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Over time, technological innovation has played an important role in the conduct of war and progressively replaced the function of humans in many areas. During interwar period between World War I (WWI) and WWII war was theorized at greater distances, with faster execution and through increasingly complex machines. Current military capabilities are the result of an evolutionary trend in which technology and information play a central role. The impact of new technologies and the increased speed in the future battlespace may over-centralize the Command and Control functions at the political or strategic level. This element is at the foundations of a moral dilemma for the next political/strategic leadership.

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**Command and Control in the age of automated decision-making process,
Challenges and Opportunities.**

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Title: Command and Control in the age of automated decision-making process, challenges and opportunities.

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Thesis: The impact of new technologies and the increased speed in the future battlespace may over-centralize the Command and Control functions at the political or strategic level by-passing the advisory meaning of a qualified staff. As a result, Political/Strategic leaders might find appealing pursuing pre-emptive and preventive war as a strategy to acquire the asymmetric advantage over the enemy.

Discussion: Over time, technological innovation has played an important role in the conduct of war and progressively replaced the function of humans in many areas. During interwar period between World War I (WWI) and WWII war was theorized at greater distances, with faster execution and through increasingly complex machines. Current military capabilities are the result of an evolutionary trend in which technology and information play a central role. The impact of new technologies and the increased speed in the future battlespace may over-centralize the Command and Control functions at the political or strategic level. This element is at the foundations of a moral dilemma for the next political/strategic leadership.

Conclusion: The ability to balance the decision-making process between the indiscriminate use of automation and its blind confinement will be a critical aspect for the development of effective Command and Control functions in the operating environment featured by autonomous systems.

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Preface

In the last four year of my military carrier I have served as a staff officer at the operational level in national and international organizations. At the national level, I served at the Italian Joint Operations Headquarters (JOHQ) in Rome while at the international level my primary experience was in Afghanistan during the sensitive transition from the operation ‘International Security Assistance Force’ (ISAF) to the operation ‘Resolute Support Mission’ (RSM), 2014-2015. During these experiences I had the remarkable opportunity to participate in several planning activities across the entire spectrum of warfare. From different perspective, I have concluded that the role of the staff is not just to provide courses of actions, it has the advisory function when the leader is called to take critical decisions. In less than five year, however, I have also seen a progressive replacement of humans with automated, computer-based systems. In the targeting cycle, for instance, the need for quick and precise assessment on potential targets has brought always more sophisticated programs in the game, and many “old style” military planner replaced by civilian consultant, contractors, or defense employees for their skills in computer programming. I have witnessed a drastic change in the staff organization that seems unstoppable. What will be the next step? Will a political/strategic leader need my expertise once the technological development will be at a level that almost all human brain capabilities will be outperformed by an algorithm? And, what will be the effect of the automation on the decision-making process? In a recent conference USMC General John R. Allen warned that this accelerated process will end in the collapse of the USAF Col. John Boyed’s Observe, Orient, Decide, Act (OODA) loop.

For the development of this paper, I am grateful to USMC Col. Christopher Williams and Doctor Paolo Tripodi. Both of them have believed in my idea and encouraged me to keep writing. Dr. Tripodi, in particular, helped me to be tenacious and his advices were critical points for acute reflections, without him I would not have completed this project. My last thanks go to my wife Zildjian, she is always by my side and her smiles are the most beautiful moments of my days.

Introduction

While the nature of war does not change, the means and methods used in warfighting evolve continuously.¹ The universal principle is based on the idea that war is a clash between different wills in order to establish the subordination of one, or many, to another.² How to impose supremacy has, over time, informed the ever-changing character of the war.

Over time, technological innovation has played an important role in the conduct of war and progressively replaced the function of humans in many areas. The interwar period between World War I (WWI) and, WWII has been a particularly interesting time. Military innovations in the 1920s and 1930s marked the track for modern concepts of warfare. During this period war was theorized at greater distances, with faster execution and through increasingly complex machines. The general staff became more complex to cope with and properly process a greater amount of information, the battlefield gradually moved away from the Commander and the Command and Control, a critical function for warfare, moved its first steps toward automation.

Current military capabilities are the result of an evolutionary trend in which technology and information play a central role. With Net-Centric warfare, Commanders can get a technological God's eye³ view of the entire battlespace with an almost global reach. Already now, the political or strategic decision maker could be at a distance, and still have the possibility to control, in real time, tactical actions carried out on the battlefield supported by technology in the information management and the decision-making process.

The introduction of new technologies (autonomous weapons and artificial intelligence)⁴ is the next step toward the automation of warfare with critical implication on the Command and Control. USMC Gen. John R. Allen, former ISAF Commander, stated in a recent interview: the AI will lead to a new era of war in which the processes of decision and action will be

significantly faster than anything we have seen before; [a hyper-war in which] the human being will be removed from the processes of analysis of the environment and will have a less direct control over the events.⁵

This paper reflects on the decision-making process expressed by USAF Colonel John Boyd's O.O.D.A. loop and the relevance of human judgment independently of new technologies. While, the introduction of highly autonomous technologies has a significant impact on the Observation (O), Orientation (O), and Action (A) phases, the Decision (D) phase still requires a human "on the loop"⁶ to control the conduct of operations.

The impact of new technologies and the increased speed in the future battlespace will over-centralize the Command and Control functions at the political or strategic level by-passing the advisory meaning of a qualified staff. As a result, Political/Strategic leaders might find appealing pursuing pre-emptive and preventive war as a strategy to acquire the asymmetric advantage over the enemy. This paper investigates the roots of this trend connecting historical perspectives with implications for next-generation technology may have on Command and Control.

Doctrinal aspects

The conduct of warfare is intrinsically linked to translation of commander's intent into actions. Commanders observe the surrounding situation, process the information, develop a plan, and execute it, using the organizational structures and technological systems at disposal. The conduct of the battle, therefore, is the prerogative of the Commander. As much as you order your car to turn left or right and in the meanwhile control speed, direction, road status etc., in the realm of military operations it is impossible to separate the command, as the right to use and control something⁷, from the control itself, as a mean of limiting or regulating something.⁸ From the beginning of their education, military leaders receive the notion of Command and Control as an inseparable dogma: giving an order includes gathering and analyzing information, making decisions, organizing resources, planning, communicating instructions and other information, coordinating, monitoring results, and supervising execution⁹, verifying command's effectiveness. Definitions of this theoretic dogma, like interpretations, are various and for this reason it is necessary to establish a definition.

Martin Van Creveld in his *Command in War* says:

...I will use the word "command" [instead of Command, Control, and Communication] throughout in much the same way as people commonly writing out the term "management" to describe the manifold activities that go into the running of a business organization.¹⁰

The author assumes that control activities are intrinsic to attributions of command. As a manager of a business gives purpose and direction to his commercial activities, so a Commander must be able to do the same in the warfighting business.

The British doctrine for the conduct of operations states:

Complex operations demand a Command and Control philosophy that does not rely upon precise control, but is able to function despite uncertainty, disorder and adversity;¹¹

The definition helps to think about the impossibility of a detailed control in the warfare. Given the human and violent nature of war, a level of uncertainty must be accepted and shall not limit the initiative at the tactical level.

NATO doctrine provides the idea of a mission driven function, in fact:

Command and Control (C2) encompass the exercise of authority and direction by a commander over assigned and attached forces in the accomplishment of the mission.¹²

The Marine Corps, finally, gives the idea of this function as a loop:

Command and Control are the means by which a commander recognizes what needs to be done and sees to it that appropriate actions are taken.¹³

Collectively, Command and Control as a function is the integration of all four definitions or above statements.

A comprehensive definition may be: Command and Control are military functions that describe the inseparable connection between the authority and direction by a commander over the assigned forces and the action performed by a subordinate unit aimed at the accomplishment of a given mission.

Roots of modern Command and Control.

The conduct of the battle is the prerogative of the Commander. This assumption seems to be as absolute as the nature of war. For several millennia of human history, the Commander-in-Chief had a significant level of proximity to the battlefield, participating directly in the conduct of warfighting, and representing the decision-making loop.

The dawn of modern Command and Control can be identified already in the Napoleonic wars. The offensive approach of the French Emperor imposed a partial delegation of leadership responsibility on the battlefield to subordinate commanders. Yet, at the tactical level Command and Control of operations were still integrated into the leadership of a single man¹⁴. In response to the effectiveness of Napoleon's war machine, the defeated states responded by adapting their military instrument. In relation to Command and Control, the best response came from Prussia with creation of the General Staff. The Prussian army developed an approach to warfare based on a centralized command with the combination of valid initial analysis, clear and concise orders, and decentralized control with total understanding of the plan by subordinate commanders, and autonomy at the lower level. This approach shaped the initial function of Command and Control and informed the contemporary idea of Mission Command (or tactics).¹⁵ At the end of the nineteenth century, the Prussian Army was able to capitalize on a number of technological innovations, among them the telegraph, and, as Geoffrey L. Herrera has indicated, the combination of railroad and telegraph became elements of the communication system.¹⁶

As a result, armies had the ability to mobilize large masses of soldiers in less time, to engage the enemy from greater distances, and finally to control operations from miles of distance. Subsequently, WWI was fought (controlled) mainly in the trenches, but commanded hundreds of miles away. Despite the technological evolution and the introduction of new

weapon systems, large armies in Europe fought again in a static manner, nullifying the need to control large masses in movement, after 1915.

During the interwar period, despite military budget restrictions, a greater availability of new technologies and the lessons learned in WWI created the conditions for the WWII.¹⁷ For the objective of this paper, it is important to focus on three main concepts that characterized the military innovation¹⁸ of that time: speed and distance, combined arms, and information and communication. The choice of these elements, and their interconnectedness, depends on the idea that the future operating environment will be characterized by the same three elements, even if with different characteristics, such as autonomy.¹⁹

Speed and Distance.

At the end of WWI, winners and losers had suffered an unmatched loss of human lives and had weakened national economies. More than anything else, WWI had demonstrated that the war of attrition was economically unsustainable. For Williamson Murray and Allan R. Millet, innovation in the interwar period was characterized by, but not limited to, by the development of amphibious warfare, armored warfare, strategic bombardment, and aircraft carrier development.²⁰ The common driver in each of these innovations might be the requirement to rapidly maneuver large armies and, in doing so, avoid the exhausting and costly trench fighting experiences during WWI. In fact, all these elements respond to the same logic: to project combat power in the shortest possible time and at ever greater distances. The choice to develop a given military capability was the result of strategic needs, geographical aspects, and military tradition. Commonly, speeding up and broadening the battlefield had a direct impact on the ability to control events.

The German school, built on the tradition of General Helmuth Von Moltke the elder, continued to develop a mission control order approach (*Auftragstaktik*) during rigid trainings and frequent exercises.²¹ The German doctrine (*Die Truppenfuhrung*) appreciated the bottom-up approach and the requirement for junior officers to assume responsibility and exercise judgment. Once the order was issued and the operation launched, German units could act with great autonomy. This type of doctrine was based on the construction of a relationship of full adherence to the strategic plan and of unconditional trust between the strategic Commander and the tactical one.

The juxtaposition of the dynamic German doctrine was the French approach that emphasized the strength of artillery fire and the role of fortifications. In the same way, the Command and Control of the French school was inspired by the rigid execution of orders from higher command. Like General Maurice Gamelin, Commander-in-Chief of the French Forces, said: the high command was the only arbiter in the conduct of military operations.²²

The German and French examples are not the only ones from the interwar period. They are chosen to justify the first teaching point of the interwar period. Speed and distance, as characteristics of warfighting, generate dispersion of forces. This dispersion, particularly in offensive warfare, requires the surrender of part of control to peripheral agents.

Combined Arms

Integration of arms is not a novelty of the WWI and II. Roman legions were already composed by cavalry, infantry, and a very first example of combat engineers. The modernity of the interwar period, in this respect, lies on the fact that for the first time different weapons and different services were combined for the same purpose, a concept today more commonly known as jointness. It was once again the need to avoid the static combat in trench warfare to stimulate

innovation. Battles fought in the previous war had seen an initial integration between the various weapons, but the static character of the war had not allowed forces to exploit all of its potential. It was again the German Army, under the guidance of General von Seeckt, to theorize the integration of all available capacities under unified commands. With the doctrine of the Command and Combat of Combined Army, the *Reichswehr* first and *Wehrmacht* after, had sensed that the key to maneuver was the concentration of all weapons even to lower levels.²³ The German doctrine was not the only one informed by integration of weapons. Russia in the interwar period identified the key of innovation in the combined arms, as well. The *Gluhoky hoi* (Deep Battle) concept, also known as *Tukhachevsky* doctrine from his developer, provided for the integration of infantry, cavalry, mechanized forces, and aviation in support at the corps and division level.²⁴ This doctrine belied its effectiveness and obvious evolution of the German doctrine (to which probably it was inspired²⁵). In both German and Russian cases, the main challenge for Command and Control was the ability to coordinate multiple weapons available at the tactical level in maneuver warfighting. The "combined" education of the German and Russian officers (even though the purge carried out by Stalin between 1936 and 1938 did not allow to see the Russian doctrine on the field) was inoculated from the lower ranks. Furthermore, the organic structure of the German and Russian units reflected the idea of integration.

It is possible to draw a second teaching point from the interwar experience: the efficiency of Command and Control functions is the result of the creation of a widespread "combined" culture (today we would say joint philosophy). To achieve this level of informed culture, military organizations must carry out frequent and realistic tests and exercises during peace-time.

Information²⁶ and communication

In the summer of 1932, the *Reichswehr* conducted an important exercise aimed at testing radio troops integrated in the combined units in offensive.²⁷ The scenario involved the invasion of a red army (Czechoslovakia) in German territory (blue). The signal corps of the two opposing armies followed the maneuvers of land units to provide communication support fit for the conduct of the operations. The result of this exercise revealed the need to further develop the coordination between the tactical level (divisions) and the operational level (the corps).²⁸ The Germans identified, in advance, that new technologies (in this case the radio) offered the possibility of achieving a smooth Command and Control system between the tactical and operational level by spreading orders and coordinating all the arrangements available.

Radio in combat dates back to WWI when both the Germans and the English armies made extensive use of it. However, the initial technology was expensive and particularly complex. In the interwar period, the spread of the radio also in civil society made the production less expensive, the research more advanced, and therefore technical instruments more available²⁹. The use of electromagnetic waves became relevant in the widest spectrum of the Command and Control system. As Alan Beyerchen pointed out, the radio, as well as the radar, contributed to the operational change in the operating environment by integrating all arms and helping in visualizing the battlefield even at a distance.³⁰ In 1936, General Heinz Guderian published an article in which he argued that ‘radio troops’ were the backbone of intelligence.³¹

Gen Guderian also expressed a concept still valid today: the rapid sharing of information at all levels is essential for effectively maneuvering units in attack. Furthermore, the construction of a single ‘image’ of relevant information facilitated collaborative planning and assisted all echelons to achieve situational awareness, it was the progeny of the modern Common

Operational Picture (COP).³² The idea of operating electromagnetic waves in the interwar period has led many contemporary armies to speak of warfare in the electromagnetic spectrum (EMS).³³ In the EMS, information ‘converge’, is processed and becomes one of the critical elements of the modern Command and Control system.³⁴

To summarize, interwar period experiences demonstrated that to realize fully the possibilities of a military-technical revolution, it is necessary to exploit all the elements that characterize such revolution. Oftentimes, the failure to grasp the increase in military effectiveness is not as much a case of the political and military leadership of a state ignoring technological change as it is a failure to see and initiate new operational concepts and organizational innovation.

A new technology alone, without new operational concepts and new organizational structures, is unlikely to fundamentally influence the outcome of a future military confrontation, with the exception of very specific technology such as the atomic bomb. It is therefore important to pay more attention to factors besides new weapons or technology and the acquisition of them in order to improve the overall understanding of the true nature of the military competition.

If we can imagine the future operating environment featured by autonomous weapons, it is a mistake to believe that Artificial Intelligence itself will cope with the complexity of future battles. At the same time, fighting against innovation will leave a free space for our competitors to gain the asymmetrical advantage that leads to their success. German military leaders of the interwar period visualized future war and prepared its war machine not only to be competitive, but also to be victorious.

There are many similarities between the WWI and WWII interwar and the current period: theorists look for a war with less human direct involvement, at least in the bloodiest initial phases

of the next war; the power projection, meaning the offensive character of war, is still the most desirable condition. Power projections deal with space and distance and reduced control over the forward units (either human or autonomous); integration of all means is one of the most important features for success; lastly, information is not a supporting aspect of warfare rather another dimension of warfare. In an era featured by over-information, the fog of war could become again thick, nullifying the ability of the Commander to visualize the battlespace.

Command and Control in current era

Vignette 1: It is November 2016. A coalition of western countries led by the USA has decided to support Country X, invaded by proxy forces of Country Y. US Central Command, the geographical Combat Command designated as Operational Command, plans to intervene and establish a Combined Joint Task Force led by Major General Smith, initially located in the closest US base in the area. The plan is inspired by the brilliant Operation “Desert Storm”: a first phase of sea and airborne kinetic strikes on High Value Targets followed by the infiltration of ground and Marine forces to control liberated territories and exploit the air-naval campaign’s success. The Operational Plan, called “fast and deep”, assumes that coalition forces retain the complete dominance of the air, sea, and information environment³⁵, allowing a detailed control of all kinetic efforts, prior to the landing of ground/Marine forces. December 2016, as the CJTF performs first strikes, an unprecedented cyber/EW attack from an external source affects the net-centric C2 structure undermining the ability to control the events, slowing down the operational tempo, and jeopardizing the decision-making process. In addition, an adversary information-campaign, promoted by Country Y media outlet, shows alleged civilian casualties caused by the coalition bombardment. The resulting factor is a severe loss of the international support and the exit of three of the major contributing countries to the coalition.

Vignette 2: Lieutenant Amber is a platoon leader in a security operation in Country Z. While he is performing a local leader engagement (LLE) with village elders, a group of insurgents from a dominating position opens fires on his unit forcing them to take cover in the village, return fires, and move out from the killing zone. Lt Amber’s radio operator, following the procedures, digits on the Blue Force Tracker (BFT) “Troops in Contact (TIC)” and asks for air support. Lt Amber simultaneously orders squad Alpha to move to a better position and use

trucks' turrets to fix adversaries since the arrival of the "two birds". At the arrival on the spot, F35's C2 system alerts the platoon BFT to draw back 500 meters to be out of the danger close range. At the same time, Pilot asks for Positive Identification (PID)/Pattern of Life (PoL) and the clearance from the On-Scene Commander (OSC) to execute the air strike. Lt Amber, while maneuvering his unit on the ground, authorizes the strike. A Guided Bomb Unit (GBU)-39 is released from one of the two aircraft eliminating four insurgents, but also killing two locals within the village. The Higher HQ, then, orders Lt Amber to assess battle damages and return to base to further report about the event. On the way back, truck number two of Lt Amber's platoon strikes an Improvised Explosive Device (IED) resulting in three Killed In Action (KIA) and total destruction of a Mine-Resistant Ambush Protected (MRAP) tactical vehicle.

The two vignettes describe possible scenarios that might involve armed forces in a conflict today. Each of them is aimed to isolate critical vulnerabilities³⁶ of a conventional and counter-insurgent type of warfare, the most likely warfare in present days. In the first case, the confidence in retaining dominance in the information dimension has exposed the command and control system to countermeasures of an opponent apparently not present in the battle space. The effect is the disintegration of the coalition and the de-legitimization of the entire operation (critical vulnerability). In the second case, the delegation of control of valuable assets at the tactical level leads to an unfavorable action from the cost-effective point of view, both in human and economic terms (critical vulnerability). In both cases, the assumption is that the interconnection between all elements of the warfare, facilitated by the information, makes modern conflict a complex system and that every action, even at a tactical level, can emerge for strategic relevance. While military organizations have done great efforts in Command and

Control to deal with uncertainty and time in war, new threats arise in the current paradigm³⁷ that thicken the “fog of war”.

Assumptions of the current paradigm.

The mainstream of modern Command philosophy is inspired by the German *Auftragstaktik* renamed in different ways. Concepts such as Mission Command, Mission tactics, and Mission Type-order are different interpretations of the same “conduct of military operations through decentralized execution based upon mission-type orders”³⁸. However, the current paradigm is built on techno-centric assumptions of warfare undermining or at least complicating the actual application of the mission command.

Stand-off/precision systems.

In broader terms, the standoff operating concept is formed on the idea to create enough distance between our center of gravity and the enemy out-reach capability, gaining time, through the execution of multiple and synchronized actions (kinetic and non-kinetic), in order to achieve physical and cognitive effects. In other terms, Ron Tira rightly stated in his “The Limitations of Standoff Firepower-Based Operations: On Standoff Warfare, Maneuver, and Decision”, as a result of technological development, current doctrines look at enhanced standoff and precision systems which can reduce the risk of loss, induce shock on the enemy, gain the asymmetrical advantage and ultimately win the war. As a consequence, a majority of current military plans for conventional warfare are organized around a linear/phased approach that seeks engagements from great distances and allows ground/maneuver force intervention only when the enemy is “softened” enough to pose an acceptable risk.

Efficiency vs Resiliency

Modern military structures are built to be efficient in a specific environment or for specific purposes. To generate a new operational requirement, the Armed Forces must follow a slow process that considers a foreseen future operating environment. In the modern armed forces, as an example, some projects of today's equipment are based on assumptions made thirty years ago, or so. The F35 Joint Strike Fighter (JSF) program, for instance, was initiated at the end of the 90s, with the intent to integrate into one single aircraft different platforms but also to be "invisible" to enemy counter measures. There are also ways to reduce the time of the acquisition process, but these ways are based on mission urgent requirements and the acquisition project must be complementary and not alternate of a weapon system or structural equipment already available. Generally, because this kind of process is threat based, the outcome is a product that responds specifically to the threat. The implication of the efficiency- (often technology driven) -based approach is that the decision-making process is influenced by the technology/equipment available rather than a resilient solution to solve the same military problem. In vignette n.2, the young Lt suppresses the low equipped/non-technological threat by using an expensive GBU released by an expensive F35. The risk associated is a mindset that imposes to fight with what you have instead of what you need. Because the majority of current weapons are "few and exquisite" and designed for a technological war, the enemy could exploit the current system and bring the confrontation to a level that is not favorable from cost/benefit standpoint or change the elements of the paradigm so quickly that it makes timing adaptation difficult.

Global Communication

J.C.R. Licklider of MIT, in August 1962, discussed for the first time about a “Galactic Network” concept that was meant to enable the social interactions networking a series of interconnected computers, globally. Licklider became the first head of the computer research program at Defense Advanced Research Projects Agency (DARPA) and continued that project for the military purpose, giving the foundations for the Internet.³⁹ The distributed connection today allows not only voice/sound communication but also images transmission at every remote corner of the globe and with such a speed that every person involved in the communication can ‘sense’ the other side. Current technology has virtually reduced the physical distance between levels of commands. A Commander situated in his/her command post can listen, see, and direct a subordinate without being personally present in the field. The global communication capability gives a Commander the “*directed telescope*”⁴⁰ of the battlefield by using his own staff on his own duty location. US ARMY General Stanley McChrystal in a very inspiring speech described in great details the shared context that global communication (apparently) gives to the Commanderⁱ⁴¹

Technology informs and influences current Command and Control functions. Regardless the principle of delegation, actual C2 systems are technologically built to control details of the battlefield from distant Headquarters and consequently leave less freedom of action at the

ⁱ US Army Gen. (ret) McChrystal said: “...more importantly, the force that I led was spread over more than 20 countries. And instead of being able to get all] ...[leaders]... [in a single room and look them in the eye and build their confidence] ... [I've got to use other techniques. I've got to use video teleconferences, I've got to use chat, I've got to use email, I've got to use phone calls -- I've got to use everything I can, not just for communication, but for leadership.”

tactical level. The comprehensive perspective of modern C2 systems are envisioned in the Network-Centric Warfare.

The Network-Centric warfare

(NCW) is the current theory of war in the information age. The term network-centric warfare broadly describes the combination of strategies, tactics, techniques, procedures, and organizations that a fully or even a partially networked force can employ to create a decisive warfighting advantage.⁴²



Figure 1: Transformation from the Air Force Perspective, Maj. Gen. Greg Power, 9 March 2005.

Generally described as a revolution in military affairs (RMA), the Network-Centric theory is informed around three themes:

- “The shift in focus from the platform to the network;
- The shift from viewing actors as independent to viewing them as part of a continuously adapting ecosystem; and
- The importance of making strategic choices to adapt or even survive in such changing ecosystems.”⁴³

It is easy to draw a logical connection between the concept of NCW and Combined Arms. With the introduction of the global communication systems and the advance in high precision/standoff weapon systems, all connected within the information domain, the step toward a hyper combined

force is the natural evolution of the same idea of synchronizing operations, speeding up the decision-making process, and gaining the asymmetrical advantage on the enemy. Yet, the effect on the mission type order is the potential ability for the Commander to reach-out to almost all his subordinate units and possibly

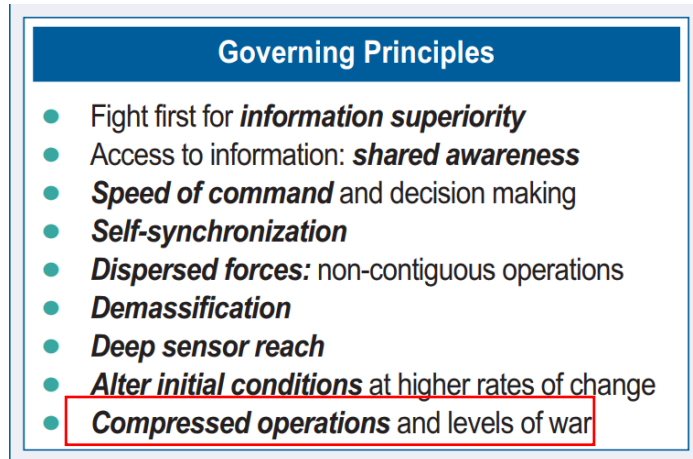


Figure 2: Governing Principles of a Network-Centric Force, from "The Implementation of Network-Centric Warfare, US DoD Office of Force Transformation, 5 January 2005, pg. 8.

command them no more as a coach of sport team, but as a chess player with his pieces. Improved battlefield "visibility"—provided by NCW and built on assumptions mentioned before—allows us to grasp the battle much more precisely, quickly, and distantly. Thus, technology has made the conduct of warfare, apparently, more certain and precise than before.

For all intents and purposes, Commanders can get a technological God's eye view of the entire battlefield. It is believed that Clausewitz's "fog of war" can be blown away redoubling

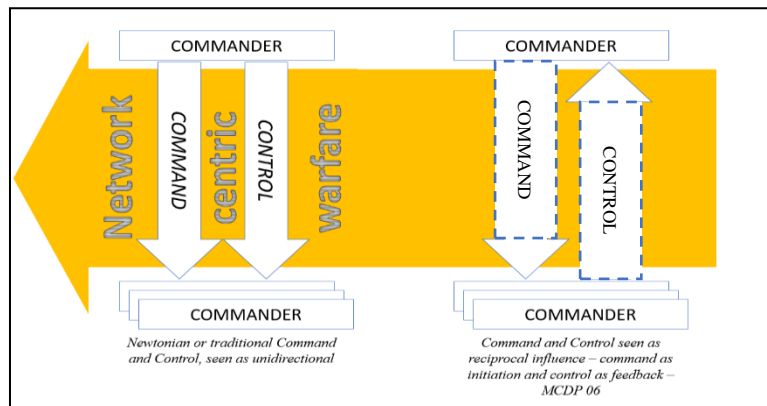


Figure 3: NTW and Command and Control Functions.

acquisition efforts on technological and exquisite equipment.⁴⁴ The natural result is a return to a Newtonian, or traditional Command and Control, where both Command and Control are possibly seen as unidirectional rather than as a reciprocal influence. The potential risk associated with this trend is the micromanagement of

the warfare at the expense of the mission command philosophy. Yet, it is not the only one foreseeable.

A secondary effect of the NCW is the compression of operations and level of war. Given the illusion that operations could be potentially conducted from a remote station, as a pilot of a RQ-1 Predator flies his aircraft, there is less appetite to involve ground forces in a conflict and consequently there is less need for delegation and relocation of HQ on or close to the battlefield. Particularly, if the Strategic Command is co-located with the tactical agents of the war, the operational level might disappear or at least be overlapped by the other two levels.

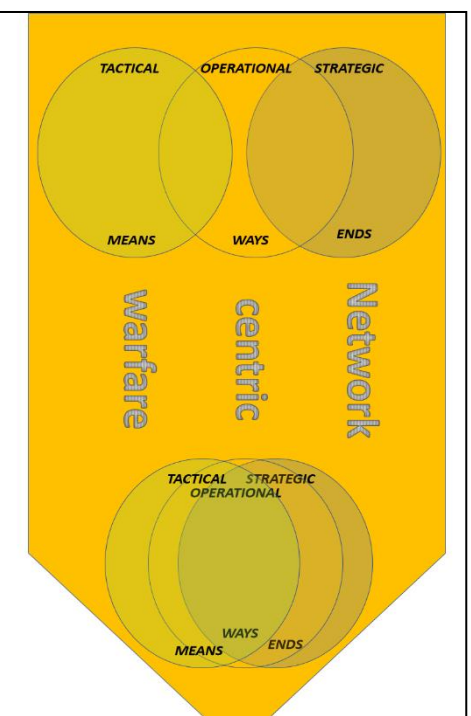


Figure 4: NWF and Levels of Warfare.

So far there are trends between the interwar period and current paradigm that identify continuity in Command and Control.

1. Regardless what doctrine advises⁴⁵, there is more attention in attaining certainty and achieving understanding of the battlefield than what a commander “needs” vice what he “wants”. Normally, a material solution (technologically driven) is the preferred option to that end;
2. One of the keys of success in war is the integration of forces with the delegation of control to tactical agents. The hyper integration, however, has broken the second principle by integrating not only forces in the field but also concentrating in one single shared view of the battlefield. If everybody, from the squad to the geographic combat

command, sees the same picture, there is the desire to control pieces of the battle as a chess player⁴⁶, disrupting the virtuous cycle of feedback;

3. The involvement of human being in the battlefield is something to be avoid as much as possible. As in the interwar period strategist thought to mechanize the battlefield improve the fire-power and to protect soldiers, today paradigm sees the automatization as a primary solution to achieve the victory without involving troops on the ground (at least during first phases of conflict). This trend seems to be unstoppable and dangerous because it seeks to rely on the supposed perfection of the automated execution of a command.

Command and Control in the future

During the interwar period, experimentations in several fields aimed to identify the most effective platform to win the war. Even if integration of all means available at the tactical level created the real asymmetrical advantage, “advocates” of each platform raised their own point at such a level to gain the attention of strategist and ultimately to bring another piece in the mosaic of warfare.

Air power theorists believed that the airplane itself was the game changer in the next conflict, at a level that other “traditional” ways to fight were going to be overshadowed. Among all, Giulio Douhet believed that in times of war there was no longer the distinction between combatants and civilians. Because the war was a matter of nations confronting each other in their entirety, civilians become legitimate targets and the strategic success could only come from airplanes and massive bombardment from the air. In addition, Douhet was convinced that because victory could only come by breaking the enemy’s morale, every solution was an acceptable means to achieve the success, including poisoning civilians with gas. Lastly, it was critical to deny the enemy the ability to build their air forces or resources would have to be repeatedly applied to defeating enemy air fleets.

History has made clear that this absolutist vision was inaccurate. Airpower itself was not the game changer, yet it helped to create an asymmetrical advantage at all levels of warfare combination with other platforms. Perhaps, when the airplane was combined with the nuclear bomb⁴⁷, humanity entered in a new era of warfare⁴⁸, confirming the assumption that integrating/combining available means is the way for success on the battlefield and beyond.

As we are rapidly approaching to an increasingly automated world, some authors indicate that a revolutionary breakthrough is at the door of warfighting and it will change it in such a way

that it “may even challenge the very nature of warfare itself.”⁴⁹ The confrontation between advocates and sceptics of autonomous revolution is open as much it was at the time of Douhet. On one side, advocates are confident that the race toward the superiority in the automation will eventually lead to a war thoroughly fought without humans. Paul Sharre in his “Army of None”⁵⁰ envisions the combination between a developed artificial intelligence and autonomous machines able to plan and execute military operations without any interaction with soldiers, sailors, airmen etcetera. On the other side, a large group of theorists believes that automation will never replace human nature of the war. If history teaches us something, supporters of advanced automation will bring the piece in the mosaic of warfare, leaving in the hands of the next generation of leaders the dilemma whether and how to rely on automated systems or not.

Autonomous systems and autonomous warfare

Autonomy is the right or condition of self-government.⁵¹ Yet, the self-governments implicitly underlies the presence of someone else or something else that can influence the independence. When the concept of autonomy comes to the relationship between the human being and weapon systems, the concept is less clear than it seems. The implication of self-governance and weapons spans from the automatic rifle to U.S. Navy aegis (shield) combat system.⁵² Andrew P. Williams and Paul D. Scharre define,

Machines that perform a function for some period of time, then stop and wait for human input before continuing, are often referred to as ‘semiautonomous’ or ‘human in the loop’. Machines that can perform a function entirely on their own but have a human in a monitoring role, who can intervene if the machine fails or malfunctions, are often referred to as ‘human-supervised autonomous’ or ‘human on the loop’. Machines that can perform a function entirely on their own and humans are unable to intervene are often referred to as ‘fully autonomous’ or ‘human out of the loop’.⁵³

In Williams and Sharre’s definition there are three elements of interest: first, from the machine gun to the robot every machine has a given level of autonomy to perform a specific task whose

complexity defines whether the human being is in/on/out of the loop; second, the loop is the cognitive and physical process by which the operator articulates his will to achieve an objective, more specifically it is the decision-making cycle that John Boyd has synthesized with the acronym O.O.D.A.; third, the definition mentions the relation between a machine and human interaction, yet the machine is “An apparatus using mechanical power and having several parts, each with a definite function and together performing a particular task”⁵⁴, in sum the machine is a system of elements.

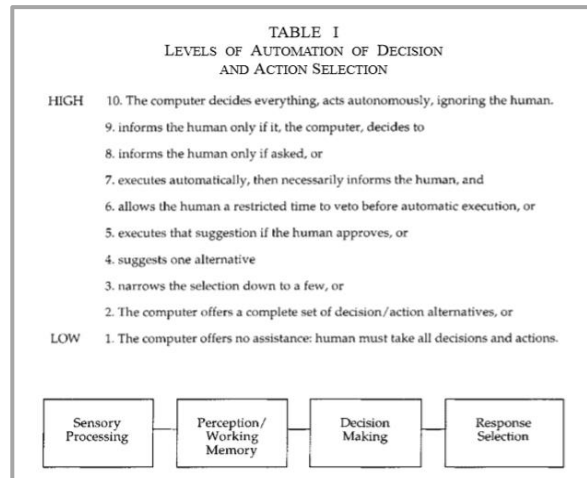


Figure 5: Raja Parasuraman, Thomas B. Sheridan, Fellow, IEEE, and Christopher D. Wickens. May 2000

Marine Corps Doctrinal Publication 1 (MCDP-1) describe war as clash between opposed wills where each belligerent is not guided by a single intelligence because it is a complex system consisting of numerous individual parts.⁵⁵ Two elements are summoned in this description, on one side, warfare can be considered a system of systems, on the other side delegating a certain level of autonomy (self-government) depends on the creation of an autonomous cognitive process able to cope with more abstract and unbounded problems, including those that require an understanding of meanings and values.

The critical factor is the realization of a general artificial intelligence that coordinate multiple modular artificial intelligence integrated in every subsystem of warfare.⁵⁶ It is possible

to deduce that with the sophistication of AI, the future of warfare may involve operations where the decision-maker is completely out of the loop, therefore an autonomous warfare.

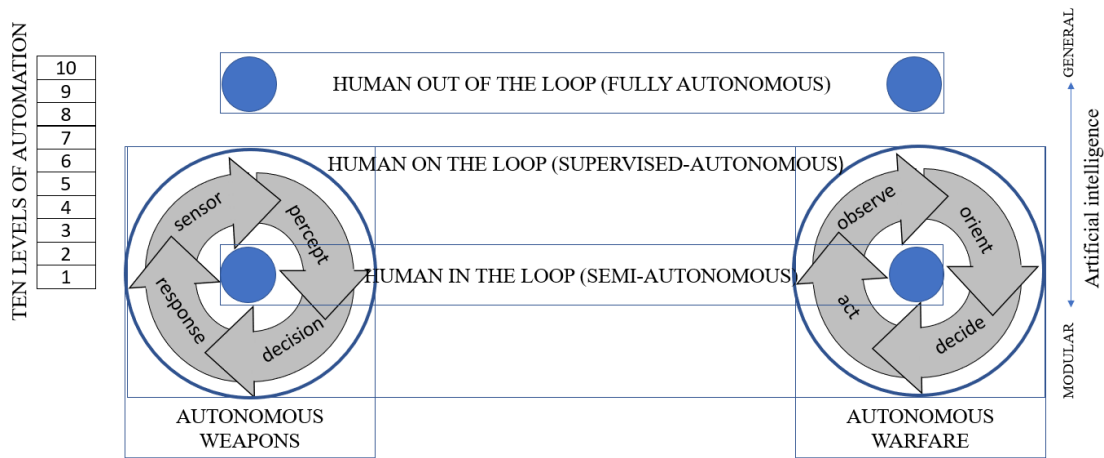


Figure 6: parallelism between autonomous weapons and autonomous warfare

The idea of autonomous warfare carried out by autonomous systems raises critical concerns of existential nature⁵⁷, nevertheless the competition among major powers is pressing the race in the acquisition of AI and AI-integrated systems. China aims to use AI for exploiting large troves of intelligence, generating a common operating picture, and accelerating battlefield decision-making.⁵⁸ Russia continues to pursue its defense modernization agenda, with the aim of robotizing 30% of its military equipment by 2025⁵⁹, while pursuing the integration of different platforms in the development of a swarming capability.⁶⁰ The United States Department of Defense has a more conservative approach to AI. US “Summary of the 2018 Department of Defense Artificial Intelligence Strategy” directs the use AI in a human-centered manner and in particular, enhanced military decision-making and operations across key mission areas, improved situational awareness and decision-making, increasing the safety of operating equipment, implementing predictive maintenance and supply, and streamlining business processes. In addition, the strategy states: “We will prioritize the fielding of AI systems that augment the

capabilities of our personnel by offloading tedious cognitive or physical tasks and introducing new ways of working”.⁶¹

Taking all these approaches together, the trends are:

- automation of information gathering and situational awareness;
- enhanced robotization of the battlefield and integration of platforms;
- augmented decision-making process to keep the speed of machine execution.

Tactical and Strategic implications

There is probably a long way before a general artificial intelligence will be effectively deployed in the battlefield and put the humans “out of the loop”, solving autonomously every problem in warfare.⁶² Current capabilities can operate, and somehow outperform human operators, in specific domains. Nevertheless, the development in technology makes the autonomous systems able to coordinate themselves under the supervision of humans (humans on the loop) and swarm against a given threat, as demonstrated by the US Navy with the Control Architecture for Robotic Agent Command and Sensing.⁶³

At the tactical level, autonomous capabilities give clear advantages to whomever will be able to deploy them. In a 2016 video, Semenov Dahir Kurmanbievich, a Russian inventor, demonstrates how autonomous weapons could easily destroy adversaries’ conventional forces or perform actions of strategic relevance against a senior government leader, exploiting surprise.⁶⁴ The main features of autonomous weapons in battle are low signature, low visibility, low cost, absence of human direct involvement, high precision, durability, interconnection between tactical agents, self-construction, and adaptability. In sum, at the tactical level, it is possible to envision a tapestry of platforms interconnected that can deliver the same or greater fire power with less human and economic costs.⁶⁵ As an example, the USMC is developing robotic war

balls to support the most dangerous phase of amphibious operations, the ship to shore movement. These autonomous systems set the condition for a safer landing of forces, by swarming and storming enemies defense structures ashore.⁶⁶ An attack of this kind can only be defended with systems that operate quickly, with autonomy and intelligence,⁶⁷ feeding the ride to automation.

Domain-specific AI will transform conflict, and like previous transformations in military capability it has the potential to be profoundly disruptive of the strategic balance.

At the strategic level, AI plays two different roles. On one side, the competition on the most performant AI is already re-designing the balance of power on the global scale. Russian President Vladimir Putin stated, “Whoever leads in AI will rule the world” but also that “competition for AI superiority most likely will cause a third world war”.⁶⁸ The US National Security Strategy also recognizes the strategic impact of artificial intelligence, calling for a shared responsibility the private sector in those instances that can affect the national security challenges.⁶⁹ The framework at the strategic level is the rapid achievement of the asymmetrical advantage against competitors by automation, in fact one of the objectives of the last US National Defense Strategy is to “invest broadly in military application of autonomy, artificial intelligence, and machine learning, including rapid application of commercial breakthroughs, to gain competitive military advantages”.⁷⁰

The critical application of AI and Autonomous systems, among others, is the augmented capability to predict patterns, visualize potential threats, as the DARPA’s Knowledge-directed Artificial Intelligence Reasoning Over Schemas (KAIROS)⁷¹, and develop courses of actions more quickly than ever, like the application of AI in wargaming⁷² that can could go through rounds much faster than a human counterpart, and process every possible move simultaneously, providing previously unseen recommendations.⁷³ British General Richard Barrons said, “Open-

source big data and AI will be at the heart of intelligence systems; commercial low-Earth orbit CubeSats will provide much of the imagery formerly done by expensive geo-stationary military satellites - in a far more accessible and low-cost way; unmanned vehicles on land, at sea and in the air will replace some of the humans now in harm's way⁷⁴. The statement reflects a trend that look at security structures, but also the private sector, operating as a system rather than a collection of separate agencies, a whole of government approach⁷⁵ and whole of industry as well, but address, intrinsically, the centralization of the decision-making process on few decision-makers.

The future of the Decision-Making process will probably see the introduction of autonomous technologies impacting significantly on the Observation (O), Orientation (O), and Action (A) phases, and a further centralization the Decision (D) phase.

Perils of autonomy

The automation of armed conflict offers such clear opportunities as to represent the next asymmetrical advantage. In broader terms, autonomous systems are, allegedly, the solution for uncertainty, power projection in contested environment, and economy of (human) forces. Yet, the relationship between humans and autonomous systems is a field not thoroughly explored, in the prospective of Command and Control.

Risk-Free warfare. Chris Coker has noted, political leaders may “become so intoxicated by the idea of precise, risk-free warfare that we believe what we want to believe.”⁷⁶ A traditional Staff assessing the risk of a military intervention is influenced by the bias of imperfect information. A modular AI might help in the near future to analyze and assess risks, with a lesser percentage of error. Such technology is already available in the medical field and it

is considered the world's best diagnostician.⁷⁷ From the political perspective, an alleged risk-free operation has a reduced domestic audience cost⁷⁸ and makes the decision to intervene easier.

Time and Information (out of) control. USMC General James Cartwright in 2007 predicted that “the decision cycle of the future is not going to be minutes...the decision cycle of the future is going to be microseconds⁷⁹”. In the near future, engagement will probably be at the speed-of-light for every one that owns that capability. Future Command and Control architectures will see combined ground and space-based sensors, uninhabited combat aerial vehicles (UCAV), and missile defense technologies, augmented by directed energy weapons. Moreover, the decision-making process (human-based) will be affected by data overload produced by the proliferation of information-based systems.⁸⁰ Given the ability to engage faster, and with smaller agents, the defender will not be able to observe the activity, orient himself, decide how to respond, and act on that decision. The attacker will place himself “inside” the defender’s OODA Loop, invalidating the adversary’s ability to conduct an active defense.⁸¹ The loop of action-reaction-counteraction that has informed the Military Decision-Making Process⁸² so far will become too fast and too unpredictable to be managed in a traditional way. From the Strategic and Operational perspective, the centralization of the decision will be the most preferred to deal with the “flesh war”⁸³ and its required reactivity, the short time available, the information dispersion.

The over reliance on the autonomous agents⁸⁴. Autonomous agents, can cope far better with huge quantities of information, and without susceptibility to cognitive biases. Moreover, autonomous agents are not subject to physical factors like fatigue or to the adoption of human heuristics to make connections in data that may not be warranted.⁸⁵ At the strategic level, those decision-makers assisted by an AI able to offer recommendations, may perceive the

function of automated systems as an ‘oracle’⁸⁶, that will replace the advisory function of a qualified staff. The critical implication is the enhancement of two psychological aspects linked to the decision-making process. On one side, the oracle augments the sense of agency of the decision maker, even if not directly experienced in the warfare.⁸⁷ On the other side, it will supplant the effortful mental activities that a critical decision demands, reducing the relevance of the experienced staff in favor of the speed of a computer-based advice.

Risk of pre-emptive attacks. A semiautonomous warfare will be characterized by integration of systems, information dominance, almost risk-free implication, and amplified stand-off. A modular AI can be programmed to deal with a full range of strategic issues. It is not difficult to envision a tendency to escalation dominance⁸⁸ with the aim to impose the time to the adversary and force it to surrender. All this is profoundly destabilizing and might encourage pre-emptive attacks, as well as prompting developments in asymmetric warfare.⁸⁹ The instantaneous decision-making implied in high-intensity operations, in cyberspace, and in the employment of missiles and unmanned vehicles moving at velocities greater than the speed of light have led to warnings about “hyper-war.”⁹⁰ Clausewitz rightly noted,

the maximum use of force is in no way incompatible with the simultaneous use of intellect. if one side uses forces without computation, undeterred by the bloodshed it involves, while the other side refrains, the first will gain the upper hand that side will force the other to follow suit each will drive its opponent toward extremes, and the only limiting factor are the counterapproaches inherent the war.⁹¹

Conclusions

Technological innovations, such as the ones during the interwar period, give an effective advantage to the possessors. It is indisputable the role of the radio, the radar, the tank, and others for the result of WWII. It is also undeniable that a technological innovation alone cannot change the course of events if it is not integrated in an overarching culture of warfare. In Europe, German *Reichswehr* was able to capitalize on technological innovations by integrating them into a doctrine that pursued fighting at greater distances, with faster execution, and through increasingly combined units. The German general staff became a critical asset to cope with and properly process a greater amount of information, and the *Auftragstaktik*, the command approach of the *Reichswehr*, was improved in the interwar period to serve the same concept of “short and lively.”⁹² Yet, the idea of seeking “short and lively” campaigns was indeed a traditional approach in the German Army, and its roots went far beyond the interwar period. The military culture, founded in the German military tradition, played a primary role in the development of modern and effective tactics that kept the adversary powers unprepared at the beginning of the WWII. For Russel H.S. Stolfi,

Prussia transferred the tradition of a great captain (Frederick I), the flexibility of the reformers of the Napoleonic period (Scharnhorst), the insights of a philosopher of war (Clausewitz), and succinct, practical style of a great chief of staff (Moltke) to a later army of 1914-1945 that continued to have to attack to win. It can be no surprise, therefore, that the German army operated on the offensive more effectively than any other.⁹³

Altogether, new military capabilities and disruptive technology innovations, coordinated through a rooted doctrine and aimed at serving a political scope, led a willing state (Germany) to wage war against less adaptive states (Poland, France, and Russia).

If it is true that the *Auftragstaktik* has influenced the contemporary mission command philosophy⁹⁴ in many modern doctrines as the preferred approach to deal with the uncertainty of

warfare, with current military capabilities commanders can get a technological God's eye view of the entire battlespace with an almost global reach. This very aspect informs the Net-Centric Warfare. Yet, the God's eye view conflicts with the original idea of *Auftragstaktik*. While the German 7th Panzer Division in the invasion of France at the beginning of WWII enjoyed decisional autonomy, the entire chain of command observed from afar the maneuver of the 1st US Marine Division during the invasion in Iraq in 2003, because the HHQ "wanted to know where Land Component units were."⁹⁵ In military operations other than war, such as the counter-insurgency operation in Afghanistan, the level of control at the lowest level is even more critical. As an example, in many cases the targeting approval authority is the theater Commander even if the tactical operation is performed by units at squad/platoon level.⁹⁶ The technology advancement is built to respond to the military leadership need for certainty, despite every doctrinal recommendation to deal with uncertainty and free tactical levels from the ties of a centralized control of operations. This is an irreversible trend engrained at every level of warfare. It may also be the result of a western military culture eager to commit forces to fight quickly, precisely, and distantly but less prone to the indiscriminate use of violence and more careful of human losses (friendly, enemy, or civilians). In this context, the natural result is a return to a Newtonian, or traditional Command and Control, where both Command and Control are possibly seen as unidirectional rather than as a reciprocal influence. Moreover, if the Strategic Command is virtually co-located with the tactical agents of the warfare (through an integrated common operating picture), the operational level may disappear or at least be overlapped by the other two levels. The potential risk associated with this trend is the micromanagement of the warfare at the expense of the mission command philosophy, again.

The integration of autonomous weapons is a key aspect of future warfare. Automation augments the decision-making process and the tactical execution of military actions. Yet, current technologies need a human on the loop, at least. In the near future, the creation of effective autonomous systems, with humans out of the loop, will be real and, whomever possess them, they pose strategic risk because of their impact on the balance of power. The idea of a risk-free war based on ‘oracle’ advice and tireless autonomous weapon systems may find appealing the pursuit of pre-emptive and preventive war appealing as a strategy to acquire the asymmetric advantage over the enemy. Yet, as Clausewitz has advised us, it is possible that such behavior can escalate the confrontation among competitors, rather than achieving a prompt surrender. The same idea of bias-free artificial intelligence is wrong, invalidating the overreliance on a perfect solution. Modular Artificial Intelligence and machine learning, at the foundation of autonomous systems, are limited by the dataset that a human programmer has integrated in the development of the algorithm (therefore biased from the start). In fact, scientific articles caution the use of artificial intelligence in risk-related matters.⁹⁷ At the tactical level, important questions rise from an ethical standpoint. In an information-degraded battlefield, autonomous agents will have the delegation of the control of tactical actions, based on a programmed artificial intelligence that might diverge from a deontological behavior of a just war. All these elements are at the foundations of a moral dilemma for the next political/strategic leadership. Allowing autonomous systems to perform freely their warfare tasks may result in an escalation of the uncontrollable use of violence. On the contrary, restraining the development and use of autonomous systems leaves opposing powers in a position of strategic advantage. The ability to balance the decision-making process between the indiscriminate use of automation or its blind confinement, therefore, can only be achieved through the advisory role of senior and

experienced military leaders that will fill the gap between the ‘oracle-like’ use of the autonomy and the personal human judgment of the political/strategic decision maker.

At the end of this brief research inside the challenges and opportunities of Command and Control in the age of automated decision-making process, the recommendation is to focus the attention on the education of the next-generation of military leaders to prepare them in supporting the decision-maker in such a complex and unpredictable environment.

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