation regime is made up of multilateral and regional treaties, export-control regimes and several codes of conduct. Key multilateral treaties include the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the 1996 Comprehensive Nuclear-Test-Ban Treaty (CTBT), which has not yet entered into force. An example of a code of conduct is the Hague Code of Conduct against Ballistic Missile Proliferation (HCOC), which calls for restraint in the production, testing and export of ballistic missiles. The NPT distinguishes between states that have nuclear weapons (haves) and those that do not (have-nots). Without creating obstacles to the peaceful use of nuclear energy, the have-nots undertake not to develop nuclear weapons, while the haves reciprocally undertake to reduce their nuclear arsenals. The International Atomic Energy Agency (IAEA) monitors compliance with these agreements. The CTBT, for its part, encompasses a ban on explosive nuclear testing.

However, there are key differences between nuclear weapons and autonomous weapons that would render a non-proliferation regime for autonomous weapons almost unfeasible. For example, it is impossible in practice to distinguish between autonomous haves and have-nots, as autonomous technologies are also used in the civilian sector. A non-proliferation regime for autonomous weapons would also be hard to enforce, as it would be difficult to establish the existence of such 'weapons' in the case of dual-use technology and readily available programming languages, in contrast to plutonium or uranium. This would require a stringent inspection and verification regime. It is debatable whether many countries would welcome such a regime, which would cover military and civilian companies and severely encroach on state sovereignty. Moreover, countries would not be able to trust that other countries were respecting the relevant agreements.

For these reasons, the AIV/CAVV currently regards a moratorium as inexpedient and unfeasible. However, it cannot rule out that developments in the field of artificial intelligence and robotics might necessitate revision of this position in the future. It is therefore important to closely monitor such developments and ensure that the government actively participates in international discussions on the legal, ethical, technological and policy implications of autonomous weapons (especially within the CCW, but also within NATO).

94 For the speeches of the delegations, see: <http://www.unog.ch/80256EE600585943/(httpPages)/6CE049BE22EC75A2C1257C8D00513E26?OpenDocument>, (accessed on 27 August 2015).

VII Summary, conclusions and recommendations

VII.1 Summary and conclusions

Definition
Autonomy has been a feature of offensive weapons (e.g. fire-and-forget missiles) and defensive weapons (such as Patriot surface-to-air missiles) for decades. As yet, however, there is no internationally agreed definition of an autonomous weapon. Any workable definition will have to make a clear distinction between existing weapons with autonomous functions and future autonomous weapons.

For the purpose of this report, an autonomous weapon is defined as:

A weapon that, without human intervention, selects and attacks targets matching certain predefined characteristics, following a human decision to deploy the weapon on the understanding that an attack, once launched, cannot be stopped by human intervention.

The person operating the weapon does not know which specific target will be attacked, but the type of target is pre-programmed. A weapon is only autonomous if the critical functions for using potentially lethal force – namely 'target selection' and 'target engagement' – are performed autonomously, keeping humans out of the loop. The term 'loop' refers to the decision-making process for selecting and attacking targets. This may cover only the critical processes (target selection and engagement) carried out autonomously by the weapon (the narrow loop) or the entire targeting process in which humans play a decisive role (the *wider* loop). At present, there are only a few weapon systems that leave humans out of the *narrow* loop. These include the Israeli Harpy unmanned combat aerial vehicle, which is designed to attack enemy radar systems.

The AIV/CAVV believes that the term 'loop' should be interpreted in its wider sense. After all, prior to the process whereby it selects and attacks a specific target, a weapon is deployed and programmed by humans. This involves decisions on target selection, which are part of a wider targeting process that includes such tasks as formulating objectives, target selection, weapon selection and implementation planning. NATO has a standard procedure for this purpose that also takes account of the potential consequences for civilian populations. Over the next few decades, humans will remain responsible for the decision whether or not to deploy weapons.

Current and future deployment of autonomous weapons
Deploying autonomous weapons can provide key advantages. For example, computers collect and process data faster than humans, thus facilitating effective defence against incoming missiles. In addition, autonomous weapons can to some degree replace humans on the battlefield, thereby reducing the risk to friendly troops. They can also operate in environments where humans cannot survive, for example due to high pressure, extreme temperatures or lack of oxygen. Autonomous weapons can also help limit the number of casualties among civilians and friendly military personnel. Over the next few decades, these weapons will most likely be developed and deployed to attack specific types of targets or carry out defensive tasks.

It is highly unlikely that autonomous weapon systems will entirely or substantially take over the role of humans on the battlefield. Rather, it is thought they will be deployed alongside troops and existing weapon systems and in coordination with other military and civilian technologies. This is because the nature of modern conflicts complicates the deployment of such systems. One characteristic of these conflicts is that military targets are increasingly located in predominantly civilian areas. In many cases, moreover, the parties to a conflict deliberately do not distinguish themselves clearly from non-combatants. This often makes it difficult to deploy autonomous weapons. A second characteristic of modern conflicts is the importance of winning the hearts and minds of the local population. That is another reason why autonomous weapons are expected to play a limited role in modern conflicts, while humans will continue to play a crucial one.

Long-term developments regarding autonomous weapons are largely dependent on advances in the field of artificial intelligence. A weapon system that has the capacity to learn, formulate its own rules of conduct and independently adjust to changes in its environment would be *fully* autonomous and place humans beyond the wider loop. Such 'self-aware' systems, which do not exist at present, would effectively be beyond human control. The AIV/CAVV considers it unlikely that fully autonomous weapons that are *designed* to function without any human control will be developed within the next few decades. If that were to happen, these weapons would be programmed to perform the entire targeting process autonomously, from formulating the military objective to determining the time and place of deployment. Setting aside the question of technological feasibility, the AIV/CAVV fails to see why a state would want to develop or commission such a weapon.

The concept of meaningful human control has attracted a lot of attention in recent years as a result of factors including fears aroused by the idea of fully autonomous weapon systems. The increasing complexity of autonomous systems may ultimately lead to a partial or near-complete loss of human control. Because this possibility cannot be excluded, the AIV/CAVV believes that it needs to be taken seriously. It is therefore important to keep a close eye on developments in the fields of artificial intelligence and robotics.

Legal framework governing the admissibility of autonomous weapons and their deployment

International law prohibits the use of force between states, except in cases listed in the UN Charter. States may use force (1) for the purpose of self-defence, (2) under a UN Security Council mandate or (3) with the permission of the state where force is being used. Whether or not the use of force involves the deployment of autonomous weapons makes no difference in this context.

International humanitarian law prohibits the use of weapons if, when deploying those weapons, it is impossible to distinguish between military targets on the one hand and civilians and civilian objects on the other, if they cause unnecessary suffering and/or excessive injuries among enemy combatants or if the effects of their deployment cannot be controlled in a manner prescribed by international humanitarian law, resulting in indiscriminate harm to military personnel and civilians. There is no reason to assume that autonomous weapons *by definition* fall under any one of these categories. Under article 36 of the First Additional Protocol to the Geneva Conventions, states are obliged to determine whether new weapons are compatible with the requirements of international humanitarian law. The question whether a *specific* autonomous weapon falls under one of the categories of prohibited weapons therefore needs to be assessed on a case-by-case basis.

Apart from certain specific arms control treaties, there are two legal regimes that regulate the use of force: international humanitarian law and human rights law. Armed conflicts are regulated by international humanitarian law, which imposes certain requirements for the deployment of weapons: application of the principles of distinction (between military and civilian objects), proportionality (weighing military advantage against expected collateral damage) and precaution (protecting civilians and civilian objects as much as possible). In certain specific situations, such as the deployment of autonomous weapons on the high seas, under water, in the air or in sparsely populated areas, the requirements of international humanitarian law will generally be satisfied. However, in many other cases, at least for the next decade, the deployment of autonomous weapons may be complicated by a lack of prior certainty as to whether the requirements of distinction, proportionality and precaution can be met. The question whether autonomous weapons can be deployed without violating international humanitarian law is therefore highly dependent on context. During the targeting process, military personnel in the wider loop will have to determine whether deploying autonomous weapons in a specific context can be justified in accordance with the requirements of international humanitarian law.

The above-mentioned legal regimes apply to the use of all types of force, and there is no reason to assume that this would be any different for autonomous and fully autonomous weapons. When deploying such weapons, therefore, states and individuals are obliged to ensure compliance with these rules of law. The AIV/CAVV believes that discussing whether autonomous weapons might be able to perform this task themselves one day is a hypothetical exercise. From an international humanitarian law perspective, it makes no difference whether or not they would be able to do so, since the same legal requirements continue to apply to the deployment of all weapons.

Accountability

The AIV/CAVV believes that the existing legal regime, as described above, is an adequate formal legal framework for holding offenders accountable. There is no accountability gap as regards the deployment of autonomous weapons, as long as the decision to deploy, taken in the framework of the targeting process, remains with humans. At any rate, there is no reason to assume that there will be any erosion of the liability under criminal law of commanders, subordinates or those in positions of political or administrative responsibility during the next decade. They are responsible for deciding whether deploying and activating autonomous weapons in a given context is consistent with the requirements of international humanitarian law and ethically justified. Likewise, there are no gaps in state responsibility as regards the deployment of autonomous weapons.

However, compared to the deployment of weapons that require continuous human operation, such as those employed by a rifleman or by a fighter pilot during aerial combat, there is a shift in accountability in the case of autonomous weapons. This is because the deployment of autonomous weapons does not involve a decision to attack a specific target; rather, that decision is implicit in the decisions to deploy and activate them. As a result, accountability lies primarily with the commander who decides to deploy the weapon and the soldier who activates it, as opposed to a soldier who selects and attacks specific targets. This means that commanders and soldiers who are involved in the deployment of autonomous weapons must be well trained and well informed as regards their potential effects. They are required to make judicious decisions concerning distinction, proportionality and precaution without knowing which specific targets will be attacked. In other words, there has to be meaningful human control.

The basic norms of international humanitarian law strictly regulate the deployment of autonomous weapons. Any deployment that does not comply with these norms is therefore unlawful. As a result, commanders can actually be held accountable for reckless deployment of autonomous weapons that results in violations of international humanitarian law. Factors such as the interval between the weapon's activation (i.e. the last moment at which distinction, proportionality and precaution can be considered) and the actual attack on a target, as well as the complex nature of autonomous weapons, give rise to a need for greater restraint in their deployment. In other words, these factors cannot be invoked to evade accountability by arguing that certain consequences were unforeseeable.

Meaningful human control

The AIV/CAVV prefers the concept of meaningful human control to the terms 'judgment' and 'predictability'. International consensus also seems to be emerging on the usefulness of this concept. Although there is no general agreement on its definition, it is widely acknowledged that the concept can serve as a criterion for distinguishing between acceptable and unacceptable types of autonomous weapons and deployment.

Despite the lack of an internationally agreed definition of the concept of meaningful human control, it already plays a key role in public acceptance of weapon systems that independently select and attack targets. The AIV/CAVV adheres to the principle that humans should be responsible for all decisions concerning the use of lethal force. Meaningful human control implies that humans make informed, conscious choices regarding the use of weapons, based on adequate information about the target, the weapon in question and the context in which it is to be deployed. In addition, the design of the weapon, its testing in a realistic operational environment and the training of those who operate it should all be geared to ensuring meaningful human control. Incidentally, these requirements apply to all weapons.

The AIV/CAVV relates meaningful human control to the entire targeting process (the wider loop), as decisions concerning the selection and engagement of targets are taken at various stages of this process, even in cases involving the deployment of autonomous weapons. Meaningful human control is supposed to serve as a guarantee for well-founded ethical and legal decisions concerning the use of potentially lethal force. Moreover, it is possible in principle to attribute responsibility and accountability to individuals if humans have control over autonomous weapons. Meaningful human control is thus instrumental to compliance with the requirements of international humanitarian law and ethical principles and the attribution of responsibility and accountability.

The AIV/CAVV believes that the concept of meaningful human control should be regarded as a standard deriving from existing legislation and practices (such as the targeting process), which means that there is no need for new or supplementary legislation. It does not have to become a new norm within international law. The concept of meaningful human control can serve as a benchmark when assessing compatibility with article 36 of the First Additional Protocol to the Geneva Conventions. In addition, it can be useful in identifying potential violations of international humanitarian law as a result of the deployment of such weapons. The procedure for assessing the compatibility of autonomous weapons with article 36 should also examine whether the degree to which human control has been incorporated into the design of the weapon in question offers adequate guarantees of compliance with international law. It is therefore important to achieve international consensus on the precise definition and meaning of the concept of meaningful human control.

An interpretative guide could clarify the current legal landscape with regard to the deployment of autonomous weapons. The process leading to such a document might also promote consensus on the concept of meaningful human control. For example, it could list best practices – classification levels of national systems and procedures permitting – on such issues as the role of meaningful human control in the article 36 procedure and in relation to the deployment of autonomous weapons. Such a guide, which would be informative and educational, could conceivably be produced within the framework of the Convention on Certain Conventional Weapons (CCW).

Ethics and autonomous weapons

National and international law are based on ethical principles, which are broader in scope than the law. The AIV/CAVV believes that as long as the deployment of autonomous weapons is subject to meaningful human control, ethical issues (such as human dignity) will not give rise to any problems. Within the wider loop, humans are responsible for making a balanced decision to deploy autonomous weapons for the purpose of eliminating enemy units and objects. The use of potentially lethal force is intentional in such cases, even if the targets are selected and attacked by an autonomous weapon. Deploying autonomous weapons with meaningful human control can spare military lives on the battlefield and help prevent or limit civilian casualties. Nevertheless, the number of situations in which such weapons can be deployed in a responsible manner is expected to be limited.

In the future, advances in the field of artificial intelligence could undermine human control over autonomous weapons. This might happen, for example, if self-learning systems were able to modify their own rules of conduct. The AIV/CAVV believes that this will not happen within the next few decades. It also believes that autonomous weapons should not be used if humans no longer have meaningful control over them. The AIV/CAVV therefore attaches great importance to the discussions that are currently taking place within the CCW framework on the legal, ethical, technological and policy implications of long-term developments in the field of autonomous and fully autonomous weapons. The issue is also being discussed within NATO, and the Netherlands should actively contribute to this debate.

A moratorium?

In April 2013, the UN Special Rapporteur on extrajudicial, summary or arbitrary executions, Professor Christof Heyns, called for a moratorium on 'at least the testing, production, assembly, transfer, acquisition, deployment and use of LARs [lethal autonomous robots] until such time as an internationally agreed upon framework on the future of LARs has been established'. During the CCW's informal meeting of experts on lethal autonomous weapon systems in April 2015, he highlighted the importance of meaningful human control: 'As long as they [autonomous weapon systems] are good tools, in the sense that humans exercise meaningful control over them, they can and should be used in an armed conflict situation. […] If they are no longer tools in the hands of humans, they should not be used.'

Over the next ten years and, in all likelihood, the next few decades, autonomous weapon systems will probably not fall under any of the categories of prohibited weapons, which means their use can and must comply with the existing legal framework and the relevant ethical principles (such as those that have been recognised and enshrined in international humanitarian law and rules of engagement). The technology in question is therefore neither unlawful nor unethical. Its use, however, may be either, but this applies to all weapons. The AIV/CAVV anticipates that autonomous weapons will remain under

meaningful human control for the next ten years at least. This provides ample opportunity to ensure compliance with international law and respect for human dignity. The AIV/CAVV believes it is important to continue investing in research in the field of autonomous weapons. In order to gain proper insight into their ethical, legal and technological aspects, a thorough understanding of these systems and their development is crucial.

The AIV/CAVV believes that there are various practical objections to a moratorium or a ban. Much of the relevant technology is being developed for peaceful purposes in the civilian sector and has both civilian and military (dual-use) applications. It is therefore difficult to draw a clear distinction between permitted and prohibited technologies. In addition, there is no international consensus on the definition of the relevant concepts. The question thus becomes: a moratorium on what? A non-proliferation regime would also be hard to enforce, as it would be difficult to establish the existence of 'weapons' in the case of dual-use technology and readily available programming languages. Countries would not be able to trust that other countries were respecting the agreement. During the CCW's informal meetings of experts in April 2015, it became apparent that there was no support among states for a moratorium or a ban. Only five countries (Cuba, Ecuador, Egypt, the Holy See and Pakistan) indicated that they would support such an initiative. A treaty establishing a moratorium or a ban is not viable without widespread support. For these reasons, the AIV/CAVV currently regards this option as inexpedient and unfeasible. However, it cannot rule out that advances in the field of artificial intelligence and robotics might necessitate revision of this position in the future.

VII.2 Recommendations

1. The AIV/CAVV believes that if the Dutch armed forces are to remain technologically advanced, autonomous weapons will have a role to play, now and in the future. However, as explained in this report, the deployment of such weapons must always involve meaningful human control.

2. The AIV/CAVV considers it important to distinguish between autonomous weapon systems (in which humans play a crucial role in the wider loop) and fully autonomous weapon systems (in which humans are beyond the wider loop and there is no longer any human control).

3. The AIV/CAVV believes that the Netherlands should remain actively involved in discussions within the CCW framework on the legal, ethical and policy implications of developments in the field of autonomous weapon systems. It also stresses the importance of conducting a public debate on new technologies and advises the government to maintain close contacts with NGOs, the scientific community and other interested parties regarding this issue.

4. The AIV/CAVV is of the opinion that participants in the upcoming CCW meetings should reach agreement on the definition of autonomous weapons and the concept of meaningful human control as quickly as possible. NATO members should also seek to coordinate their positions on this issue. The AIV/CAVV believes it is important that for the purpose of these discussions the decision-making 'loop' be interpreted as relating to the entire targeting process in which humans play a decisive role and not merely to the narrow loop of critical processes – target selection and engagement – that autonomous weapons perform independently.

5. The AIV/CAVV advises the government to use the upcoming CCW meetings to advocate a more widespread implementation of the article 36 procedures at national level, greater transparency concerning the outcomes of these procedures and more international information sharing.

6. The AIV/CAVV believes that, when procuring autonomous weapons, the government should strictly apply the procedure relating to article 36 of the First Additional Protocol to the Geneva Conventions. It further believes that the concept of meaningful human control should serve as a benchmark for this purpose. In the AIV/CAVV's opinion, the Dutch Advisory Committee on International Law and the Use of Conventional Weapons should play a key role in advising the Dutch government on the compatibility of specific autonomous weapons with existing and emerging rules of international law, in particular international humanitarian law.

7. In light of the importance of attributing responsibility and accountability, the AIV/CAVV believes that, when procuring autonomous weapons, the government should ensure that the concept of morally responsible engineering is applied during the design stage.

8. The AIV/CAVV believes that, when procuring autonomous weapons, the government should ensure that they are extensively tested under realistic conditions.

9. The AIV/CAVV advises the government to ensure that ethics training programmes for military personnel, in particular commanders, devote attention to ethical issues relating to the deployment of autonomous weapons.

10. The AIV/CAVV advises the government to push internationally (especially within the CCW framework) for a process that will lead to the formulation of an interpretative guide that clarifies the current legal landscape with regard to the deployment of autonomous weapons. Such a document, which would be informative and educational, could list best practices on such issues as the role of meaningful human control in the article 36 procedure and in relation to the deployment of autonomous weapons.

11. In light of the rapid advances in the fields of robotics and artificial intelligence and the ongoing international debate (especially within the CCW framework) on the legal, ethical and policy implications of autonomous weapon systems, the AIV/CAVV advises the government to review the relevance of this advisory report in five years' time.

Annexes

Request for advice

Professor J.G. de Hoop Scheffer
Chairman of the Advisory Council on International Affairs
Bezuidenhoutseweg 67
P.O. Box 20061
2500 EB The Hague

Professor W.G. Werner
Chairman of the Advisory Committee on Issues of Public International Law,
Bezuidenhoutseweg 67
P.O. Box 20061
2500 EB The Hague

Date 7 April 2015
Re Request for advice on autonomous weapons systems

Dear Professor De Hoop Scheffer and Professor Werner,

In order to be able to respond to current and future threats, the armed forces must continue to innovate. They must therefore make use of the latest technologies, including robotics and information technology. It is often the civilian sector that is at the forefront of new advances in this area.

For some time now, the Dutch armed forces have been using systems that can to a large extent operate automatically, such as the ship-based Goalkeeper close-in weapons system and Patriot surface-to-air missiles. The degree to which these systems are set to 'automatic' by their operators depends on the security environment and the threat situation. The greater the threat and the shorter the response time, the more automatically these systems need to operate in order to be effective, though they are continuously monitored by their operators.

Rapid technological advances are reinforcing the trend towards computerised – or in some cases autonomous – functions in a wide range of products, including weapons systems. The future development of fully autonomous weapons systems with artificial intelligence that are capable of selecting targets and applying potentially lethal force without human intervention is no longer a fanciful idea.

Although they do not yet exist, a debate about the legal, ethical and policy implications of fully autonomous weapons systems has arisen in the international arena. In 2013, the Special Rapporteur on extrajudicial, summary or arbitrary executions of the UN Human Rights Council, Christof Heyns, published a report on lethal autonomous robots (LARs) that addresses these issues. In addition, several NGOs have joined forces in the international Campaign to Stop Killer Robots to draw attention to the potential consequences of developing autonomous weapons systems.

The government articulated its position on autonomous weapons systems in its letter to parliament of 26 November 2013 (Parliamentary Papers 33 750 X, no. 37), in which it stated that the Dutch armed forces are not developing such systems and that they have no plans to do so. It reiterated the guiding principle that all weapons systems and their deployment in armed conflicts have to comply with all the relevant requirements of international law. Under article 36 of the First Additional Protocol to the Geneva Conventions, the government is obliged to determine whether new weapons and new methods of warfare are compatible with

international law. For this purpose, it created the Advisory Committee on International Law and the Use of Conventional Weapons.

In other words, the acquisition or deployment of autonomous weapons systems is prohibited if the relevant requirements of international law cannot be met. In a previous advisory report, the Advisory Committee on Issues of Public International Law (CAVV) stated that 'the deployment of any weapons system, whether or not it is wholly or partly autonomous, remains subject to the same legal framework' (Advisory report no. 23: *Armed Drones*, July 2013, p. 9).

The government wants to encourage debate on autonomous weapons systems. For example, the Netherlands is funding research on the issues raised by these systems. This month, moreover, it is attending the second Meeting of Experts on Lethal Autonomous Weapons Systems (LAWS) under the UN Convention on Certain Conventional Weapons (CCW). At the first meeting of experts in May 2014, consensus seemed to be emerging on the introduction of the concept of 'meaningful human control' as a factor in determining whether or not an autonomous weapons system complies with ethical norms. Another issue discussed was whether the fact that a weapons system is potentially incompatible with ethical norms automatically means that it is in violation of international law.

However, opinions on what constitutes 'meaningful human control' differ widely, and further investigation is required to clarify this concept. In addition, it is worth investigating whether other concepts might be helpful in examining the compatibility of autonomous weapons systems with ethical norms.

In light of the above, the government has formulated the following questions for the AIV and the CAVV:

1. What role can autonomous weapons systems (and autonomous functions within weapons systems) fulfil in the context of military action now and in the future?

2. What changes might occur in the accountability mechanism for the use of autonomous or fully autonomous weapons systems in the light of associated ethical issues? What role could the concept of 'meaningful human control' play in this regard, and what other concepts, if any, might be helpful here?

3. In its previous advisory report, the CAVV states that the deployment of any weapons system, whether or not it is wholly or partly autonomous, remains subject to the same legal framework. As far as the CAVV is concerned, there is no reason to assume that the existing international legal framework is inadequate to regulate the deployment of armed drones. Does the debate on autonomous or fully autonomous weapons systems give cause to augment or amend this position?

4. How do the AIV and the CAVV view the UN Special Rapporteur's call for a moratorium on the development of fully autonomous weapons systems?

5. How can the Netherlands best contribute to the international debate on this issue?

The government would appreciate receiving the report in time for the parliamentary budget debate this autumn.

We look forward to receiving your report.

Bert Koenders
Minister of Foreign Affairs

Jeanine Hennis-Plasschaert
Minister of Defence

The targeting process and international humanitarian law (IHL)

Annexe II

	Phase 1: End state and commander's objectives	**Phase 2:** Target development and prioritisation	**Phase 3:** Capabilities analysis	**Phase 4:** Commander's decision and force assignment	**Phase 5:** Mission planning and force execution	**Phase 6:** Assessment
IHL	In this phase, IHL serves chiefly as a guideline, alongside legal and other considerations. The strategic, operational and tactical objectives of the commander and of the operation must comply with the applicable law (jus ad bellum, mandate and IHL). The operational guidelines (OPLAN and CONOPS) must be formulated in accordance with all relevant and applicable legal frameworks.	In this phase, the principle of distinction is paramount: only objects and persons that can be classified as military objectives may be targeted. The definition of a military objective falls into two parts: 1. The person or object must by its nature, location, purpose or use make an effective contribution to military action. 2. Its destruction, neutralisation or capture must offer a definite military advantage based on information available at the time. Persons and objects that may not be attacked are also identified in this phase (no-strike entities such as cultural property, embassies and hospitals). There are also 'restricted target' lists of objectives that may be engaged (NB not attacked) subject to certain restrictions.	The principle of distinction and precautionary measures feature prominently in this phase, in which available military capabilities are assessed against the characteristics of designated targets (target-capability pairings) in order to formulate options for the commander. Other factors, such as the risk to friendly troops and others who may not be attacked, are also assessed. Preliminary weaponeering (choosing the weapon system and munitions to be used) plays a role in this assessment. An electronic target folder for designated targets is established (this often starts in phase 2 or even earlier).	Proportionality and precautionary measures play a key role in this phase, in which information from previous phases of the process is combined with information on the available weapon systems, sensors and other available capabilities. This phase also encompasses the preparation of detailed estimates of potential collateral damage and weaponeering (deploying specific weapons or weapon systems). The chosen capabilities are assigned.	In this phase, considerations of proportionality (the need to limit expected and unexpected side-effects as much as possible) occupy centre stage and operations must always implement precautionary measures (to ensure that non-state entities and civilians are spared as much as possible). This phase also sees the formulation of a detailed mission execution plan, which takes the greatest possible account of unforeseeable and unexpected events. The weapon is activated.[1]	In this phase, the outcome and effects of the operation are assessed at all levels (strategic, operational and tactical). Reports of collateral damage (proportionality) and accountability (whether all applicable IHL rules have been complied with) both play a key role in this context. In addition, recommendations for new operations are formulated, based on assessments that take account of all applicable IHL rules.

NB: This table presents a simplified picture of the targeting process, which is an iterative process that often does not follow clearly defined steps. Specific IHL rules cannot be categorised according to these phases and often play a role in several or all of them. At the very least, the end result of the process must comply with all applicable rules.

1 An autonomous weapon system will independently select and engage targets after it has been activated, in contrast to weapon systems which require military personnel to be directly involved in target selection and engagement.

Abbreviations

AIV	Advisory Council on International Affairs
AUV	autonomous underwater vehicle
CAVV	Advisory Committee on Issues of Public International Law
CCW	Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects (Convention on Certain Conventional Weapons)
CTBT	Comprehensive Nuclear-Test-Ban Treaty
ICRAC	International Committee for Robot Arms Control
ICRC	International Committee of the Red Cross
IED	improvised explosive device
IHL	international humanitarian law
IHRL	international human rights law
LAR	lethal autonomous robot
NATO	North Atlantic Treaty Organization
NGO	non-governmental organisation
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
TNO	Netherlands Organisation for Applied Scientific Research
UCAV	unmanned combat aerial vehicles
UGV	autonomous unmanned ground vehicle
USV	unmanned surface vehicle
UN	United Nations
UNIDIR	United Nations Institute for Disarmament Research

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