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THE FUTURE IMPLICATIONS ON THE BATTLEFIELD BY AUTONOMOUS AND SEMI-AUTONOMOUS UAS, AND THE ETHICAL CONSTRAINTS

Maj A. Gundermann

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By / Par le Major Armin Gundermann

“. . . life or death decisions will be made only by humans -- even though machines can do it faster and, in some cases, better.”
General Paul J. Selva USAF, vice chairman of the Joint Chiefs of Staff

INTRODUCTION

The Ruston Proctor Aerial Target was the first aircraft without a pilot. It was based on A. M. Low's radio control techniques and built in 1916, during and shortly after World War I. The aim was to use it against Zeppelins. On September 12, 1917 the Hewitt-Sperry Automatic Airplane, also known as the "flying bomb" was presented to the public, as an introduction to the concept of an unmanned aircraft.[1] The first use to gather information over the Battlefield, being the eye in the sky, took place during the Balkan Wars in the 1990’s. The CIA identified the necessity of more current information right at the beginning of the conflict. 84 years after the first introduction of an Unmanned Aerial Vehicle (UAV) on October 7, 2001 the CIA performed the first drone strike with a Hellfire missile, delivered by a Predator with the tailfin number 3034, which is now on display in the Smithsonian Air and Space Museum in Washington, D.C., assuring its place in history.[2] The development of UAVs has come a long way from being used as a tool for target simulation to a “flying bomb” to an asset for reconnaissance towards the combination of real-time reconnaissance and strike capability.

Since 9/11 the US, NATO and coalition forces are engaged in wars and deployed in theatres where they predominantly face insurgencies which operate on a different (mostly lower) technological level. Therefore the focus has been set on “counterinsurgency, counterterrorism operations, nation-building efforts to stabilize such

[1] Taylor A. J. P., *Jane's Book of Remotely Piloted Vehicles*, n.d..
[2] Chris Woods, “The Story of America's Very First Drone Strike,” *The Atlantic*, May 30 May 2015.

countries as Iraq and Afghanistan and other areas in the Middle East and Africa."[3] The complexity of facing an opponent who uses predominantly irregular warfare increased the need for information to lift the fog of war as much as possible. Due to this need, the development of new technologies has received more and more attention as well as more and more efforts have been put into it. The increase in numbers of UAVs used in conflicts also shows the limitations of current UAVs related to their quite limited level of autonomy at the same time.

So far the primary mission tasks have been the gathering of information, performing surveillance operations, reconnaissance gathering and small-scale kinetic effect projection. The air dimension of the campaign environment was and is dominated and there is no need for self-protection.[4] To be able to use UAVs in the same manner in a congested environment or integrate new developed capabilities a greater level of autonomy is needed. The scarce resource of datalinks, time delays due to satellite links, the loss of link problematic, and crew limitations for operators requires the system itself to be able to follow the mission profile, alter it in case of a threat, employ the sensors properly, analyze gathered data and return to base after completion of the mission or due to an emergency. Greater autonomy for UAVs is the next step forward in modern warfare and will have not only a tremendous impact on the tactical level but will also change the way of conflict engagement on the strategic level.

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[3] Daniel Gonzales, Sarah Harting, *Designing Unmanned Systems with Greater Autonomy —Using a Federated, Partially Open Systems Architecture Approach*, (Santa Monica, RAND Corporation, —2014), XI.

[4] Daniel Gonzales, Sarah Harting, *Designing Unmanned Systems with Greater Autonomy —Using a Federated, Partially Open Systems Architecture Approach*, (Santa Monica, RAND Corporation, —2014), XI.

At first this paper will describe the different levels of autonomy by introducing the NATO definition before discussing the ethical implications in the final portion. This is followed by the introduction of the architecture principle and its implications on future development as well as force structure and joint employment. The third argument will describe the advantages of a higher level of autonomy in UAVs and what the impact on the battlefield will be, furthermore the current challenges will be described and future lookouts provided. Finally the focus is drawn to the ethical implications and what has to be considered by increasing the levels of autonomy. After the last argument a conclusion will summarize the findings and present an overall way ahead.

MAIN PART

1. THE DEFINITION OF THE DIFFERENT LEVELS OF AUTONOMY

There is more than one way to describe the levels of autonomy. In general the challenge lies not only in the development of technology and the following establishment of definitions but also in bringing the proof of the technologies capabilities. To do that the development of a process to evaluate the level of autonomy reached is equally important.[5]

There are numerous approaches on how to compare and evaluate the capabilities of systems, for example the attempt of comparing the execution of the surveillance mission by human directed systems and by autonomous systems.[6] Not only the US Department of Defence has invested some effort into this task, several other studies were conducted

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[5] Marco Protti, Riccardo Barzan, *UAV Autonomy – Which level is desirable? – Which level is acceptable? —Alenia Aeronautica Viewpoint,* (Torino, Italy, Alenia Aeronautica for NATO RTO, 2007). 12-5.
[6] Ibid.

defining the autonomy in UAVs.[7] A quite comprehensive product has been delivered by the US Air Force Research Laboratory which categorises the Autonomous Control Level (ACL) by subdividing it into 11 levels of autonomy oriented on the ability to follow the principle of Observe-Orient-Decide-Act (OODA-Loop).[8]

The National Institute of Standards and Technology (NIST) came up with a different approach to address the autonomy issue. The group developed a framework to classify the Autonomy Levels for Unmanned Systems (ALFUS)[9] by defining them through the ability of a system to achieve its mission goals. A more complex mission implies higher levels of autonomy. NATO also launched a specific initiative with the aim to come up with an agreed definition of the level of autonomy.[10] The working group developed four levels to classify the autonomy of a UAV system. The first level describes a remotely controlled system. These systems are totally dependent on the operators input. The second level consists of automated systems. These are systems which will react in a limited way depending on their fixed programming. The third level describes autonomous non-learning system. Their behavior depends on programmed rules which provide some degree of flexibility (goal-directed reaction and behavior) but still make it predictable. The forth level describes autonomous learning systems that are able to modify programmed rules and behavior within an overarching set of inviolable rules/behaviours

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[7] Patrick Chisan Hew, *The Generation of Situational Awareness within Autonomous Systems – A —Near to Mid Term Study – Issues*, (Edinburgh, Australia: DSTO Information Sciences Laboratory, 2006), —1.

[8] Bruce T. Clough, "Metrics, Schmetrics! How The Heck Do You Determine A ***UAV'***s Autonomy ——— —Anyway?" *Proceedings of the Performance Metrics for Intelligent Systems Workshop* (Gaithersburg, — —Maryland, 2002).

[9] National Institute of Standards and Technology, "Autonomy Levels for Unmanned Systems —(ALFUS) Framework", ed. Hui-Min Huang, Version 2.0 (2008). 16.

[10] NATO Industrial Advisory Group, "Pre-feasibility Study on UAV Autonomous Operations", Study Group 75, Annex C Autonomous Operations (2004).

to achieve a mission. This principle of classification is oriented on the ability of a system to follow the OODA loop steps.[11]

The RAND Corporation introduced the Unmanned Aerial System (UAS) Modular Technical Reference Model (TRM). It focuses on the implementation of autonomy in the system architecture of UAS following the principle of the earlier described categorization of levels of autonomy.[12] "The TRM would enable autonomy to be inserted into four key areas in the UAS architecture: the real-time Auto Pilot Module, the ground situational awareness and targeting module, the onboard planning module, and the low latency air track management services."[13] The Auto Pilot Module's task is the standard flight control, maintaining track, speeds and altitudes. The ground situational awareness and targeting module is in control of the air to ground sensors available. The low latency air track management service provides the sensor data from the air to air sensors. Finally the onboard planning module processes the generated information of the other modules and adjusts the profile accordingly to fulfill the task that is to be completed.

It is important to understand that a greater level of autonomy means less input required from the operator on the ground. As described in the different levels used by NATO to categorize and how it can be incorporated into the system architecture, it becomes clear that the idea is to enable a UAV/UAS to adjust its profile according to the changes of environment it is operating in. "An autonomous weapon system is a weapon system that, based on conclusions derived from gathered information and preprogramed

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[11] Ibid.
[12] Daniel Gonzales, Sarah Harting, *Designing Unmanned Systems with Greater Autonomy Using a ——— —Federated, Partially Open Systems Architecture Approach*, (Santa Monica, RAND Corporation, ——— —2014),56.
[13] Ibid. 58.

constrains, is capable of independently selecting and engaging targets."[14] So the system is always following programmed rules and behaviors with the aim to reduce the workload of the operator and help to reduce the amount of personnel (analysts for processing, exploitation and dissemination) that is required to handle the sheer volume of intelligence data generated by a single combat air patrol.[15]

2. FUTURE CAPABILITIES AND ADVANTAGES TO TODAYS UAVs

Since the beginning of the 21st century UAV and UAS overall, have become more and more important and dominant in the way we fight wars. They provide the commanding officer and his staff with "unprecedented situational awareness by virtue of powerful on-board sensors and significant loitering ability, circling the terrain at altitude to provide real-time intelligence, surveillance and reconnaissance (ISR) data."[16] But not only purely ISR is what they are used for, also do UAVs "offer an ability to identify, target and destroy (or 'find, fix and finish') adversaries with a single platform."[17] By providing these capabilities the use of UAVs has changed our way of fighting. It allows us the application of military force in areas where the risk for military personnel is considered to be too high or a direct political involvement is not favorable. As described during the introduction, this has been the case in an environment where the air superiority was gained and maintained. The spectrum of operations has to consider congested

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[14] Rebecca Crootof, "The killer robots are here: legal and policy implications", *Cardozo Law Refiew*, Vol. —36 (2015): 101.
[15] Michael Mayer, "The new killer drones: understanding the strategic implications of next-generation ——unmanned combat aerial vehicles," *International Affairs 91*, no. 4 (2015): 770.
[16] Ibid. 766.
[17] Ibid.

airspaces as well as a growing demand in UAV operations and new tasks like cargo transport, aerial refueling, air defence and others.[18]

Both, the requirements and the demands raise the need for UAV operations with a decreased reliance on human interaction. The USAF RPA Vector describes the concept of Remote Split Operations (RSO) to “increase the percentage of assets available for operations due to the distributive nature of RSO”[19], to face the challenge of increasing demands. The concept “refers to the geographical separation of the launch and recovery cockpit and crew from the mission cockpit and crew.”[20] The cornerstone of this concept, as it is used in parts already today, is global communications architecture. Today UAV crews participate in complex mission sets that stress today’s communication and link capabilities beyond their capacities. But not only is the supporting communications architecture complex and at its limit, it is also the main cost factor especially in the areas beyond line of sight where satellite communications are used.[21] The attributes of the next generations of UAVs need to show “sensor and C2 improvements, increased autonomy to reduce pilot workload and processes that allow for more efficient use of limited communication bandwidth,”[22] as well as the abilities to operate in adverse weather, congested areas and improved manned/unmanned (MUM) teaming. Further the increase in autonomy will also help to accelerate the processing, exploitation and dissemination (PED) process, not only bringing profits in the operational and strategic level, also

[18] United States Air Force, “RPA VECTOR, Vision and Enabling Concepts 2013-2038,” Headquarters ——USAF (February, 2014). 76.
[19] United States Air Force, “RPA VECTOR, Vision and Enabling Concepts 2013-2038,” Headquarters ——USAF (February, 2014). 20.
[20] Ibid.
[21] Ibid. 22.
[22] Ibid. 30.

allowing the tactical level to profit from the generated information immediately.[23] The automated PED will "filter/screen massive amounts of collected video and audio and assist analysts in producing products."[24] To put it precisely: "autonomous onboard planning algorithms can help reduce communications loads and lessen the need for frequent maneuver, heading, or flight commands."[25] On top of the onboard autonomous processing of sensor data, the system is also able to perform sensor fusion functions "such as automated geo-registration and multi-sensor processing, can select small image chips from full images to communicate, and can even potentially automatically detect and track targets using pattern recognition or other techniques."[26] By only sending already preselected material, the need in communication and link capabilities and personnel to process it is reduced. This again decreases the costs, helps to employ more assets, with the resources at hand at the same time and it makes the link less vulnerable to opponent attacks.

Despite an increase in interoperability to "achieve horizontal integration and commonality across remotely piloted, manned and ground support systems"[27], the further advancement of multi-mission capability will profit from a higher degree of autonomy. Groups of UAVs operating in the same airspace collectively will be able to support more than just a single type of mission; rather they will be able to support multiple missions

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[23] Michael Mayer, "The new killer drones: understanding the strategic implications of next-generation ——unmanned combat aerial vehicles," *International Affairs 91*, no. 4 (2015): 770.
[24] United States Air Force, "RPA VECTOR, Vision and Enabling Concepts 2013-2038," Headquarters ——USAF (February, 2014). 31.
[25] Daniel Gonzales, Sarah Harting, *Designing Unmanned Systems with Greater Autonomy Using a ——Federated, Partially Open Systems Architecture Approach*, (Santa Monica, RAND Corporation, ——2014). XII.
[26] Ibid.
[27] United States Air Force, "RPA VECTOR, Vision and Enabling Concepts 2013-2038," Headquarters ——USAF (February, 2014). 35.

with different sensors and weapons needed due to a greater variety of payload in the swarm.[28] "Modularity is the key enabler for RPA mission agility, flexibility, and adaptability and growth capability to support expanded missions."[29] Following this the next generation of UAVs will be networked not only with the ground controlling station but also among each other to use the advantages of autonomous flight control in coordination of larger formations and swarms. They need to be able to operate in all weather and environment conditions and the weapon systems used will not only be effectors anymore but also sensors which will expand the variety of capabilities of each individual UAV and for each supported element on the ground or in the air.[30]

3. ETHICAL IMPICATIONS

The ethical implications of an increasing level of autonomy have sparked multiple discussions over the last decade. It is important to understand the system structure of a UAV, as described in the beginning, to fully understand what autonomy really means and on what areas it is and will be applied. The systems currently used, according to their level of autonomy, are not performing automated targeting and weapon engagement. Professor Peter Asaro, a philosopher of technology and founding member of the international committee of Robot Arms Control (ICRAC)[31], describes in his text on banning autonomous weapon systems the dilemma we are about to face: "In order for the taking of a human life in armed conflict to be considered legal it must conform to the

[28] Chris Baraniuk, "US military tests swarm of mini-drones launched from jets," *BBC News,* last modified —10 January, 2017, http://www.bbc.com/news/technology-38569027.
[29] United States Air Force, "RPA VECTOR, Vision and Enabling Concepts 2013-2038," Headquarters ——USAF (February, 2014). 36.
[30] United States Air Force, "RPA VECTOR, Vision and Enabling Concepts 2013-2038," Headquarters ——USAF (February, 2014). 37.
[31] www.icrac.net

requirements of International Humanitarian Law (IHL)."[32] He further elaborates that it is the duty of the state and organisations as well as individuals operating in the name of the first not to delegate the decision of the use of lethal force to a machine or automated process to maintain its legitimacy.[33] "It must remain the responsibility of a human with the duty to make a considered and informed decision before taking human lives."[34] The autonomous decision over the use of ultimate force performed by an UAV is the core of today's discussion. But as already mentioned today's UAVs are not capable of making this decision and their autonomous ability does not exceed basic flight manoeuvers. The man in the loop is still at present and makes the final calls. Nevertheless it is important to have a discourse due to an increasing level of overall autonomy. The Auto Pilot Module will not remain the only module provided with greater autonomy also the ground situational awareness and targeting module, the onboard planning module and the low latency air track management services will experience an increase in capability. To maintain legitimacy in accordance with the International Humanitarian Law, International Human Rights Law and the Law of Armed Conflict the deployment of autonomous UAVs and Systems in general needs to follow an ethical code. "Robots will change the way that wars are fought",[35] and therefore it is required to differentiate in the levels of ethical autonomy an UAV can exercise in the same way as it is necessary to differentiate in the different levels of autonomy. Gianmarco Veruggio and Keith Abney presented a way to differentiate robot ethics into three different categories. The first category focuses

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[32] Peter Asaro, "On banning Autonomous weapon systems: human rights, automation, and the dehumanization of lethal decision-making", *International Review of the Red* Cross, Volume 94, no. 886 (Summer 2012). 696.
[33] Ibid. 688.
[34] Ibid.
[35] Patrick Lin, Keith Abney, George A. Bekey, *Robot Ethics: The Ethical and Social Implications of Robotics*, MIT Press (2012). 111.

on the ethics of the designers, manufacturers, programmers and users of robots and the capabilities they invent. The second category focuses on the ethical behaviour of the robots themselves resulting from their programing. And the third category describes the robots ability to perform ethical reasoning and making ethical decisions, this is also described as machine ethics.[36] If in the future a UAV is supposed to have the capability to decide on its own about the use of lethal force, machine ethics need to be installed, and still then it is quite controversial. Spinning the wheel further and considering the effects generated on the future battlefield more ethical and legal questions are raised, particularly in perspective of obeying the IHL and its principles of distinction, proportionality and military necessity. Furthermore the implications on irregular warfare, counter insurgency, avoidance of collateral damage, distinguishing combatants from civilians and the effect of lowering the threshold for nations to start wars due to a reduced risk of casualties and political costs on their own side.[37]

It must be the aim to develop a UAV that is capable to follow an ethical code, differentiate and use proportionality, literally applying the IHL. As long as this has not been achieved the man in the loop concept still has to be applied. It is not a question if artificial intelligence development will create a level of autonomy that is not in need of human supervision, it is the question when this will be happen. "Automating the rules of IHL would likely undermine the role they play in regulating ethical human conduct. It

[36] Ibid. 347, 348.
[37] Peter Asaro, "On banning Autonomous weapon systems: human rights, automation, and the ——————dehumanization of lethal decision-making", *International Review of the Red* Cross, Volume 94, no. 886 —(Summer 2012). 692.

would also explain why designers have sought to keep humans-in-the-loop for the purposes of disambiguation and moral evaluation."[38]

CONCLUSION

To fully understand the future implications of a greater autonomy of UAVs it is vital to understand what sort of autonomy we are speaking of. The different levels introduced in the first part help to differentiate and also feed into the future capabilities to expect as well as they define the ethical and moral questions to be answered. Autonomous systems will change the way operations are conducted in the future not only down at the tactical level for the troops in need of support, either kinetic or through ISR, also on the operational level and the strategic level. New capabilities open up new possibilities of operations for example through the conduct of multiple missions at the same time by teaming of multiple UAVs with each other or by teaming them with other troops. The spectrum of new options is only limited by cost-efficiency and ethical boundaries. Not only will an autonomous UAV reduce the workload on all personnel involved, it will also provide greater accessibility for all troops in need due to better human/machine interfaces. A forward air controller will not be in need of a long term special training to request support. The strategic implications will focus on the availability of information provided by these types of UAVs and on the supporting tool that will be at the expanse of government leaders to perform small scale and/or covert operations. This is also one of the negative effects created. The expanse to go to war will decrease due to the further separation of human life from the battlefield and make it thereby cheaper to maintain a conflict. Also the man in the loop principle is needed to

[38] Ibid. 699.

maintain legitimacy for the state acting; the ethical discussion needs to proceed to clearly understand the implications of lethal force applied by a machine, respective UAV, in correlation with the IHL, IHRL and LOAC.

> "*Three Laws of Robotics:*
> *A robot may not injure a human being or, through inaction, allow a human being to come to harm.*
> *A robot must obey orders given it by human beings except where such orders would conflict with the First Law.*
> *A robot must protect its own existence as long as such protection does not conflict with the First or Second Law."*
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> *-Isaac Asimov, 1942*

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